Section 6 - Employer’s Requirements

This Section contains the Specifications, Drawings, Supplementary Information that describe the Works to be procured, Personnel Requirements, and Equipment Requirements.

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| **GENERAL TECHNICAL SPECIFICATIONS** | | |
| **1.** | **SECTION 1 GENERAL** |  |
| **1.1** | **INTERPRETATION OF DOCUMENTS** |  |
| 1.1.1 | Application of the General Specification for Civil Engineering Works | (1) The provisions contained in the Particular Specification and the Drawings shall prevail over the provisions contained in this General Specification for Civil Engineering Works (GS). |
|  |  | (2) The provisions contained in this General Specification for Civil Engineering Works shall prevail over the provisions contained in British Standards, British Standard Codes of Practice and similar standard documents stated in the Contract. |
| 1.1.2 | Abbreviations | (1) The following list shows the meaning of the abbreviations for the common terms used in this GS but is not intended to be exhaustive: |
|  |  | AASHTO: American Association of State Highway and Transportation  Officials  APHA: American Public Health Association  AWWA: American Water Works Association  ANSI: American National Standards Institute  ASTM: American Society for Testing and Materials  BQ: Bills of Quantities  BS: British Standards  BS EN European Standard adopted as British Standards  BS EN ISO European Standards (EN) & International Organization for  Standardization for (ISO) ’s Standards adopted as British  Standards  CBR: California Bearing Ratio  CD: Chart Datum  C & D Construction and demolition  CI Cast iron  CIPP Lining with cured-in-place pipes  CP British Standard Code of Practice  DI Ductile iron  DDF Disposal Delivery Form  DFT Dry film thickness  DN Nominal size  dn Nominal size of tees and tapers  DRS Daily Record Summary  EM&A Environmental Monitoring and Audit  EPA Environmental Protection Agency  ET Environmental Team  FGL Finished ground level, or finished level of the permanent works  GCC General Conditions of Contract  GEO Geotechnical Engineering Office, Civil Engineering and  Development Department  GI Galvanized iron  GS General Specification for Civil Engineering Works  HDPE High-density polyethylene  HSFG High strength friction grip  ISO International Organisation for Standardization  LPG Liquefied petroleum gas  PC Portland cement  PD Principal Datum  PFA Pulverised-fuel ash  PFAC Portland fly ash cement  ppm parts per million  PS Particular Specification  PTFE Polytetrafluoroethylene  PVC Polyvinyl chloride  QPME Quality Powered Mechanical Equipment  RAP Reclaimed asphalt pavement  SCC Special Conditions of Contract  SMM Standard Method of Measurement for Civil Engineering Works  SRPC Sulphate resisting Portland cement  TTS Trip-ticket system  ULSD Ultra-low-sulphur diesel  uPVC un-plasticised polyvinyl chloride  VHS Video Home System  VOC Volatile Organic Compound  WIS Water Industry Specification, Water Research Centre |
|  |  | (2) The following list shows the meaning of the abbreviations for the units used in this GS but is not intended to be exhaustive: |
|  |  | T  °C degrees Celsius  dB decibels  g gram  g/mL gram(s) per millilitre  g/m2 gram(s) per square metre  ha hectare  hr hour  Hz hertz  J joule  kg kilogram  kHz kilohertz  kJ kilojoule  km kilometer  km/hr kilometre(s) per hour  kN kiloNewton  kPa kiloPascal  kV kiloVolt  kW kiloWatt  L litre  L/min litre(s) per minute  L/s litre(s) per second  m metre  m2 m3 m/s square metre cubic metre metre(s) per second  Mg megagram  Mg/m3 min megagram(s) per cubic metre minute  mL millilitre  mm millimetre  mm2 mm3 mm/s square millimetre cubic millimeter millimetre(s) per second  MPa megaPascal  N Newton  N/mm N/m2 Newton(s) per millimeter Newton(s) per square metre  No. number  NTU nephelometric turbidity units  Pa.s Pascal(s) second  r/min revolution(s) per minute  r/s revolution(s) per second  s second  t tonne  µm micrometer(micron)  % percentage |
| 1.1.3 | Glossary of terms | (1) Words and expressions to which meanings are assigned in any section of the GS shall have the same meanings in other sections of the GS except when the context otherwise requires.  (2) Utilities are the installations (including cables, ducts and pipes) used to supply or provide electricity, lighting, traffic control, telecommunications, cable television, gas, water, drainage, sewerage and tramway, including all associated protection, supports, ancillary structures, fittings and equipment. |
| 1.1.4 | Trials and approval | (1) Reference in this GS to the approval of the Engineer shall mean approval given by the Engineer in writing. Materials, methods of construction and any other matters, which have been approved by the Engineer, shall not be changed without the approval of the Engineer to the proposed changes.  (2) Trials shall be carried out as stated in the Contract to demonstrate that proposed materials and methods of construction will produce work which complies with the specified requirements.  (3) Trials shall be carried out before the relevant permanent work starts so as to allow the Engineer a sufficient period to determine if the trial complies with the specified requirements. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before the trial starts.  (4) Trials shall be carried out using materials and methods of construction of the types submitted to the Engineer, and at locations agreed by the Engineer.  (5) If in the opinion of the Engineer, the work that complies with the specified requirements has not been produced in the trial, particulars of proposed changes to the materials or methods of construction shall be submitted to the Engineer. Further trials shall be carried out until the work that complies with the specified requirements has been produced in the trial unless otherwise agreed by the Engineer. Works for which trials are required shall not commence, until in the opinion of the Engineer, the work that complies with the specified requirements has been produced in the trial.  (6) Unless permitted by the Engineer, the materials and methods of construction used to produce the work that complies with the specified requirements in a trial, shall not be changed unless further trials have been carried out to demonstrate that the proposed changes are satisfactory. |
| 1.1.5 | British Standards, Codes of Practice and other standards | (1) Unless otherwise stated in the Contract, reference in this GS to British Standards, British Standard Codes of Practice and similar standards shall be to the latest edition  (2) Later editions of British Standards, British Standard Codes of Practice and other similar standards, or standards which are considered to be equivalent, shall not apply unless approved by the Engineer. The Engineer shall not be bound to give or withhold his approval until the Contractor has provided him with a legal copy of the relevant standard for information. If approval is obtained, the Contractor shall provide two legal copies of the document for use by the Engineer. |
| 1.1.6 | Specifications in metric and imperial units | Specifications in imperial units shall not be substituted for specifications in metric units stated in the Contract unless approved by the Engineer. |
| 1.1.7 | Dimensions from Drawings | Dimensions shall not be obtained by scaling from the Drawings. Dimensions that are not shown on the Drawings or calculable from dimensions shown on the Drawings shall be obtained from the Engineer. |
| **1.2** | **PROGRAMME** |  |
| 1.2.1 | Programme | (1) In addition to the programme to be submitted to the Engineer, the Contractor shall submit within a further 14 days a programme showing a detailed breakdown of the work to be carried out in the first 3 months, and an outline for the remainder of the work. A programme showing the work completed to date, a detailed breakdown of the work to be carried out in the next 3 months and an updated outline for the remainder of the work shall be submitted to the Engineer not later than 4 weeks before the commencement of each subsequent 3-monthly period.  (2) Programmes submitted in accordance with clause **1.2.1** shall be in the form of a bar chart showing the earliest and latest start and finish dates for each activity, and the critical path.  (3) The breakdown of the work to be shown for each Section of the Works on the programme submitted in accordance with clause **1.2.1** shall be comprehensive. It shall include the key activities, key dates and milestones, together with the following:  Work to be carried out, including testing and commissioning,  Fabrication, delivery and installation of materials to be fabricated off the Site,  Delivery of critical materials originating from outside the country  Activities for which the Employer or Engineer is responsible, including the issue of critical drawings and other information, provision of materials by the Employer, nomination and approval of Nominated Sub-contractors and consideration and approval of drawings and proposals, and  Work to be carried out by Government departments, utility undertakings and other contractors.  (4) The Contractor shall be responsible for arranging, co-ordinating and agreeing with the utility undertakings a programme for their works. The Contractor shall make full allowance for time and provision of facilities for the utility undertakings in the preparation of his programmes. |
| **1.3** | **CONTRACTOR'S SUPERINTENDENCE** |  |
| 1.3.1 | Surveyor | (1) The Contractor shall employ on the Site a Surveyor for setting out the Works and for conducting slope and retaining wall record survey.  (2) The Surveyor shall possess a Diploma/Higher Certificate in Land Surveying from a technical institute/polytechnic or university, or equivalent qualification appropriate to the nature of the survey work required for the Contract, plus a minimum of 2 years of relevant experience in engineering surveying. |
| 1.3.2 | Foreman for concrete works | If structural concrete works are included in the Contract, the Contractor shall employ on the Site a Foreman who is suitably experienced in concrete works. The Foreman shall be on the Site at all times when concreting is in progress. |
| **1.4** | **SAFETY** |  |
| 1.4.1 | Safety | (1) The Contractor shall keep on the Site a set of the current Construction Site Safety Manual. Attention of the Contractor is drawn about the need to keep one set of the legislation, regulations and/or codes pf practice on the Site.  (2) Safety precautions for working in sewers, drains and other confined spaces shall comply with the Factories and Industrial Undertakings (Confined Spaces) Regulations. (if any)  (3) Divers shall undergo regular medical checks and obtain certificates of fitness.  (4) Adequate safety equipment including, as appropriate, safety helmets, goggles, ear protectors, safety belts, safety equipment for working in sewers, drains and confined spaces, equipment for rescue from drowning, fire extinguishers, first aid equipment and other necessary safety equipment shall be available on the Site at all times.  (5) Safety equipment, scaffolds, working platforms, ladders and other means of access, and lighting, signing and guarding equipment shall be inspected and maintained regularly. Lights and signs shall be kept clean and easy to read. Equipment that are damaged, dirty, incorrectly positioned or not in working order shall be repaired or replaced immediately.  (6) Posters in both English and Dhivehi to draw attention to safety shall be obtained from the Labour Department and displayed at prominent locations around the Site including site offices, workshops and canteens. |
| **1.5** | **WORK ON ROADS** |  |
| 1.5.1 | Approval for temporary traffic arrangements and control | (1) In addition to any other requirements stated in the Contract, temporary traffic arrangements shall be in accordance with conditions and restrictions imposed by the relevant authority for Transport and the Commissioner of Police. Temporary lighting, signage, guarding and traffic control arrangements shall be in accordance with conditions and restrictions imposed by the relevant authority. Traffic signs that are not prescribed by the Road Traffic regulation or its subsidiary legislation shall be in accordance with conditions and restrictions imposed by the relevant authority for Transport.  (2) The Contractor shall make all arrangements with and obtain the necessary approvals from the relevant authority for Transport, the Commissioner of Police, and any other relevant authority for temporary traffic arrangements and control. |
| 1.5.2 | Temporary traffic arrangements and control | (1) Temporary traffic diversions and pedestrian routes shall be provided where work in roads or footways obstructs existing vehicular or pedestrian access. The relevant work shall not commence until the approved temporary traffic arrangements and control have been implemented.  (2) Temporary traffic arrangements and control for work in roads and footways shall comply with the actual requirements in the Maldives.  (3) Temporary traffic light signals shall be of a type approved by the designated authority and shall comply with the actual requirements in the Maldives  (4) Temporary traffic signs, including posts, backing plates and faces, shall comply with the requirements for traffic signs contained in Section 11 except as stated in clause **1.5.3**  (5) The thickness of backing plates for temporary traffic signs that will be erected for less than 6 months may be reduced to 1.5 mm. The posts for signs may be constructed of timber or other material provided that in the opinion of the Engineer the traffic signs will be stable and safe.  (6) The Contractor shall design the arrangement of information on sign the faces for temporary traffic directional signs. The details of the background, borders and legends, including letters, numerals, characters and symbols, shall comply with the requirements of the relevant authority for Transport.  (7) The Contractor shall inspect and regularly maintain the temporary traffic arrangements and control, both day and night. He shall keep the traffic lights, lights and signs clean and easy to read, and shall immediately repair or replace the equipment that is damaged, dirty, incorrectly positioned or not in working order. |
| 1.5.3 | Particulars of temporary traffic arrangements and control | The following particulars of proposed temporary traffic arrangements and control shall be submitted to the Engineer for approval at least 7 days before the traffic arrangements and control are implemented:  Details of traffic diversions and pedestrian routes,  Details of lighting, signage, guarding and traffic control arrangements and equipment, and  Any conditions or restrictions imposed by the relevant authority for Transport, the Commissioner of Police, or any other relevant authority, including copies of applications, correspondence and approvals. |
| 1.5.4 | Use of roads and footways | (1) Roads, footways and cycle -tracks on the Site shall be maintained in a clean and passable condition and shall not be used to store materials or park constructional plant or other vehicles, other than those required for immediate use on the Works. The construction plant, materials and temporary works shall be placed with minimum interference with or disturbance to the use of any right of way by the public.  (2) Measures shall be taken to prevent excavated material, silt or debris from entering drainage systems in roads, footways and cycle -tracks. Entry of water to gullies shall not be obstructed.  (3) Surfaced roads on the Site and leading to the Site shall not be used by tracked vehicles unless protection against damage is provided.  (4) Construction plant and other vehicles leaving the Site shall be properly cleaned, loaded and covered in such a manner that excavated material, mud or debris is not deposited on roads. Measures to be adopted shall include but not be limited to those specified under clause **23.4.2** and clause **23.5.7** |
| 1.5.5 | Work on roads and footways | (1) Work on roads on the Site shall be carried out in sections such that the length of road occupied at any time does not exceed that stated in the Contract and the width of road occupied at any time does not exceed the width of one traffic lane unless permitted by the Engineer. Work on each section shall be completed and the road shall be reinstated and opened to traffic before work commences on the next section. Work on any section, including loading and unloading, shall be carried out in such a manner that traffic and utilities on the adjacent road and pedestrian access in the adjacent footway are adequately maintained.  (2) Before excavations are carried out on roads or footways, except in areas covered with paving blocks or tiles, the limits of the area to be reinstated shall be bounded by a continuous saw-cut groove. The groove shall be at least 6 mm wide and at least 50 mm deep. Cutting the groove and breaking out the road or footway shall be carried out in such a manner that the adjacent road or footway, including edges, is not damaged.  (3) Excavated material shall not be stored adjacent to excavations in roads or footways unless permitted by the Engineer.  (4) Vehicular access across excavations in roads shall be provided with steel covers. The covers shall be designed to BS 449: Part 2 and shall be capable of withstanding the full load of traffic permitted to use the road. The covers shall be secured in position and shall have anti-skid coating so that the skid resistance values of the covers measured in accordance with BS 3262 shall be not less than 45. Sufficient steel covers shall be kept on the Site adjacent to excavations in roads to permit vehicular access across the excavations in case of emergency. When installed, the steel covers shall be set to be flush with the road surface and shall not result in any noise nuisance by rocking under the action of traffic.  (5) Work on roads, footways and cycle -tracks shall be carefully planned to minimize the period of temporary excavation. If the Contractor is unable to proceed with the works after any excavation is carried out, he shall immediately backfill or temporarily reinstate the excavation.  (6) In respect of works covered by the excavation permits issued by Lands Department as appropriate where the Contractor is the Nominated Permittee and the Employer is the Permittee, the Contractor shall comply with all conditions stated in the excavation permits. |
| 1.5.6 | Reinstatement of roads and footways | Temporary diversions, pedestrian access and lighting, signage, guarding and traffic control equipment shall be removed immediately they are no longer required. Roads, footways and other items affected by temporary traffic arrangements and control shall be reinstated to the condition existing before the work started or to such other condition as may be agreed or instructed by the Engineer. |
| **1.6** | **CARE OF THE WORKS** |  |
| 1.6.1 | Protection from water | (1) Unless otherwise permitted by the Engineer, all work shall be carried out, as near as may be practicable in the circumstances, in dry conditions, except where the work is required to be carried out in or with water or other fluids.  (2) Where necessary and as far as practicable, the Works including materials for use in the Works shall be kept free of water and protected from damage due to water. Temporary drainage, pumping systems or other effective measures approved by the Engineer shall be used. Silt and debris shall be intercepted with traps before water is discharged from the Site.  (3) The discharge points of the temporary drainage and pumping systems shall be approved by the Engineer. The Contractor shall make all arrangements with and obtain the necessary approvals and inspections from the relevant authorities for discharging water to drains, watercourses or the sea. The relevant work shall not start until the approved arrangements for disposal of the water have been implemented.  (4) Measures shall be taken to prevent flotation of new and existing structures. |
| 1.6.2 | Protection from weather | (1) Works shall not be carried out in weather conditions that may adversely affect the works unless protection by methods agreed by the Engineer is provided.  (2) Permanent works, including materials for permanent works, shall be protected by methods agreed by the Engineer from exposure to weather conditions that may adversely affect the work or materials. |
| 1.6.3 | Protection of works | Finished works shall be protected with methods agreed by the Engineer from damage that could arise from the execution of adjacent works. Works shall be carried out in such a manner that works carried out by others, including Government departments, utility undertakings and other contractors, is not damaged. |
| **1.7** | **DAMAGE AND INTERFERENCE** |  |
| 1.7.1 | Damage and interference | (1) Works shall be carried out in such a manner that, as far as is reasonable and practicable, there is no damage to or interference with the following, other than such damage as is required to enable the execution of the Works:  Utilities;  Structures, roads including street furniture, or other property;  Public or private vehicular or pedestrian accesses; and  Trees or graves.  (2) The Contractor shall inform the Engineer as soon as practicable of any item, utility or thing which is not stated in the Contract as requiring diversion, removal or relocation but which the Contractor considers as requiring diversion, removal or relocation to enable the Works to be executed. The Contractor shall not divert, remove or relocate any such item, utility or thing without the prior approval of the Engineer.  (3) Items which are damaged or interfered with as a result of the works being carried out and items which are diverted, removed or relocated to enable the works to be carried out, shall be reinstated to the same service level as was existing before the works started or to such other condition as may be agreed or instructed by the Engineer. |
| 1.7.2 | Utilities | (1) The details of existing utilities are given for information only and the accuracy of the details is not guaranteed. The Contractor shall make his own enquiries and shall carefully excavate inspection pits to locate accurately the utilities indicated to him by the utility undertakings.  (2) Temporary supports and protection to utilities shall be provided by methods agreed by the Engineer. Permanent supports and protection shall be provided if instructed by the Engineer.  (3) The Contractor shall inform the Engineer and the utility undertakings without delay of the following:  Damage to utilities,  Leakage of utilities,  Discovery of utilities not shown on the Drawings, and  Diversion, removal, repositioning or re-erection of utilities, which is required to enable the execution of the Works.  (4) The Contractor shall take all steps necessary to enable the utility undertakings to proceed in accordance with the programme agreed between the Contractor and the utility undertakings clause **1.2.1**. The Contractor shall maintain close liaison with the utility undertakings and shall inform the Engineer of any delays in works by the utility undertakings.  (5) Records of existing utilities encountered shall be kept by the Contractor on the Site with a copy provided for the Engineer. The records shall be agreed by the Engineer and shall contain the following details:  Location of utility,  Date on which utility was encountered,  Nature and size of utility,  Condition of utility, and  Temporary or permanent supports provided.  (6) Further to clause **1.7.1**, the Contractor shall submit for the Engineer's agreement, at least 14 days before any excavation by mechanical plant, a proposal for investigations to ascertain the nature, location and size of existing utilities by hand-dug inspection pits. Such investigations by inspection pits shall not relieve the Contractor of any of the duties, responsibilities, obligations or liabilities imposed upon him by any of the provisions of the Contract.  (7) Unless otherwise agreed by the Engineer in writing, the Contractor shall carry out investigations to locate utilities in accordance with the proposal referred to in clause **1.7.1**. The Contractor shall make his own enquiries with the utility undertakings as and when required and should any utility installations including cover tiles be exposed, the respective utility undertakings shall be contacted to determine if all their utilities have been located. Utility installations including cover tiles shall only be removed by the utility undertakings concerned.  (8) No excavation with mechanical plant shall commence until the nature, location and size of utilities that may be affected by the excavation have been ascertained and the setting-out details have been checked by the Engineer. The nature includes the type of utilities, protective uPVC/GI ducts or conduits, concrete surround, haunching and the like. The location includes the top/bottom levels, the coordinates of the center-lines of the utilities and the like.  (9) The Contractor shall provide adequate and experienced site personnel to control the operation of heavy mechanical plant in the proximity of utilities.  (10) The Contractor shall make arrangements to avoid any heavy mechanical plant or vehicles standing or passing over buried pipe-work in particular those at shallow depths with less than 1 metre overburden cover, especially when the road surface is removed. Unless agreed by the Engineer, the Contractor shall not stockpile any material immediately over or in the vicinity of any pipe-work.  (11) Pursuant to clause **1.7.1**, the Contractor shall carry out the Works in such a manner to avoid any damage or interference with any concrete blocks or structures attached to the utilities. The Contractor shall ensure that all cable draw-pits, valve-pits and the like are not covered up or removed as a result of his works and are accessible by utility undertakings at any time during the course of the Works for emergency repair.  (12) Further to clause **1.7.1**, where utility installations are exposed, the Contractor shall liaise with the utility undertakers about the necessary protection for the exposed utilities and provide temporary protective measures and warning signs to prevent damaging the utility installations. |
| 1.7.3 | Structures, roads and other property | The Contractor shall immediately inform the Engineer of any damage to structures, roads or other property not required for the execution of the Works. |
| 1.7.4 | Access | Alternative access shall be provided if interference with existing public or private vehicular or pedestrian access is necessary to enable the execution of the Works. The arrangements for the alternative access shall be as agreed by the Engineer. The permanent access shall be reinstated as soon as practicable after the works are complete and the alternative access shall be removed as soon as practicable after it is no longer required. |
| **1.8** | **RECORDS** |  |
| 1.8.1 | Records of wage rates | The average, high and low wage rates for workers of each trade employed on the Site shall be entered on monthly wage return forms provided by the Engineer, and the completed forms returned to the Engineer within 4 days of the start of the succeeding month. For the purpose of completing the returns, actual trades shall be entered as the equivalent trades stated in Table 1.1. |
| 1.8.2 | Records of correspondence | Copies of correspondence relevant to execution of the Works (and not of a confidential nature) received from or despatched to Government departments, utility undertakings and other contractors employed by the Employer shall be submitted to the Engineer for information as soon as possible , but in any case not later than 7 days after receipt or despatch. |
| 1.8.3 | Records and reports | Reports and records, which are to be submitted to the Engineer, shall be in a format agreed by the Engineer. Reports and records shall be signed by the Contractor's agent or by another representative authorised by the Contractor. |

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| Table 1.1: Equivalent trades |

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| Actual trade | Equivalent trade |
| Office attendant | Labourer (unskilled) |
| Watchman | Labourer (unskilled) |
| Working ganger | Ordinary worker in the trade in which he is employed or, if the trade is not listed, lorry driver |
| Survey labourer | Contractor's labourer |
| Turf-layer | Contractor's labourer |
| Bituminous material layer | Contractor's labourer |
| Shot-firer | Plasterer |
| Lorry checker | Labourer (unskilled) |
| Motor driver (car/van) | Truck driver |
| Survey leveller | Plumber |
| Welder | Painter |
| Coxswain, barge Engineer | Truck driver |
| Dredger crew, barge crew | Diver's linesman |

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| **1.9** | **LIAISON WITH OTHERS** |  |
| 1.9.1 | Liaison with others | (1) The Contractor shall make all necessary arrangements with and obtain the necessary approvals from Government departments, utility undertakings and other duly constituted authorities for carrying out the Works.  (2) The Contractor shall maintain close liaison with other contractors employed by the Employer, and utility undertakings or other authorities who are carrying out works on or adjacent to the Site. The Contractor shall ensure as far as possible that the progress of the Works is not adversely affected by the activities of such other contractors. |
| **1.10** | **SITE CLEANLINESS** |  |
| 1.10.1 | Site cleanliness | (1) The Site shall be maintained in a clean and tidy condition. Materials, including materials required for Temporary Works, shall be stored in an orderly manner. The measures to be taken shall include but not limited to the following:  Promptly remove all debris and litter on the site including those dumped into the site from outside by the public.  Promptly remove debris and litter not within the site if the debris and litter are in connection with the Works or disposal of by the persons working on the site.  Keep traffic cones, temporary traffic lights and signs clean, secure and in an orderly manner and refurbish, repaint and/or repair hoardings and/or steel barriers half yearly.  Keep passageways clear and free of greasy dirt, waste and timber.  (2) The Contractor shall assign a designated person, with adequate knowledge, experience and authority, for the overall co-ordination, monitoring and overseeing of the performance of the site on cleanliness and control of mosquito breeding. Thereafter, the Contractor shall notify the Engineer of the name and contact telephone number of the assigned person and any subsequent change. |
| 1.10.2 | Prevention of mosquito breeding | (1) Measures shall be taken to prevent mosquito breeding on the Site. The measures to be taken shall include the following:  Empty cans, oil drums, packings and other receptacles that may retain water shall be deposited at a central collection point and those not required for future use shall be removed from the Site regularly.  Standing water shall be treated at least once every week with an oil which will prevent mosquito breeding.  Construction plant and other items on the Site which may retain water shall be stored, covered or treated in such a manner that water will not be retained.  Properly cover all water storage tanks, remove unnecessary stagnant water and disused containers, or use non-hazardous larvicide to prevent mosquito breeding as the last resort. The Contractor shall submit the characteristics, mixing formulation and method of application of the proposed larvicide to the Engineer for approval before its use;  (2) Posters in both English and Dhivehi drawing attention to the dangers of permitting mosquito breeding shall be obtained from the relevant authority and displayed prominently on the Site. |
| 1.10.3 | Prevention of dust | Works shall be carried out in such a manner that avoidable dust is not generated. Measures to be adopted shall include but not be limited to those specified under clause **23.4.2**. |
| **1.11** | **MATERIALS AND EQUIPMENT** |  |
| 1.11.1 | Materials and equipment provided by the Employer | (1) Materials and equipment which are to be provided by the Employer will be as stated in the Contract.  (2) Materials and equipment provided by the Employer shall be collected by the Contractor from the locations stated in Contract and delivered by the Contractor to the Site. The Contractor shall inspect the materials and equipment before taking receipt and shall immediately inform the Engineer of any shortage or damage.  (3) Materials or equipment provided by the Employer which are damaged after collection shall be repaired by the Contractor and submitted to the Engineer for approval. Materials or equipment, which are lost or which in the opinion of the Engineer are not capable of being or have not been repaired satisfactorily, shall be replaced by the Contractor.  (4) Crates and containers for materials or equipment provided by the Employer shall be disposed of by the Contractor.  (5) Equipment and materials provided by the Employer which are surplus to the requirements of the Works shall be returned to the locations stated in the Contract.  (6) The Contractor shall protect and maintain equipment provided by the Employer while it is on the Site and shall provide operatives, fuel and other consumables required to operate the equipment. |
| 1.11.2 | Materials | (1) Materials for inclusion in the permanent works shall be new or other material as stated in the Contract or approved by the Engineer.  (2) Certificates of tests by manufacturers that are submitted to the Engineer shall relate to the material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates cannot be obtained from the manufacturer. A letter from the supplier stating that the certificates relate to the material delivered to the Site shall be submitted with the certificates.  (3) Samples of materials submitted to the Engineer for information or approval shall be kept on the Site and shall not be returned to the Contractor or used in the permanent works unless permitted by the Engineer. |
| **1.12** | **TESTING** |  |
| 1.12.1 | Quality assurance schemes | Tests stated in the Contract may be omitted or reduced in number as agreed by the Engineer if materials or articles delivered to the Site:  Bear the stamp of the registered certification trade mark of the British Standards Institution (BSI), known as the BSI Kitemark, or  are covered by a manufacturer's quality assurance scheme stated in the Contract or approved by the Engineer. |
| 1.12.2 | Batches, samples and specimens | (1) A batch of material is a specified quantity of the material, which satisfies specified conditions such that it may be assumed that all of the material in the batch is of consistent type and quality. If one of the specified conditions is that the material is delivered to the Site at the same time, material delivered to the Site over a period not exceeding 7 days may be considered as part of the same batch if in the opinion of the Engineer there is sufficient evidence that the other specified conditions applying to the batch apply to all of the material delivered over the period.  (2) A sample is a specified amount, or a specified number of pieces or units, taken from a batch for testing, such that the result of tests on the sample can be taken as representing the quality of the batch as a whole.  (3) A specimen is a portion of a sample that is to be tested. |
| 1.12.3 | Samples for testing | (1) For the purpose of this clause and clauses **1.12.4**, **1.12.6** and **1.14.5**, “the Employer’s laboratories” shall mean:  The laboratories currently appointed by the Employer.  (2) Samples for laboratory tests or test locations for insitu tests shall be randomly selected by the Engineer. In addition, the Engineer shall be free to select samples he suspects to be defective. The test locations for insitu tests so selected and, if applicable, the area/extent of Works covered by the tests, shall be traceable by means of either a referenced co-ordinates system or a location plan with defined test positions and levels.  (3) Samples shall be representative and of sufficient size to enable all specified tests to be performed.  (4) Samples shall be taken on Site under close supervision of the Engineer or by the Employer’s laboratories having no direct commercial relationship with the Contractor or material supplier, and shall be clearly, indelibly and individually marked for identification.  (5) Once selected and taken, samples stored on Site before delivery to the place of testing shall remain in the charge of the Engineer or the Employer’s laboratories, who/which shall be given adequate facilities (including sample store room) to keep samples securely under lock and key inaccessible to unauthorised persons at all times.  Samples shall be protected, handled and stored in such a manner that they are not damaged nor contaminated such that the properties of the sample do not change. The method of storage shall comply with the requirements of the relevant test methods.  Where insitu concreting works are to be carried out, the Contractor shall, at the discretion of the Engineer, provide sufficient number of steel container rooms (or the like) and curing tanks for storage and curing test cubes to the satisfaction of the Engineer in accordance with clause **1.14.5**.  (6) Samples shall be collected and delivered by the Contractor under close supervision of the Engineer or by the Employer’s laboratories to the specified place of testing. During transportation from Site to the specified place of testing, all samples shall be securely locked in containers or suitably modified vehicle compartments unless otherwise approved by the Engineer, with keys kept by the Engineer or the Employer’s laboratories.  (7) The transfer of samples from one place/person to another shall be clearly documented and checked. The person receiving the samples shall acknowledge the receipt and confirm the identification of the samples. A record showing:  When, where and by whom the samples are taken, and  Persons who have handled the samples before and during delivery to the place of testing,  shall be prepared and maintained by the Engineer (with assistance of the Employer’s laboratories when necessary) so that the samples de livered from Site to the specified place of testing are traceable.  (8) For those tests where supervisory attendance is essential for providing guidance on Site or for obtaining test data, details of such supervisory site staff present shall be recorded in relevant data sheets and/or sample submission forms to enhance data integrity.  (9) For the purpose of stock control to preclude the swapping of materials under test and where applicable the unauthorised use of materials before receipt of test results, the Contractor shall:  Clearly identify all batches of materials arriving on the Site (the identification marks so designed shall contain information which can reveal the identity of the batch for each type of material such as the Contract number, type of material, batch number and other information as required by the Engineer);  Keep stockpiles and stock items from which samples have been taken pending test results separated from other materials by means of labels denoting “Stock under Test” or similar agreed by the Engineer;  Establish and maintain a record system showing identification marks, testing status of all materials (under test or approved for use or rejected or re-test or omitted for testing, etc.), key dates (e.g. date of testing) and locations of storage; and  In connection with the above, submit a proposal for a stock management system on Site peculiar to the Contract to prevent unauthorised or uncontrolled use of materials for approval by the Engineer at the commencement of the Contract and subsequent supervision by the Engineer.  (10) Samples on which non-destructive tests have been carried out shall be collected from the place of testing after testing and delivered to the Site or other location instructed by the Engineer.  (11) Samples which have been tested may be incorporated in the permanent works provided that:  The sample complies with the specified requirements,  The sample is not damaged, and  Such use as permitted under clause **1.11.2**  (12) Additional samples shall be provided for testing if in the opinion of the Engineer:  Material previously tested no longer complies with the specified requirements, or  Material has been handled or stored in such a manner that it is no longer represented by previously tested samples. |
| 1.12.4 | Testing | (1) Unless otherwise stated in the Contract, insitu tests and laboratory tests shall be carried out by the Employer’s laboratories if the aforesaid tests can be undertaken by the Employer’s laboratories. Testing shall not be carried out in other laboratories unless permitted by the Engineer. If testing is permitted to be carried out by the Contractor:  Independent laboratories with no affiliation as a legal entity to the Contractor or its sub-contractors shall be used,  Accredited Laboratories or institutes for the relevant tests shall be used, if available, in which case results shall be issued on endorsed test reports,  Particulars of the laboratory proposed by the Contractor shall be submitted to the Engineer for approval, and  Tests shall be adequately supervised by the Engineer.  (2) The Contractor shall be entitled to attend testing associated with the Works that is carried out in the Employer’s laboratories, and to inspect relevant records.  (3) Unless otherwise stated in the Contract, equipment, apparatus and materials for insitu tests and laboratory tests carried out by the Contractor shall be provided by the Contractor. The equipment and apparatus shall be maintained by the Contractor and shall be calibrated before testing starts and at regular intervals agreed by the Engineer. The equipment, apparatus and materials for insitu tests shall be removed by the Contractor as soon as practicable after testing is complete.  (4) Workability tests of fresh concrete shall be carried out by skilled personnel of the Contractor. |
| 1.12.5 | Compliance of a batch | (1) Unless otherwise stated in the Contract, the results of tests on samples or specimens shall be considered as representing the whole of the batch from which the sample was taken.  (2) A batch shall be considered as complying with the specified requirements for the material if the results of specified tests for specified properties comply with the specified requirements for the properties.  (3) If additional tests are permitted and separate compliance criteria for the additional tests are not stated in the Contract, the Engineer shall determine if the batch complies with the specified requirements for the material on the basis of the results of all tests, including the additional tests, for every property. |
| 1.12.6 | Raw records of tests and test reports | (1) Raw records of insitu tests and laboratory compliance tests carried out by the Contractor (excluding the laboratories engaged by the Contractor) shall be submitted to the Engineer immediately after the tests, or at such other time stated in the Contract, with a copy of the whole set of records kept by the Contractor on the Site.  (2) For all insitu tests and laboratory compliance tests, a test report shall be submitted to the Engineer in sealed envelope within 7 days, or such other time stated in the Contract, after completion of each test. The report shall contain the following details:  Material or part of the work tested,  Location and area/extent of the batch from which the samples were taken or location and area/extent of the part of the work,  Place of testing,  Date and time of each test,  Weather conditions in the case of insitu tests,  Technical personnel supervising or carrying out the tests,  Size and description of samples and specimens,  Method of sampling,  Properties tested,  Method of testing,  Readings and measurements taken during the tests,  Test results, including any calculations and graphs, and  Other details stated in the Contract.  (3) All test reports compiled by the laboratories (which refer to the Employer’s laboratories and those engaged by the Contractor) shall be delivered directly to the Engineer in a sealed envelope without routing through the Contractor.  (4) Copies of test records carried out through the Employer’s laboratories will be given to the Contractor on request. |
| **1.13** | **WORKMANSHIP AND TOLERANCES** |  |
| 1.13.1 | Workmanship | Workmanship shall comply with best trade practice and with relevant British Standard. |
| 1.13.2 | Tolerances | (1) Tolerances stated in the Contract shall be measured perpendicular to the specified lines unless otherwise stated in the Contract.  (2) If adjacent parts of the Works are subject to different dimensional tolerances then the most critical tolerance shall apply to all such works that relate to each other in respect of dimension, line and level. |
| **1.14** | **SITE ESTABLISHMENT** |  |
| 1.14.1 | Use of the Site | (1) The Site shall not be used by the Contractor for any purpose other than for executing the Works or carrying out other works associated with the Works and approved by the Engineer.  (2) Concrete batching and mixing plant erected on the Site shall not be used to provide concrete for work outside the Site.  (3) Bituminous materials batching and mixing plant erected on the Site shall not be used to provide bituminous materials for works outside the Site.  (4) Rock crushing plant shall not be erected on the Site unless stated in the Contract.  (5) The location and size of stockpiles of materials, including excavated material, within the Site shall be as agreed by the Engineer. Stockpiles shall be maintained in a stable condition.  (6) Entry to and exit from the Site shall be only gained at the locations stated in the Contract or agreed by the Engineer. |
| 1.14.2 | Submission of particulars | (1) The following particulars shall be submitted to the Engineer for approval not more than 14 days of the commencement of the Works:  Drawings showing the layout within the Site of the Engineer's and Contractor's accommodation, project signboards, access roads and major facilities required early in the Contract,  Drawings showing the layout and the construction details of the Engineer's accommodation, and  Drawings showing the details to be included on project signboards.  (2) Drawings showing the location of stores, storage areas, concrete and bituminous materials batching and mixing plants, rock crushing plants and other major facilities not required early in the Contract shall be submitted to the Engineer for approval as early as possible, but in any case not later than 28 days before such facilities are constructed on the Site. |
| 1.14.3 | Survey of the Site | A survey of the Site to establish the precise boundaries of the Site and the levels within the Site will be carried out by the Engineer after site clearance, and before other works start in each area to be surveyed. The Contractor shall carry out the survey jointly with the Engineer and agree the result as soon as practicable after completion of site clearance, before commencing other works in the area surveyed. |
| 1.14.4 | Fences and signs on the Site | (1) Hoardings, fences, gates and signs on the Site shall be maintained in a clean, presentable, stable and secure condition. Logos, pictures and text shall be legible and not visually obstructed at all times.  (2) Project signboards stated in the Contract shall be erected not more than 4 weeks, or such other period agreed by the Engineer, after the date for commencement of the Works. Other advertising signs shall not be erected on the Site unless permitted by the Engineer.  (3) The Engineer’s permission shall be obtained before hoardings, fences, gates or signs are removed. Hoardings, fences, gates and signs that are to be left in position after completion of the Works shall be repaired and repainted as instructed by the Engineer.  (4) All components of site hoardings and signboards shall be metallic and not be made of timber. Bolts and nuts shall be used to join the panels of hoardings and signboards unless otherwise approved by the Engineer. |
| 1.14.5 | The Contractor's Site accommodation | The Contractor's offices, sheds, stores, mess rooms, latrines and other accommodation on the Site shall be maintained in a clean, stable and secure condition. Living accommodation shall not be provided on the Site unless stated in the Contract or approved by the Engineer. |
| 1.14.6 | Site utilities and access | (1) Temporary water, electricity, telephone, sewerage and drainage facilities shall be provided for the Engineer's accommodation and for the Contractor's use in carrying out the Works. The Contractor shall make all arrangements with and obtain the necessary approvals from the relevant authorities for the facilities.  (2) Access roads and parking areas shall be provided within the Site as required and shall be maintained in a clean, passable and stable condition with regular suppression of dust as required in Section 23. |
| 1.14.7 | Clearance of the Site | Temporary Works that are not to remain on the Site after completion of the Works shall be removed on completion of the Works or at other times instructed by the Engineer. The Site shall be cleared and reinstated to the lines and levels and to the condition existing before the Works started except as otherwise stated in the Contract. |
| **1.15** | **MEETINGS** |  |
| 1.15.1 | Meetings | The Contractor's agent shall attend, and shall arrange for the representatives of Sub-contractors, Government departments, transport companies, utility undertakings and other Contractors to attend, meetings when required by the Engineer. The Contractor shall inform the Engineer in 48 hours (or such a shorter period as agreed by the Engineer) before conducting meetings with Government departments, transport companies, utility undertakings and/or other Contractors and shall give the Engineer an opportunity to attend such meetings. |
| **1.16** | **PHOTOGRAPHS** |  |
| 1.16.1 | Photographs | Colour photographs, including underwater photographs, showing the progress of the Works and the quality of the materials and workmanship shall be taken at the times and at locations instructed by the Engineer. Photographs shall be captioned with the time, date and location. Selected prints shall be authenticated by the Contractor and the Engineer by signing the back of the prints and the following shall be provided for the Engineer:  A negative of each photograph,  One 3R print of each photograph,  Albums to store the photographs, and  Framed 8R prints of photographs selected by the Engineer. |
| **2.** | **SECTION 2 SITE CLEARANCE** |  |
| **2.1** | **GENERAL** |  |
| 2.1.1 | General requirements | The works and materials specified in clauses **2.1.2** and **2.1.3** shall comply with the sections stated, unless otherwise stated in this Section |
| 2.1.2 | Pipes and manholes to be abandoned | The abandonment of pipes and manholes shall comply with Section 5 |
| 2.1.3 | Earthworks | Earthworks, shall comply with Section 6. |
| 2.2 | SITE CLEARANCE |  |
| 2.2.1 | Demolition | (1) Areas adjacent to demolition works shall be protected from damage resulting from the demolition.  (2) Structures that are to be demolished shall be surveyed by the Contractor and the result given to the Engineer, before demolition starts.  (3) Particulars of the proposed methods of carrying out demolition works, handling and sorting of recyclable materials and disposal of construction and demolition waste shall be submitted to the Engineer for information at least 14 days before the demolition starts.  The proposed methods shall enhance site safety, maximize recovery of recyclable materials and minimize generation of construction and demolition waste. |
| 2.2.2 | Pipes and cables | The Contractor shall make all arrangements with and obtain the necessary approvals from the relevant authorities for disconnecting utilities inside and outside the Site. The ends of disconnected utilities shall be made good and sealed; the positions of the ends shall be marked with marker posts or by other methods agreed by the Engineer. |
| 2.2.3 | Trees | The Contractor shall comply with the requirements of preservation and protection of existing trees before commencing site clearance. |
| 2.2.4 | Reinstatement | (1) Unless otherwise permitted by the Engineer, areas affected by site clearance shall be reinstated as stated in clause **2.2.4**  (2) Fine fill material shall be deposited and compacted in voids that are left in the ground.  (3) Holes that are left in structures and pavements shall be made good using material similar to that in the adjoining area.  (4) The ends of fences, walls, structures, utilities and other items shall be made good in such a manner that the affected parts will not corrode or deteriorate, and will remain stable.  (5) Straining posts shall be fixed at the end of strained fences that have been cut, and the fences shall be restrained. |
| 2.2.5 | Materials and equipment for re-use and storage | (1) Items that are to be re-used or taken to store shall be dismantled and removed by a suitable method so as to avoid damage or minimise the damage if this is unavoidable. The items shall be cleaned before re-use or taking to store.  (2) Items that are to be re-used in the Works shall be kept in storage areas provided by the Contractor. Storage areas shall be on levelled, well drained and maintained hard-standing ground to facilitate cleansing and minimize dust generation.  (3) Items that are to be taken to the Employer’s store shall be delivered by the Contractor.  (4) Materials or equipment which are to be re-used or taken to store and which are damaged due to the Contractor's negligence shall be repaired by the Contractor by a method agreed by the Engineer. Materials or equipment that are lost or, in the opinion of the Engineer, are not capable of being repaired satisfactorily shall be replaced by the Contractor. Except for items which are to be re-used or taken to store, demolished items, trees, shrubs, vegetation, boulders, debris, rubbish and other items arising from site clearance shall be disposed of by the Contractor and shall become the property of the Contractor when they are removed from the Site. |
| **3** | **SECTION 3 PLANTING AND GARDENING** | **N/A** |
| **4.** | **SECTION 4 FENCING** |  |
| **4.1** | **GENERAL** |  |
| 4.1.1 | General requirements | The works and materials specified in clauses shall comply with the sections stated, unless otherwise stated in this Section. |
| 4.1.2 | Handrailing | Handrailing shall comply with Section 17. |
| 4.1.3 | Earthworks | Earthworks shall comply with Section 6. |
| 4.1.4 | Pedestrian guardrailing | Pedestrian guardrailing shall comply with Section 10. |
| 4.1.5 | Formwork and finishes to concrete | Formwork and finishes to concrete shall comply with Section 13. |
| 4.1.6 | Reinforcement | Reinforcement shall comply with Section 14. |
| 4.1.7 | Concrete | Concrete shall comply with Section 15. |
| 4.1.8 | Steelwork | Steelwork, including protective treatment, shall comply with Section 16. |
| **4.2** | **MATERIALS** |  |
| 4.2.1 | Wire | (1) Wire for fencing, including plastic coated wire, shall be galvanized mild steel complying with BS 4102.  (2) Barbed wire shall consist of two line wires and point wire formed in accordance with BS 4102, Clause 4.1.  (3) Galvanized coating to steel wire shall comply with BS EN 10244-2:2001.  (4) Plastic coating to steel wire shall be green and shall comply with BS 4102, Section 6. |
| 4.2.2 | Chain link fence | Chain link fence shall comply with BS 1722: Part 1 unless otherwise stated in this Section. |
| 4.2.3 | Timber | Timber shall not be used unless approved by the Engineer |
| 4.2.4 | Steel | Steel for fencing shall comply with the following:  Hot rolled sections : BS 4: Part 1  Hot rolled structural steel sections  Equal and unequal angles BS 4848: Part 4  Hollow sections BS 4848: Part 2  Weldable structural steel BS 436 |
| 4.2.5 | Bolts, nuts, washers and fittings | (1) Bolts, nuts and washers for fencing shall comply with the following:  ISO metric black hexagon bolts, screws and nuts : BS 4190  ISO metric black cup and countersunk head, bolts and screws with hexagon nuts: BS 4933  Metal washers for general engineering purposes: BS 4320  (2) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.  (3) Fittings, including eye bolt strainers, cleats, winding brackets, stretcher bars, extension arms, hook bolts and base plates, shall be galvanized mild steel.  (4) Bolts, nuts, washers and fittings for fixing to concrete and timber shall be galvanized. Bolts, nuts, washers and fittings for fixing to steel shall have the same protective treatment as the steel.  (5) Staples shall be D-section galvanized wire. |
| **4.3** | **FABRICATION OF FENCING** |  |
| 4.3.1 | Fabrication of steelwork | Steelwork for fencing shall be fabricated in accordance with BS 5950: Part 2. |
| 4.3.2 | Galvanizing to steel | (1) Steel to be galvanized shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.  (2) Galvanizing to steel shall be applied as far as possible after welding, drilling and cutting are complete. |
| 4.3.3 | Welding steel | (1) Welds to steel for fencing shall be full depth fillet welds. Weld surfaces shall be clean and flush before application of the protective coating.  (2) Steel shall not be welded after galvanizing unless permitted by the Engineer and if permitted, the welded areas shall be free of scale and slag and shall be treated with an alternative galvanizing or zinc coating system approved by the Engineer. |
| **4.4** | **POSTS AND GATES FOR FENCING** |  |
| 4.4.1 | Concrete posts | (1) Concrete posts and struts for fencing shall be precast using Grade 30/10 concrete. The finish to the formed surfaces shall be Class F4 and the finish to the unformed surfaces shall be Class U5. The tops of posts and all arises shall be rounded or chamfered.  (2) Reinforcement for concrete posts and struts shall be Grade 250 plain round steel bars. |
| 4.4.2 | Gates | (1) Steel gates shall be of welded construction. square with the corners mitred or saddled.  (2) The frame shall be Chain link infilling in gates shall be of the same type and size as in the adjoining fence and shall be attached to the framework by stretcher bars. |
| 4.4.3 | Particulars of fencing | (1) The following particulars of the proposed fencing shall be submitted to the Engineer:  Drawings showing the fabrication details of gates, and  Details of the source, type and properties of the proposed materials.  (2) The particulars of the proposed fencing shall be submitted to the Engineer at least 14 days before the fencing is erected. |
| 4.4.4 | Samples of materials | The following samples of the proposed materials shall be submitted to the Engineer at the same time as particulars of the proposed fencing are submitted:  Each type of wire and fitting,  Chain link, and  Recast concrete, steel and timber posts. |
| **4.5** | **STORAGE OF MATERIALS** |  |
| 4.5.1 | Storage of fencing | (1) Gates and concrete and steel posts and struts for fencing shall be stored off the ground on level supports and in a manner which will not result in damage or deformation to the materials or in contamination of the materials.  (2) Fencing shall be protected from damage and damaged fencing shall not be used in the permanent works unless permitted by the Engineer. |
| **4.6** | **ERECTING FENCING** |  |
| 4.6.1 | Alignment of fencing | Fencing shall be erected to a smooth alignment with no abrupt irregularities. The ground shall be trimmed or filled in such a manner that the bottom of the fence will approximately follow the level of the ground. The distance between the bottom of chain link mesh and hoardings and the ground shall not exceed 100 mm and any gap between the bottom of hoardings and the ground shall be sealed to the satisfaction of the Engineer. |
| 4.6.2 | Posts for fencing | (1) Straining posts for fencing shall be provided at all ends and corners, at changes in direction, at abrupt changes in level, at gate posts and at intervals not exceeding 30 m along straight lengths of fencing. Struts shall be fitted to straining posts in the direction of each wire secured to the post.  (2) Intermediate posts shall be provided at intervals not exceeding 3.5 m. |
| 4.6.3 | Erecting posts for fencing | (1) Posts and struts for fencing shall be set in excavations for foundations and the excavations shall be filled with Grade 30/20 concrete up to 50 mm below ground level.  (2) Struts shall be fitted into slots in concrete posts and shall be bolted to steel posts.  (3) The ground surface around posts shall be made good with the same material as in the adjoining area. |
| 4.6.4 | Fixing wire for fencing | (1) Line wire, chain link mesh and barbed wire for fencing shall be strained tightly between straining posts. Winding brackets shall be used for straining between steel posts and winding brackets or eye bolt strainers shall be used for straining between concrete posts. The tension in the wire on each side of straining posts shall be equal. Wire shall not be strained until at least 14 days after concrete has been placed in the foundation.  (2) Chain link mesh shall be secured at each straining post by a stretcher bar and shall be tied to the line wire by tying wire at 150 mm intervals.  (3) Each line wire and each line of barbed wire shall be secured to each intermediate post by one of the following methods as stated in Table 4.1.  A hairpin staple shall be passed through a hole in the post and secured to the wire by three complete turns on each side of the post.  A stirrup shall be passed through a hole in the post and the ends bent over twice.  The wire shall be threaded through a hole in the post.  The wire shall be stapled to the post.  A hook bolt shall be passed through a hole in the post and secured with a nut and washer. |

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| Table 4.1: Method of securing wire to intermediate posts |

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| Type of fence | Type of wire | Type of post | Method of securing wire |
| Strained wire | Line wire | Concrete | (a), (b) or (c) |
| Steel | (a), (b) or (c) |
| Barbed wire | Concrete | (a) or (b) |
| Steel | (a) |
| Chain link | Line wire  Mesh wire | Concrete | (a), (b) or (d) |
| Steel | (a) or (c) |
| Barbed wire | Concrete | (a), (b) or (d) |
| Steel | (a) |

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| 4.6.5 | Fixing gates | Gates shall be hung plumb and shall not be installed until the wire has been strained. |
| **4.7** | **TOLERANCES** |  |
| 4.7.1 | Tolerances: | Fencing shall comply with the following requirements:  The position of posts shall be within 75 mm of the specified position.  The level of the top of posts shall be within 25 mm of the specified level.  Posts shall be vertical to within 5 mm in the height of the post. |
| **5.** | **SECTION 5 DRAINAGE WORKS** |  |
| **5.1** | **GENERAL** |  |
| 5.1.1 | General requirements | The works and materials specified in clauses **5.1.2** to **5.1.8** shall comply with the sections stated, unless otherwise stated in this Section. Hardwood is strictly prohibited for being used in falsework and shoring of trenches and pits unless approved by the Engineer. |
| 5.1.2 | Metalwork | Metalwork for handrailing, ladders, stairs, metal flooring, toe plates and safety chains shall comply with Section 17. |
| 5.1.3 | Earthworks | Earthworks shall comply with Section 6. |
| 5.1.4 | Formwork | Formwork and finishes to concrete shall comply with Section 13. |
| 5.1.5 | Concrete | Concrete shall comply with Section 15, except that recycled aggregates may be used in the concrete if specifically permitted in the relevant clauses of this Section |
| 5.1.6 | Materials for grout | Materials for grout shall comply with Section 15 |
| 5.1.7 | Water supply pipe works | Water supply pipe works shall comply with Section 20. |
| 5.1.8 | Cable duct systems | Cable duct systems for electrical and mechanical installations shall comply with Section 12. |
| 5.1.9 | Recycled Aggregates | Recycled aggregates, if proposed by the Contractor, shall be approved by the Engineer before they are used in drainage works. |
| **5.2** | **GLOSSARY OF TERMS** |  |
| 5.2.1 | Pipes | Pipes for drainage works are pipes for conveying sewage and surface water. |
| 5.3 | MATERIALS |  |
| 5.3.1 | Precast concrete pipes and fittings | (1) Precast concrete pipes and fittings shall comply with BS 5911: Part 100.  (2) Precast concrete pipes and fittings shall have flexible spigot and socket joints. |
| 5.3.2 | Vitrified clay pipes and fittings | (1) Vitrified clay pipes and fittings shall comply with BS 65. The pipes and fittings shall be glazed and shall be the normal chemical resistant type.  (2) Vitrified clay pipes and fittings shall have flexible mechanical joints. |
| 5.3.3 | DI pipes and fittings | (1) DI pipes and fittings shall comply with BS 4772. Pipes and fittings shall be lined internally with cement mortar and shall be coated externally with bituminous coating.  (2) Flexible joints in DI pipes and fittings shall be the push-in type and shall be capable of withstanding a minimum angular deflection of 4°. Flexible joints shall also be capable of withstanding axial movements and shall allow a minimum withdrawal of 38 mm when there is no deflection of the joint.  (3) Flanged joints in DI pipes and fittings shall be PN 16 rating complying with BS 4504: Section 3.1.  (4) Pipes that are to be built in to structures shall have puddle flanges welded on. |
| 5.3.4 | Grey iron pipes and fittings, uPVC pipes and, fittings | (1) Grey iron pipes and fittings shall comply with BS 4622.  (2) uPVC pipes and fittings shall comply with the relevant British Standard stated in Table 5.1.  (3) uPVC pipes and fittings above ground shall have solvent welded spigot and socket joints. uPVC pipes and fittings below ground shall have either solvent welded spigot and socket joints or flexible spigot and socket joints with elastomeric joint rings as stated in the Contract.  (4) Joints and fittings for uPVC pressure pipes complying with BS 3506 shall comply with the following:  Injection moulded uPVC fittings for solvent welding for use with pressure pipes, including water supply : BS 4346: Part 1  Mechanical joints and fittings principally of uPVC : BS 4346: Part 2  (5) Solvent cement for uPVC pressure pipes shall comply with BS 4346: Part 3.  (6) The Class of uPVC pressure pipes complying with BS 3506 shall depend on the pressure rating. |
| 5.3.5 | GI pipes and fittings | (1) GI pipes and fittings shall comply with the following:  Steel tubes and tubulars suitable for screwing to BS 21 pipe threads : BS 1387, medium grade  Pipe threads for tubes and fittings where pressure-tight joints are made on the threads : BS 21  Wrought steel pipe fittings (screwed BSP thread): BS 1740: Part 1.  (2) GI pipes and fittings shall be medium class thickness and shall be galvanized in accordance with BS EN ISO1461: 1999. |

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| Table 5.1: uPVC pipes and fittings |

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| Use | Nominal diameter (mm) | | | British Standard |
| Gravity sewage pipes and fittings above ground | 32 - 50 | | | BS 5255 |
| 82 | - | 160 | BS 4514 |
| Gravity surface water pipes and fittings above ground | 63 | - | 75 | BS 4576: Part 1 |
| 82 | - | 160 | BS 4514 |
| Gravity sewage and storm water pipes and fittings below ground | 110 | - | 160 | BS 4660 |
| 200 | - | 630 | BS 5481 |
| Pressure pipes and fittings above and below ground | 10 | - | 600 | BS 3506 |

|  |  |  |
| --- | --- | --- |
| 5.3.6 | Bolts, nuts and washers | (1) Bolts, nuts and washers for flanged joints, detachable couplings and flange adapters shall comply with the following:  ISO metric black hexagon bolts, screws and nuts : BS 4190  Metal washers for general engineering purposes : BS 4320.  The bolts, nuts and washers shall be hot-dip galvanised in accordance with BS EN ISO1461: 1999 or treated with other suitable coating approved by the Engineer.  (2) Stainless steel bolts and nuts shall comply with BS 6105, steel Grade A4 and property Class 80. Washers shall be Grade 316 S 31 in the softened condition complying with BS 1449: Part 2.  (3) Spheroidal graphite iron bolts shall be Grade 500/7 metal complying with BS 2789.  (4) Bolts, nuts and washers shall be insulated from electrochemically dissimilar metal by non-metallic washers and sleeves.  (5) Bolts and nuts shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint. |
| 5.3.7 | Elastomeric joint rings | (1) Elastomeric joint rings shall comply with BS 2494, Type D. The rings shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.  (2) Elastomeric joint rings for flanged pipes shall be the inside diameter bolt circle type. The rings shall be natural rubber with a thickness of 3.2 mm and with other dimensions complying with BS 4865: Part 1 |
| 5.3.8 | Detachable couplings and flange adapters | (1) Detachable couplings and flange adapters shall be of a proprietary type approved by the Engineer.  (2) Detachable couplings and flange adapters shall accommodate the angular deflection and straight draw stated in Table 5.2 for the different nominal diameters of pipes connected. |

Table 5.2: Angular deflection and straight draw

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nominal diameter of pipe | Detachable coupling | | Flange adapter | |
| Angular deflection | Straight draw | Angular deflection | Straight draw |
| Not exceeding 450 mm | ± 6° | ± 10 mm | ± 3° | ± 5 mm |
| exceeding 450 mm and not exceeding 600 mm | ± 5° | ± 2.5° |
| exceeding 600 mm and not exceeding 750 mm | ± 4° | ± 2° |
| exceeding 750 mm and not exceeding 1200 mm | ± 3° | ± 1.5° |
| exceeding 1200 mm and not exceeding 1800 mm | ± 2° | ± 1° |
| exceeding 1800 mm | ± 1° | ± 0.5° |

|  |  |  |
| --- | --- | --- |
| 5.3.9 | Anticorrosion tape | (1) Anticorrosion tape shall be a proprietary type approved by the Engineer. The tape shall be a rubber/bitumen compound with fabric reinforcement and shall be backed with PVC film. The tape shall have a high resistance to cathodic disbonding, acids and alkalis and shall have the minimum properties stated in Table 5.3.  (2) Anticorrosion tape shall be applied to valves, flanged joints, slip-on couplings and flange adapters. Type 1 shall be used for pipes smaller than 700 mm diameter and Type 2 shall be used for pipes 700 mm diameter and above.  (3) Primer and mastic filler for use with anticorrosion tape shall be compatible with the tape and shall be a type recommended by the manufacturer of the tape and approved by the Engineer. |

Table 5.3: Properties of anticorrosion tape (except where stated the values shown are minimum values)

|  |  |  |
| --- | --- | --- |
| Property | Value | |
| Type 1 | Type 2 |
| Thickness of PVC backing (µm) | 85 | 500 |
| Tensile strength (N/mm) | 8 | 10 |
| Elongation (%) | ≤ 26 | ≤ 26 |
| Tear strength (N) | 20 | 36 |
| Adhesion strength (N/mm) | 2 | 2 |
| Holiday test voltage (kV)   * single layer * double layer | 10  15 | 10  15 |
| Impact strength (J) | 3.5 | 8 |
| Temperature range (°C) | 5 - 60 | 8 - 60 |
| Total thickness (mm) | 1.6 | 2.0 |
| Mass (kg/m2) | 1.8 | 2.4 |

|  |  |  |
| --- | --- | --- |
| 5.3.10 | Bituminous coatings | (1) Bituminous coatings shall comply with the following:  Bitumen based hot applied coating material for protecting iron and steel including suitable primers where required : BS 4147, Type I, Grade C  Black bitumen coating solutions for cold application : BS 3416, Type II.  (2) Bituminous coatings used for repairing joints and coatings shall be compatible with the adjacent coatings. |
| 5.3.11 | Aggregates for granular bed and granular fill | (1) Granular bed shall be Type A material and granular fill shall be Type B material.  (2) Type A or Type B material shall consist of hard, clean, crushed slag, gravel, crushed rock, crushed concrete or crushed inert demolition material having a grading within the limits of Table 5.4. The ten percent fines values shall be at least 50 KN. The material passing the 425 µm BS test sieve shall be non-plastic when tested in accordance with BS 1377.  (3) Type A and Type B materials shall be obtained from a source approved by the Engineer.  (4) Aggregates for granular bed shall have the compacting fraction values stated in clause 5.23.4 |

Table 5.4: Range of grading of Type A and Type B materials

|  |  |  |
| --- | --- | --- |
| BS test sieve | Percentage by mass passing | |
| Metric | Type A | Type B |
| 63 mm | - | 100 |
| 37.5 mm | 100 | 85 – 100 |
| 20 mm | - | 0 – 20 |
| 10 mm | 45 - 100 | 0 – 5 |
| 3.35 mm | 25 - 80 | - |
| 600 µm | 8 - 45 | - |
| 75 µm | 0 - 10 | - |

Table 5.5: Joint filler for concrete bed, haunch and surround

|  |  |
| --- | --- |
| Nominal diameter of pipe | Thickness of joint filler (mm) |
| less than 450 mm | 18 |
| 450 mm - 1200 mm | 36 |
| exceeding 1200 mm | 54 |

|  |  |  |
| --- | --- | --- |
| 5.3.12 | Joint filler and compressible padding | (1) Joint filler for joints in concrete bed, haunch and surround shall be a firm, compressible, single thickness, non-rotting filler. The thickness of the filler shall be as stated in Table 5.5.  (2) Compressible padding between pipes and supports shall be bitumen damp-proof sheeting complying with BS 743. |
| 5.3.13 | Polyethylene sheeting | Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm. |
| 5.3.14 | Precast concrete manholes | Precast concrete manhole units shall comply with BS 5911: Part 200. Cover slabs and reducing slabs shall be reinforced as required to comply with the load test requirements stated in BS 5911: Part 200. |
| 5.3.15 | Chambers and gullies | (1) Precast concrete chambers and gullies shall comply with BS 5911: Part 2. Cover slabs shall be reinforced as required to comply with the load test requirements stated in BS 5911: Part 2. The types of cement for the manufacture of precast concrete chambers and gullies, and cover slabs shall be as stated in BS 5911: Part 2, or a combination of PFA and PC or PFAC complying with BS EN 197-1. The PFA content shall not exceed 40% by mass of the cementitious content.  (2) Vitrified clay gullies shall comply with BS 65. |
| 5.3.16 | Step irons | Step irons shall comply with BS 1247. Step irons shall be malleable cast iron complying with BS 6681 and shall be hot-dip galvanized in accordance with BS EN ISO 1461: 1999. |
| 5.3.17 | Manhole covers, gully gratings and kerb overflow weirs | (1) Manhole covers, gully gratings and kerb overflow weirs shall be Grade 150 cast iron complying with BS 1452. Bolts and nuts shall comply with BS 4190.  (2) Covers, gratings and weirs shall be cleanly cast, free of air holes, sand holes, cold shuts and chill and shall be neatly dressed and fettled. Castings shall be free of voids whether due to shrinkage, gas inclusions or other causes. Bolts and nuts shall not be over-tightened.  (3) The dimensions of the different types of covers, gratings and weirs shall be as stated in the Contract. The test loads which the covers and gratings are required to withstand, and the minimum masses of covers gratings and weirs, shall be as stated in Tables 5.6, 5.7 and 5.8.  (4) Covers, gratings and weirs shall have the manufacturer's name cast integrally with the unit in a raised form and shall be protected with bituminous coating. Covers shall have a raised design on the top surface as stated in the Contract. |

Table 5.6: Details of manhole covers and frames

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of manhole cover and frame | Minimum  mass (kg) | Grade | Test requirements | |
| Diameter of block (mm) | Test load (t) |
| Double triangular manhole cover and frame | 180 | Medium duty | 100 | 5 |
| Double triangular manhole | 130 | Heavy duty | 300 | 30 |
| cover for sewers |  |  |  |  |
| Frame | 105 | Heavy duty | 300 | 30 |
| Double triangular desilting | 290 | Heavy duty | 300 | 30 |
| manhole cover for sewers |  |  |  |  |
| Frame | 165 | Heavy duty | 300 | 30 |
| Double seal terminal manhole | - | Heavy duty | 300 | 20 |
| cover for sewers |
| - Type MA2-29/29A & B |
| - Type MA2-45/45A & B | - | Heavy duty | 300 | 20 |
| - Type MC2-29/29A & B | - | Medium duty | 100 | 5 |
| - Type MC2-45/45A & B | - | Medium duty | 100 | 5 |

Table 5.7: Details of gully gratings and frames

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of gully grating and frame | Minimum  mass (kg) | Grade | Test requirements | |
| Diameter of block (mm) | Test load (t) |
| Grating for hinged gully grating  Type GA2-325  Frame | 28.0  24.5 | Heavy duty  Heavy duty | 300  300 | 20  20 |
| Grating for double triangular | 57.5 | Heavy duty | 300 | 20 |
| gully grating Type GA1-450 |  |  |  |  |
| Shallow frame |  |  |  |  |
| - adjacent to kerb | 33.5 | Heavy duty | 300 | 20 |
| - away from kerb | 36.5 | Heavy duty | 300 | 20 |
| Deep frame |  |  |  |  |
| - adjacent to kerb | 40.5 | Heavy duty | 300 | 20 |
| - away from kerb | 44.0 | Heavy duty | 300 | 20 |
| Grating for hinged gully | 61.5 | Heavy duty | 300 | 20 |
| grating Type GA2-450 |  |  |  |  |
| Frame | 37.0 | Heavy duty | 300 | 20 |

Table 5.8: Details of kerb overflow weirs

|  |  |
| --- | --- |
| Type of kerb overflow weir | Minimum mass (kg) |
| Type 1-325 | 39.5 |
| Type 3-325 | 31.5 |
| Type 1-450 | 44.0 |
| Type 3-450 | 36.5 |
| Type 4-450 | 33.0 |

|  |  |  |
| --- | --- | --- |
| 5.3.18 | Penstocks | N/A |
| 5.3.19 | Gate valves | N/A |
| 5.3.20 | Flap valves | N/A |
| 5.3.21 | Sludge valves | N/A |
| 5.3.22 | Air valves | N/A |
| 5.3.23 | Fittings for penstocks and valves | N/A |
| 5.3.24 | Filling abandoned pipes and manholes | N/A |
| **5.4** | **SUBMISSIONS** |  |
| 5.4.1 | Particulars of pipes, joints and fittings | (1) The following particulars of the proposed pipes, joints and fittings for drainage works shall be submitted to the Engineer:  Manufacturers’ literature, including details of:  manufacturing process  pressure and temperature ratings  permissible values of straight draws and angular deflection of flexible joints  recommendations for handling, storage, laying, jointing and repair  drilling and tapping equipment for connections to pipes, and  A certificate for each material showing the manufacturer's name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests required in accordance with the Contract.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 5.4.2 | Particulars of anticorrosion tape and joint filler | (1) The following particulars of the proposed anticorrosion tape and joint filler for drainage works shall be submitted to the Engineer:  Manufacturer’s literature for anticorrosion tape, and  Certificates for anticorrosion tape and joint filler showing the manufacturer’s name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests in accordance with the Contract.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 5.4.3 | Particulars of aggregates for granular bed | (1) A certificate for each type of aggregate showing the source of the aggregate and showing that the aggregate complies with the requirements stated in the Contract, and including the results of tests in accordance with the Contract, shall be submitted to the Engineer for the proposed aggregates for granular bed for drainage works.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the aggregate to the Site and thereafter each time the source is changed. |
| 5.4.4 | Particulars of manholes, chambers and gullies | (1) The following particulars of the proposed materials for manholes, chambers and gullies for drainage works shall be submitted to the Engineer:  A certificate for each type of manhole and chamber unit and for each type of gully showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests required in accordance with the Contract,  A certificate for step irons showing the manufacturer's name, the date and place of manufacture and showing that the step irons comply with the requirements stated in the Contract, and including results of tests required in accordance with the Contract, and  A certificate for each type of manhole cover, gully grating and kerb overflow weir showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests in accordance with the Contract.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 5.4.5 | Particulars of penstocks and valves | N/A |
| 5.4.6 | Particulars of foam concrete and PC/PFA grout | N/A |
| 5.4.7 | Particulars of tests | N/A |
| 5.4.8 | Particulars of diversions of flow | N/A |
| **5.5** | **TRANSPORT, HANDLING AND STORAGE OF MATERIALS** |  |
| 5.5.1 | Transport, handling and storage of pipes, joints and fittings | (1) Pipes, joints and fittings for drainage works shall be transported, handled and stored in accordance with the manufacturer’s recommendations and in a manner which will not result in damage or deformation to the pipes, joints and fittings or in contamination of the pipes, joints and fittings.  (2) Pipes, joints and fittings shall be protected from damage and damaged pipes, joints and fittings shall not be used in the permanent work unless permitted by the Engineer.  (3) uPVC pipes, joints and fittings shall be protected from exposure to conditions which may affect the material.  (4) Bolts and nuts shall be packed in sealed metal containers.  (5) Elastomeric joint rings shall be packed in bags and lubricant for joints shall be stored in sealed containers marked to identify the contents. The rings and lubricant shall be protected from exposure to conditions that may affect the material. |
| 5.5.2 | Handling of pipes and fittings | (1) Pipes and fittings shall be handled manually or by using lifting appliances or chains, wire rope or canvas slings of a type recommended by the pipe manufacturer and agreed by the Engineer. Hooks shall not be used.  (2) Slings shall be placed around the pipes and fittings and padding shall be provided at points of contact between pipes and fittings and metal lifting appliances or slings. Pipes shall not be handled by means of metal slings passed through the pipes.  (3) Pipes and fittings shall not be subjected to rough handling, shock loading or dropping and shall not be rolled down ramps unless permitted by the Engineer. If permitted, the ramps shall be padded. |
| 5.5.3 | Storage of pipes | (1) Pipes shall be stored horizontally at least 75 mm above the ground on wedged timber bearers. The bottom layers and the outer pipes in each layer shall be securely wedged to prevent sideways movement.  (2) Socket and spigot pipes shall be stored with the sockets alternating and in such a manner that loads are not applied to the sockets.  (3) The height of stacks of pipes shall not exceed 2 m unless recommended by the manufacturer and permitted by the Engineer.  (4) Pipes shall not be strung out along the route of the pipeline unless permitted by the Engineer. |
| 5.5.4 | Storage of anticorrosion tape and joint filler | Anticorrosion tape and joint filler shall be stored in accordance with the manufacturer's recommendations in a dry, weatherproof store with a raised floor. |
| 5.5.5 | Handling and storage of aggregates for granular bed | Aggregates for granular bed shall not be handled or stored in a manner that will result in mixing of the different types and sizes or in contamination of the aggregates. Different types and sizes of aggregates shall be stored in separate stockpiles. |
| 5.5.6 | Handling and storage of units for manholes, chambers and gullies | (1) Units for manholes, chambers and gullies shall be lifted only at the lifting points recommended by the manufacturer and shall not be subjected to rough handling, shock loading or dropping.  (2) Units for manholes, chambers and gullies shall be stored off the ground on level supports and in a manner that will not result in damage to the units or in contamination or deformation of the units. The units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer. |
| 5.5.7 | Storage of covers, gratings, weirs penstocks and valves | Manhole covers, gully gratings, kerb overflow weirs, penstocks and valves, including fittings, shall be stored off the ground on level supports and in a manner which will not result in damage to the units or in contamination or deformation of the units. The units shall be protected from damage and damaged units shall not be used in the permanent work unless permitted by the Engineer. |
| **5.6** | **EXCAVATION** |  |
| 5.6.1 | Excavation | (1) Excavation for any section of a trench for drainage works shall not commence until the nature, location and size of existing utilities which may be affected by the excavation have been ascertained and the setting out details have been approved by the Engineer.  (2) The effective trench width of trenches for drainage works shall not exceed the relevant effective trench widths stated in Table 5.9 for the different diameters of pipe. The effective trench width shall be measured as stated in the Contract. |

|  |
| --- |
| Table 5.9: Effective trench widths |

|  |  |
| --- | --- |
| Nominal diameter of pipe (mm) | Effective trench width (mm) |
| 100 | 550 |
| 150 | 600 |
| 225 | 700 |
| 300 | 750 |
| 375 | 1050 |
| 450 | 1150 |
| 525 | 1200 |
| 600 | 1350 |
| 675 | 1450 |
| 750 | 1500 |
| 825 | 1600 |
| 900 | 1900 |
| 975 | 2000 |
| 1050 | 2050 |
| 1125 | 2200 |
| 1200 | 2300 |
| 1350 | 2450 |
| 1500 | 2600 |
| 1650 | 2800 |
| 1800 | 2950 |
| 1950 | 3150 |
| 2100 | 3350 |
| 2250 | 3400 |
| 2400 | 3500 |
| 2550 | 3650 |
| 2700 | 3800 |
| 2850 | 3950 |
| 3000 | 4150 |

|  |  |  |
| --- | --- | --- |
| **5.7** | **LAYING AND BEDDING PIPES** |  |
| 5.7.1 | Laying pipes | (1) The Contractor shall allow the Engineer to inspect trenches, bedding, pipes, joints, fittings and valves before pipe-laying for drainage works starts. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before pipe-laying starts in any part of the permanent work.  (2) The permission of the Engineer shall be obtained before pipe-laying starts in any part of the permanent work.  (3) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after pipe-laying. Valves shall be inspected to ensure that they are in working order and are capable of being fully opened and closed. Deleterious material shall be removed and damage shall be repaired immediately before and after pipe-laying.  (4) The inside of pipelines shall be kept clean and free of water, dirt, stones, debris and deleterious material. Except when pipes are being jointed, the open ends of pipelines shall be sealed with a wooden plug or stopper or by other methods agreed by the Engineer.  (5) Measures shall be taken to prevent flotation of pipes.  (6) Pipe-laying, testing and backfilling shall follow as closely as practicable on excavation of the trench.  (7) Unless otherwise permitted by the Engineer, pipelines shall be laid in an uphill direction with sockets facing uphill.  (8) Pipes shall be laid in such a manner that water will not pond in locations with zero or shallow gradients and such that the pipes will comply with the specified tolerances. |
| 5.7.2 | Bedding pipes | (1) Surfaces on which pipes for drainage works will be laid shall be cleaned and objects that may damage the pipes shall be removed before pipes are laid.  (2) The bottom of trenches on which pipes will be laid directly shall be shaped to support the pipes uniformly along the length of the barrel. Holes shall be dug to prevent pipes resting on the sockets and to allow the pipes to be jointed. |
| **5.8** | **CUTTING PIPES** |  |
| 5.8.1 | Cutting pipes | (1) Pipes for drainage works shall be cut and the ends shall be prepared in accordance with the manufacturer’s recommendations. Purpose-made equipment recommended by the manufacturer or approved by the Engineer shall be used for cutting the pipes.  (2) Cut ends of pipes shall be square or cut to the correct angle and without damage to the pipe or coating. Cut ends shall be trimmed and chamfered to suit the type of joint and in such a manner that elastomeric joint rings will not be damaged by the cut end.  (3) Pipes requiring to be cut to form closing lengths shall not be cut until adjacent pipes have been laid and jointed and the length to be cut can be accurately measured.  (4) Reinforcement in precast concrete pipes that are cut shall be cut back flush with the concrete and protected with epoxy resin or by other methods agreed by the Engineer.  (5) Pipes which terminate at the inside face of structures shall be cut such that the end of the pipe is flush with the face. |
| **5.9** | **JOINTING PIPES** |  |
| 5.9.1 | Jointing pipes | (1) Pipes for drainage works shall be jointed in accordance with the manufacturer’s recommendations and using jointing equipment and jointing materials recommended by the manufacturer or approved by the Engineer.  (2) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after jointing. Deleterious material shall be removed and damage shall be repaired immediately before and after jointing. Surfaces that are to be jointed and jointing materials shall be cleaned immediately before jointing. Pipes shall be cleaned out with clean water.  (3) All joints in pipelines shall be watertight.  (4) The widths of gaps at joints shall be in accordance with the manufacturer’s recommendations and shall be achieved by marking the outside of the pipe, by using metal feelers or by other methods agreed by the Engineer. The position of elastomeric joint rings shall be checked by using metal feelers after jointing.  (5) Gaps at joints in pipes shall be protected after jointing, by methods agreed by the Engineer, to prevent dirt, stones or other material entering the joint. |
| 5.9.2 | Flanged joints | (1) Flanged joints in pipes for drainage works shall be made as stated in clauses 5.9.2.  (2) Bolts holes in flanged joints and joints incorporating bolted components shall be correctly orientated before the bolts are tightened. The correct size of bolts and nuts shall be used. Bolt threads shall be lubricated and bolts shall be tightened using the correct size of spanner. Bolts shall be tightened in diametrically opposite pairs working around the bolt circle until all bolts are tightened to the torque recommended by the manufacturer.  (3) Bolt holes in flanged joints shall be orientated symmetrically about the vertical diameter with no bolt holes on the vertical diameter. Elastomeric joint rings shall be the correct size and shall not protrude into the bore of the pipe. The rings may be temporarily fixed to the face of the flange using a minimum amount of adhesive of a type recommended by the manufacturer. Jointing compound or paste shall not be used for this purpose |
| 5.9.3 | Flexible collar joints | (1) Flexible collar joints in pipes for drainage works shall be made as stated in clauses 5.9.3.  (2) The elastomeric joint rings shall be placed in position inside the grooves of the sleeve. The ends of the pipes shall be well smeared with lubricant over a distance of at least 100 mm from the end of the pipe.  (3) The sleeve shall be placed on the end of the laid pipe and pushed home to the location mark on the pipe. The location mark shall be at a distance of half the length of the sleeve minus 3 mm from the end of the pipe unless otherwise recommended by the manufacturer.  (4) The pipe that is to be jointed to the laid pipe shall be placed in the sleeve and pushed home to the location mark on the pipe. |
| 5.9.4 | Push-in joints | Push-in joints in pipes for drainage works shall be made by smearing the elastomeric joint ring with lubricant and placing the ring in position on the spigot end of the pipe. The spigot shall be placed in the socket of the laid pipe and pushed home. |
| 5.9.5 | Detachable joints | (1) Detachable joints in pipes for drainage works shall be jointed as stated in clauses 5.9.5.  (2) Both CI flanges, the elastomeric joint rings and the central collar shall be placed over the ends of the pipes before the pipes are placed to the required line and level. A gap of between 5 mm and 6 mm shall be left between the ends of the pipes.  (3) The flanges, elastomeric joint rings and central collar shall be moved into position at the ends of the pipes. The central collar shall be positioned centrally over the gap between the ends of the pipe before the bolts are tightened. |
| 5.9.6 | Flange adapters | Joints with flange adapters in pipes for drainage works shall be made by placing the flange adaptor on the plain end before the bolts are tightened. |
| 5.9.7 | Solvent welded joints | Solvent welded joints in pipes for drainage works shall be made by applying solvent cement to the pipes to be jointed and pushing the pipes home. Excess solvent shall not be applied and surplus solvent shall be removed after jointing. Solvent welded pipes jointed outside the trench shall not be placed in the trench until the solvent setting period recommended by the manufacturer has elapsed. In addition, any material or thing contaminated by the solvent shall not be left in the pipe or trench. |
| 5.9.8 | Screw joints | Screw joints in pipes for drainage works shall be made using a threaded coupler. The threaded surfaces of the pipes and coupler shall be cleaned and the threads shall be painted with two coats of bituminous paint. The pipe thread shall be wrapped with three turns of spun yarn or other material approved by the Engineer and the joint tightened using purpose- made tools. Coal tar compounds or white lead paint shall not be used. Locking nuts to branch connections shall be tightened. Branch connections shall not protrude inside the pipe. |
| **5.10** | **PROTECTION OF JOINTS** |  |
| 5.10.1 | Protection of joints | (1) Flanged joints, detachable couplings and flange adapters on buried pipes for drainage works shall be protected as stated in clauses 5.10.1.  (2) The joint, including bolts and nuts, shall be cleaned to remove all moisture, dust, oil, grease and deleterious material. Bolts and nuts shall be painted with two coats of bituminous point and the joint shall be coated with primer. Mastic filler shall be applied in such a manner that all depressions, corners and voids between the bolts and nuts are filled and a smooth surface is available on which to apply the anticorrosion tape.  (3) At least two layers anticorrosion tape shall be applied to all parts of the joint and to the adjacent pipe for at least 200 mm beyond each end of the joint. The tape shall be applied in accordance with the manufacturer's recommendations and shall be wrapped spirally around the joint and pipe with at least 55% overlap per spiral.  (4) The tape shall be moulded manually after application to take up the contours of the parts being protected. |
| **5.11** | **REPAIRS TO COATINGS AND LININGS** |  |
| 5.11.1 | Repairs to coatings and linings | Damage to coatings and linings of pipes for drainage works shall not be repaired unless permitted by the Engineer. If permitted, repairs shall be carried out using materials recommended by the manufacturer and approved by the Engineer. |
| **5.12** | **THRUST AND ANCHOR BLOCKS** |  |
| 5.12.1 | Thrust and anchor blocks | (1) Thrust or anchor blocks shall be used to resist forces at bends, branches and stopends in pressure pipelines for drainage works except where self anchoring joints are used. Concrete for thrust and anchor blocks shall be Grade 20. The aggregates for the Grade 20 concrete shall be natural stone, crushed rock, crushed concrete or recycled aggregates.  (2) The bearing face, and other faces stated in the Contract, of concrete anchor and thrust blocks shall be cast directly against undisturbed ground. The faces of excavations shall be trimmed to remove loose material before concreting. Excavation required for the block beyond the trench width shall be carried out after the pipe or fitting has been jointed. Excess excavation beyond the face at the block shall be filled with concrete of the same Grade as the block.  (3) Internal pressure shall not be applied to the pipeline until thrust and anchor blocks have developed the specified grade strength. |
| **5.13** | **BED, HAUNCH AND SURROUND** |  |
| 5.13.1 | Granular bed | (1) The granular bed to pipelines for drainage works shall be constructed as stated in clauses 5.13.1.  (2) Aggregates for the granular bed shall be deposited in the trench in layers not exceeding 150 mm thick and for the complete width of the trench. Each layer shall be compacted using a plate vibrator or by other methods agreed by the Engineer.  (3) Holes shall be dug in the granular bed to prevent pipes resting on the sockets and to allow the pipes to be jointed. The pipes shall be laid directly on the granular bed. Temporary supports shall not be used.  (4) After the pipes have been jointed, aggregate shall be deposited in layers not exceeding 150 mm thick equally on both sides of the pipe to the specified level for the complete width of the trench. Each layer shall be compacted using a plate vibrator or by other methods agreed by the Engineer. |
| 5.13.2 | Concrete bed, haunch and surround | (1) The concrete bed, haunch and surround to pipelines for drainage works shall be constructed as stated in clauses 5.13.2.  (2) Concrete for the concrete bed, haunch and surround shall be Grade 20.  (3) Polyethylene sheeting or a blinding layer shall be placed on the trench bottom before concreting.  (4) Pipes shall be supported at the required level by Grade 20 precast concrete wedges, blocks or cradles or by other methods agreed by the Engineer. One support shall be placed adjacent to each end of each pipe and the spacing between supports shall not exceed 3 m. Compressible sheeting shall be placed between the pipes and supports.  (5) Flexible joints shall be formed in the concrete bed, haunch and surround at flexible joints in pipelines. Joint filler shall be placed next to the flexible joint in the pipeline and shall extend for the complete thickness of the bed, haunch and surround.  (6) Concrete shall be placed evenly over the complete width of the bed and over the complete length of the pipe being concreted up to a level of 25 mm below the underside of the pipe. Concrete shall then be placed on one side of the pipe only and worked under the pipe until the concrete spreads under the pipe. Concrete shall then be placed equally on both sides of the pipe to the specified level.  (7) Pipes for drainage works which are 1 m or less below the surface of a carriageway shall be protected with Grade 20 concrete surround.  (8) The aggregate for Grade 20 concrete stated in (1) to (7) of this clause shall be natural stone, crushed rock, crushed concrete, or recycled aggregates if available and if proposed by the Contractor. Such Grade 20 concrete shall have the following minimum cementitious content:  Exposure condition\* Minimum cementitious content (kg/m3) Moderate 280  Severe 330  [\* Exposure condition shall be as stated in the Contract] |
| 5.13.3 | Fill material surround | Fill material surround to pipelines for drainage works shall be deposited and compacted as stated in clauses 6.9.6 and 6.10.1. |
| **5.14** | **TOLERANCES** |  |
| 5.14.1 | Tolerances: pipelines for drainage works | (1) Except as stated in clause 5.14.1 pipelines for drainage works shall comply with the following requirements:  The line of gravity pipelines shall be within 20 mm of the specified line.  The invert level of gravity pipelines shall be within 6 mm of the specified invert level and shall be such that there is no backfall at any point.  The line of pressure pipelines shall be within 50 mm of the specified line.  The invert level of pressure pipelines shall be within 20 mm of the specified invert level.  (2) Termination pipes in pipelines for drainage works which are designed to connect to pipes or fittings laid by others shall comply with the following requirements:  The position of the centre of the termination face of the pipe in the longitudinal direction shall be within 10 mm of the specified position.  The position of the centre of the termination face of the pipe in the lateral direction shall be within 3 mm of the specified position.  The gradient of the termination pipe shall be within 0.5° of the specified gradient.  The invert level at the termination face of the pipe shall be within 3 mm of the specified invert level. |
| **5.15** | **CONNECTIONS** |  |
| 5.15.1 | Connections to structures | (1) The joints between pipes for drainage works and structures into which the pipes are built shall be watertight. Protective coatings shall be removed over the length to be built in before the pipe is built in. Pipe collars and sockets shall not be built in to structures.  (2) Two flexible joints shall be provided in pipelines adjacent to the outside faces of structures into which pipes will be built. The distances from the outside face of the structure to the first joint and from the first joint to the second joint shall be as stated in Table 5.10.  (3) The ends of pipes, which are built in to structures, shall be temporarily sealed with a blank flange, brickwork or timber boarding as instructed by the Engineer. The temporary seals shall be left in position until the Engineer instructs their removal. |

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| Table 5.10: Flexible joints at structures |

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| Diameter of pipe | Position of first flexible joint From structure | | Distance of second flexible joint from first flexible joint |
| Minimum | Maximum |
| not exceeding 450 mm | 150 mm | 500 mm or diameter  of pipe, whichever is less | 450 mm - 800 mm |
| exceeding 450 mm but not exceeding 1050 mm | 900 mm - 1200 mm |
| exceeding 1050 mm | 1500 mm - 1800 mm |

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| 5.15.2 | Connections to pipes | (1) Pipe saddles shall be connected to concrete or vitrified clay pipes by bedding the saddle on a cement mortar bed and forming a cement mortar fillet to provide at least 50 mm cover to the base of the saddle. Cement mortar shall consist of cement and sand in the proportions 1:3 by mass.  (2) uPVC pipe saddles shall be fixed to uPVC pipes by means of a purpose-made mechanical clip or solvent cement of a type recommended by the manufacturer and approved by the Engineer.  (3) Unless otherwise agreed by the Engineer, branch pipelines shall be connected to main pipelines using Y-junctions of the same type and strength as the stronger of the pipes being jointed. The angle of the Y-junction shall be between 30° and 45°.  (4) Pipes which are to be connected to concrete or clay pipes without a Y-junction or purpose-made pipe saddle shall be cut on a splay to form a junction such that the incoming pipe is at an angle of between 30° and 60° to the main pipe upstream of the joint. The hole that is cut in the main pipe to which a connection is to be made shall be of a suitable elliptical shape to suit the cut end of the branch pipe. The length of the branch pipe shall be such that:  The cut end of the pipe rests on the outside barrel of the main pipe, and  The cut pipe does not project inside the main pipe.  The joint between the cut pipe and the main pipe shall be sealed externally and, unless otherwise permitted by the Engineer, sealed internally flush with the main pipe with cement mortar. Cement mortar shall consist of cement and sand in the proportions 1:3 by mass.  (5) The positions of the pipe junctions relative to the manhole or structure immediately downstream shall be measured and recorded before backfilling.  (6) The ends of connecting pipes, which are not required for immediate use, shall be sealed with a blank flange, brickwork or other methods instructed by the Engineer and the position measured and recorded before backfilling. |
| **5.16** | **CHAMBERS, GULLIES, MANHOLES, AND CHANNELS** |  |
| 5.16.1 | Manholes, chambers and gullies | (1) Bases, inverts and benching for precast concrete manholes shall be constructed in-situ using Grade 20 concrete, unless otherwise stated in the Contract.  (2) Precast concrete units for manholes and chambers shall be set vertically with step irons staggered and vertically aligned above each other. Joints between precast units shall be the rebated type and shall be sealed with cement mortar. Lifting holes shall be filled with cement mortar. Surplus cement mortar shall be removed and joints shall be pointed.  (3) Concrete surround to manholes, chambers and gullies shall be Grade 20 concrete. Joints in concrete surround shall be staggered by at least 150 mm from joints in the precast units. Concrete surround to gullies shall be placed up to the sides of the excavation.  (4) The frames for manhole covers and gully gratings shall be set to the same levels as the surrounding surface, allowing for falls and cambers, using brickwork and/or concrete as specified in the Contract. The number of courses of brickwork used below frames shall not exceed three and the minimum grade for concrete shall be Grade 20.  (5) Cement mortar for fixing manhole covers and gully gratings in position and bonding brickwork shall consist of cement and sand in the proportions 1:3 by mass.  (6) Excavations around manholes and chambers in carriageways shall be filled using Grade 10 concrete up to the carriageway formation level. Fill material for excavations around other manholes and chambers shall be fine fill material. |
| 5.16.2 | Concrete open channels | (1) The top surfaces of side-walls of concrete open channels shall be constructed to the same levels as the adjoining permanent works. Excess excavation beyond the channel walls shall be filled with Grade 10 concrete.  (2) Expansion joints in concrete channels shall comply with Section 15. Expansion joints shall be provided at intervals of 10 m maximum in all concrete channels. Joints for channels, berm slabs, aprons and walls etc. shall be on the same alignment. |
| **5.17** | **MARKER BLOCKS** |  |
| 5.17.1 | Marker blocks | (1) The ends of pipes that do not terminate at a manhole, chamber, gully or structure shall be marked with marker blocks. The blocks shall be 150 mm x 150 mm x 150 mm and shall be constructed using Grade 20 concrete.  (2) A wire shall be connected from a hook on the underside of the block to the plug on the end of pipes.  (3) Marker blocks shall be set flush with level of the adjacent permanent works and shall have the letters `CD' marked on the upper surface. |
| **5.18** | **INSTALLATION OF PENSTOCKS AND VALVES** |  |
| 5.18.1 | Installation of penstocks and valves | N/A. |
| **5.19** | **PIPES AND MANHOLES TO BE ABANDONED** |  |
| 5.19.1 | Pipes and manholes to be abandoned | (1) If the top of a pipe or culvert, or the bottom of a manhole, chamber or gully, which is to be abandoned is 1 m or less below the finished ground level, the pipe, manhole, chamber or gully shall be removed and disposed of unless otherwise permitted by the Engineer. The void shall be filled with foam concrete, granular fill material, special fill material (or recycled aggregates proposed by the Contractor) as directed by the Engineer.  (2) If the top of a pipe or culvert, or the bottom of a manhole, chamber or gully, is more than 1 m below the finished ground level, the pipe, culvert, manhole, chamber or gully shall be filled with foam concrete or grout as stated in clause 5.3.24.  (3) Manholes, chambers and gullies that are to be abandoned shall be demolished to 1 m below finished ground level unless otherwise stated in the Contract. Abandoned pipes, culverts, manholes, chambers and gullies shall be filled with foam concrete or grout, by pumping or by gravity. The lowest point of abandoned pipelines shall be sealed with concrete, bricks or by other methods approved by the Engineer. Filling shall start from the lowest point and shall continue until all voids are completely filled. |
| **5.20** | **CLEANING OF PIPELINES** |  |
| 5.20.1 | Cleaning of pipelines | (1) Pipelines for drainage works shall be cleaned by pigging, by high- pressure water jetting or by other methods agreed by the Engineer. Manholes and chambers shall be cleaned and washed. Cleaning shall be carried out after:  the pipeline has been tested,  Temporary Works required for testing have been removed, and  parts of the pipeline removed for testing have been reconnected.  (2) Unless otherwise permitted by the Engineer, pipelines shall be cleaned not more than 7 days before the pipeline is handed over.  (3) Materials excavated/cleared from pipelines shall be disposed of at dumping site(s) provided by the Contractor or the Employer. They shall be handled in an environmentally responsible manner without causing pollution or nuisance to the public as far as possible. In particular :  Materials excavated/cleared shall either be placed in bags as soon as possible after excavation or, if they are temporarily stockpiled on roads/footpaths or areas close to the public, be covered and underlain by tarpaulin sheets to minimize fouling of the ground and escape of odour. The ground shall be cleansed after removal of the materials.  The materials shall be dewatered before disposal in accordance with the requirements of the dumping site if necessary. During transportation of the materials, measures shall be taken to prevent leakage of foul water onto roads and public areas and escape of odour. |
| **5.21** | **INSPECTION OF PIPELINES** |  |
| 5.21.1 | Inspection of pipelines | Unless otherwise permitted by the Engineer, the cleanliness, bore, linearity and joints of pipelines of 450 mm diameter or less shall be checked by pulling a mandrel through the completed pipeline, or parts of the pipeline if permitted by the Engineer, after cleaning. The mandrel shall be 750 mm long and 12 mm less in diameter than the nominal diameter of the pipe. |
| 5.21.2 | Inspection of pipelines by CCTV | The procedure for internal inspection of pipelines by CCTV shall be as existing regulation or similar |
| **5.22** | **TESTING: PIPES FOR DRAINAGE WORKS** |  |
| 5.22.1 | Batch: pipes for drainage works | A batch of pipes or fittings for drainage works is any quantity of pipes or fittings of the same type and nominal diameter, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time. |
| 5.22.2 | Samples: pipes for drainage works | Unless otherwise required by the Engineer, one sample of pipe for drainage works and each type of fitting shall be provided from each 50 pipes or fittings or part thereof in a batch. |
| 5.22.3 | Testing: pipes for drainage works | (1) Unless otherwise permitted by the Engineer, each sample of pipes and fittings for drainage works shall be tested in accordance with the relevant British Standard.  (2) The method of testing shall be in accordance with the following:  Concrete pipes and fittings : BS 5911: Part 100  Vitrified clay pipes, fittings and joints : BS 65  Ductile iron pipes and fittings : BS 4772  Grey iron pipes and fittings : BS 4622  uPVC pipes for industrial  purposes : BS 3506  uVC soil and ventilating pipes,  fittings and accessories : BS 4514  uPVC rainwater goods : BS 4576: Part 1  uPVC underground drain  pipes and fittings : BS 4660  Plastic waste pipes and  fittings : BS 5255  uPVC pipes and fittings for  gravity sewers : BS 5481 |
| 5.22.4 | Non-compliance: pipes for drainage works | (1) If the result of any test required in accordance with the relevant British Standard for pipes and fittings for drainage works does not comply with the specified requirements for the test, one additional sample shall be provided from the same batch and additional tests for the property shall be carried out.  (2) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property. |
| **5.23** | **TESTING: AGGREGATES FOR GRANULAR BED** |  |
| 5.32.1 | Batch: aggregates for granular bed | A batch of aggregates for a granular bed is any quantity of aggregates for granular bed of the same type, produced at the same time in the same place, covered by the same certificates and delivered to the Site at any one time. |
| 5.32.2 | Samples: aggregates for granular bed | (1) Unless otherwise permitted by the Engineer, one sample of aggregates for a granular bed shall be provided from each batch of aggregates for granular bed delivered to the Site.  (2) The size of each sample shall be 40 kg.  (3) The method of sampling shall be in accordance with BS 812: Part 102.  (4) The moisture content of the sample shall be representative of the moisture content of the material in the batch. |
| 5.23.3 | Testing: aggregates for granular bed | Each sample of aggregates for a granular bed shall be tested to determine the particle size distribution and the ten percent fines value in accordance with BS 812:Part 103 and BS 812:Part 111, and the compaction fraction value in accordance with existing standards or similar |
| 5.23.4 | Compliance criteria: compaction fraction value | The results of tests for compaction fraction value of aggregates for a granular bed shall comply with the following requirements:  The compaction fraction value for a bed for pipes not exceeding 300 mm nominal diameter shall not exceed 0.3.  The compaction fraction value for a bed for pipes exceeding 300 mm nominal diameter shall not exceed 0.15. |
| **5.24** | **TESTING: PRECAST CONCRETE UNITS FOR MANHOLES, CHAMBERS AND GULLIES** |  |
| 5.24.1 | Batch: manholes, chambers and gullies | A batch of precast concrete units for manholes, chambers or gullies is any quantity of precast concrete units for manholes, chambers or gullies of the same type and size, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time. |
| 5.24.2 | Samples: manholes, chambers and gullies | Unless otherwise permitted by the Engineer, one sample of precast units for manholes, chambers or gullies shall be provided from each 50 precast concrete units for manholes, chambers or gullies or part thereof in a batch. |
| 5.24.3 | Testing: manholes, chambers and gullies | (1) Unless otherwise permitted by the Engineer, each sample of precast concrete units for manholes, chambers or gullies shall be tested in accordance with the relevant British Standard.  (2) The method of testing shall be in accordance with the following:  Precast concrete units for manholes : BS 5911: Part 200  Inspection chambers and gullies : BS 5911: Part 2. |
| 5.24.4 | Non-compliance: manholes, chambers and gullies | (1) If the result of any test required in accordance with the relevant British Standard for precast concrete units for manholes, chambers or gullies does not comply with the specified requirements for the test, one additional sample shall be provided from the same batch and additional tests for the property shall be carried out.  (2) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property. |
| **5.25** | **TESTING: MANHOLE COVERS, GULLY GRATINGS AND KERB OVERFLOW WEIRS** |  |
| 5.25.1 | Batch: covers, gratings and weirs | A batch of manhole covers, gully gratings or kerb overflow weirs is any quantity of covers, gratings or weirs of the same type, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time. |
| 5.25.2 | Samples: covers, gratings and weirs | One sample of manhole covers, gully gratings or kerb overflow weirs shall be provided from each 20 covers, gratings or weirs or part thereof in a batch. |
| 5.25.3 | Testing: covers, gratings and weirs | (1) Each sample of manhole covers, gully gratings or kerb overflow weirs shall be weighed and subjected to a load test.  (2) The method of testing shall be as stated in existing standards or similar. The test loads shall be as stated in Table 5.6 and Table 5.7. |
| 5.25.4 | Compliance criterion: resistance to fracture of covers and gratings | Manhole covers and gully gratings shall withstand the test load without fracturing or cracking. |
| 5.25.5 | Non-compliance: mass of covers, gratings and weirs | (1) If any manhole cover, gully grating or kerb overflow weir does not comply with the specified requirements for mass, every cover, grating and frame in the batch shall be weighed to determine its mass.  (2) If any cover, grating or weir does not comply with the specified requirements for mass, it shall not be used in the permanent work. |
| 5.25.6 | Non-compliance: resistance to fracture of covers and gratings | (1) If any manhole cover or gully grating does not comply with the specified requirements for resistance to fracture, two additional samples shall be provided from the same batch and tested to determine their resistance to fracture.  (2) The batch shall be considered as not complying with the specified requirements for resistance to fracture if the result of any additional test does not comply with the specified requirements for resistance to fracture. |
| **5.26** | **TESTING: WATERTIGHTNESS OF PENSTOCKS** |  |
| 5.26.1 | Testing: watertightness of penstocks | N/A. |
| 5.26.2 | Compliance criteria: watertightness of penstocks | N/A |
| 5.26.3 | Non-compliance: watertightness of penstocks | N/A |
| **5.27** | **TESTING: GRAVITY PIPELINES FOR DRAINAGE WORKS** |  |
| 5.27.1 | Testing: gravity pipelines for drainage works | (1) Gravity pipelines for drainage works shall be tested as stated in clause 5.27.1.  (2) Gravity pipelines for sewage shall be tested by the methods stated in Table 5.11 at the following times:  After the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, and  After haunch and surround has been placed and fill material has been deposited and compacted, and  Not more than 7 days before the pipeline is handed over.  (3) Gravity pipelines for surface water shall be tested by the methods stated in Table 5.11 at the following times:  After the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, or  After haunch and surround has been placed and fill material has been deposited and compacted.  (4) Water tests and air tests on pipelines shall be carried out on the complete pipeline between manholes, chambers and structures. Pipelines shall not be tested in parts unless permitted by the Engineer or unless the specified test pressure would otherwise be exceeded. Short branch pipelines shall be tested with the main pipeline and long branch pipelines shall be tested separately.  (5) Infiltration tests shall be carried out on the complete pipeline between manholes, chambers and structures, including manholes, chambers and branches within the pipeline system.  (6) The method of testing shall be in accordance with existing standards or similar |

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| Table 5.11: Testing gravity pipelines |

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| Type of pipeline | Diameter of pipeline | Time of test | Method of testing |
| Sewage | Not exceeding 900 mm | As clause 5.27.1 (2)(a) | Water test or air test |
| As clause 5.27.1 (2)(b) | Water test or air test |
| As clause 5.27.1 (2)(c) | Infiltration test |
| Sewage | Exceeding 900 mm | As clause 5.27.1 (2)(a) | Visual inspection |
| As clause 5.27.1 (2)(b) | Water test or air test |
| As clause 5.27.1 (2)(c) | Infiltration test |
| Surface water | Not exceeding 900 mm | As clause 5.27.1 (3)(a) or  As clause 5.27.1 (3)(b) | Water test or air test |
| Surface water | Exceeding 900 mm | As clause 5.27.1 (3)(a) | Visual inspection |
| As clause 5.27.1 (3)(b) | Water test or air test |

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| 5.27.2 | Compliance criteria: gravity pipelines for drainage works | The results of tests on gravity pipelines for drainage works shall comply with the following requirements:  The leakage of water from the pipeline determined by the water test shall not exceed the permitted leakage calculated in accordance with existing standards or similar  There shall be no discernable leakage from the pipe or from any joint during the water test.  The air pressure shall remain above 75 mm head of water at the end of the air test.  There shall be no infiltration or damage to pipes or joints as determined by the visual inspection. |
| 5.27.3 | Non-compliance: gravity pipelines for drainage works | If the result of any test on gravity pipelines does not comply with the specified requirements for the test, the Contractor shall investigate the reason.  Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be re-tested. |
| **5.28** | **TESTING: PRESSURE PIPELINES FOR DRAINAGE WORKS** |  |
| 5.28.1 | Testing pressure pipelines for drainage works | (1) Pressure pipelines for drainage works shall be tested as stated in clauses 5.28.1.  (2) The pipeline shall be tested at the following times:  After the pipes have been jointed and the bedding has been placed and immediately before haunch or surround is placed or fill material is deposited, and  After haunch and surround has been placed and fill material has been deposited and compacted.  (3) The test stated in clauses 5.28.1 shall not be carried out on parts of a pipeline unless permitted by the Engineer or unless the specified test pressure would otherwise be exceeded. The test stated in clauses 5.28.1 shall be carried out on the complete pipeline.  (4) The test pressure shall be as stated in the Contract. If the test pressure is not stated in the Contract, the test pressure shall be 1.5 times the maximum working pressure in the part of the pipeline tested.  (5) Tests shall not be carried out simultaneously on more than one pipeline in the same trench.  (6) The method of testing shall be in accordance with existing standards or similar.  (7) Testing of pressure pipelines by means of tests on individual joints shall not be carried out instead of tests stated in Clauses 5.28.1 unless permitted by the Engineer. If permitted, the method of testing and the compliance criteria shall be as approved by the Engineer. |
| 5.28.2 | Compliance criteria: pressure pipelines for drainage works | The results of tests on pressure pipelines for drainage works shall comply with the following requirements:  The leakage of water from the pipeline determined by the pressure test shall not exceed the permitted leakage calculated in accordance with existing standards or similar  There shall be no discernable leakage of water from the pipeline or from any joint during the pressure test. |
| 5.28.3 | Non-compliance: pressure pipelines for drainage works | If the result of any test on pressure pipelines for drainage works does not comply with the specified requirements for the test, the Contractor shall investigate the reason.  Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be re-tested. |
| **5.29** | **REPAIR OF PIPELINES AND CULVERTS BY INTERNAL LINING** |  |
| 5.29.1 | General | (1) The internal lining for repair of cracking and leakage in drainage pipelines and culverts shall be specifically developed and manufactured by a proprietary manufacturer for such purpose, and be of the following types:  Lining with cured-in-place pipes (CIPP);  Other types of lining approved by the Engineer.  (2) The lining shall be installed in the whole length of pipeline/culvert from manhole to manhole, installed in part of the pipeline/culvert between two manholes, or be a sleeve for repair of a short section of the pipeline/culvert as specified in the Contract.  (3) Grouting of the annular space between the lining and the wall of the existing pipe shall comply with Section 7 Part 4. |
| 5.29.2 | Materials | (1) Cured-in-place lining shall be a tube of fibrous materials manufactured from synthetic or mineral fibre, impregnated with a resin that is thermosetting, ambient-cured or otherwise. The tube may contain plastic coatings and/or reinforcement material. The materials shall comply with Section 4 of Water Industry Specification WIS 4-34-04: “Specification for Renovation of Gravity Sewers by Lining with Cured-in-place Pipes”, Water Research Centre, March 1995: Issue 2 or equivalent standards.  (2) Other types of linings shall conform to internationally recognised specifications and their manufacturer’s specifications. |
| 5.29.3 | Design of lining | The lining shall be designed by the Contractor in accordance with the procedures given in “Sewerage Rehabilitation Manual”, 4th Edition, Water Research Centre, 2001. The material shall be designed to resist external loading as well as stresses developed during installation and during its lifetime. Linings for repair of pipes with leakage and/or minor structural deficiencies only shall be able to resist external loading due to ground water pressure. Linings for repair of pipes in poor structural condition which cannot withstand existing design loading shall be able to resist all external loading including traffic loads, earth loads and ground water pressure. The external loadings to be designed for are either specified in the Contract or will be determined by the Engineer on a case-by-case basis. |
| 5.29.4 | Submissions | (1) The following particulars of the proposed lining materials and methods of carrying out the lining works shall be submitted for approval by the Engineer before commencement of works :  Materials and equipment for the works, method of installation, method of sampling and design statement with supporting calculations;  Reports of tests on the lining materials including type tests on short term and long term structural properties to support the design calculations;  Performance tests to be carried out on the finished lining and the compliance criteria of such tests;  Arrangements for dealing with lateral branch connections along the pipeline to be lined, if any;  Where grouting is required, the details of grout mix, including admixtures;  Where grouting is required, the method of grouting, including grouting stages, order of working, re-grouting, controlling of seepage, methods of monitoring and instrumentation.  (2) When requested by the Engineer, the Contractor shall submit a certificate showing that the manufacturer has provided adequate training to the Contractor’s staff in respect of the relevant skills in proper production, handling and installation of the lining. The certified personnel shall submit a method statement to the Engineer. |
| 5.29.5 | Installation of lining | (1) The lining shall be installed by means of trenchless method. No excavation is permitted unless the Contractor can demonstrate that access through manholes is not adequate for installation.  (2) Before installation, the Contractor shall clean and clear the pipeline thoroughly and remove all loose material, deposits and obstructions that may affect the proper installation of the lining.  (3) After cleaning the surfaces of the pipeline and before installation of the lining, a CCTV confirmatory survey shall be carried out as required. All pertinent information such as the position, size and angle of approach of all lateral connections shall be recorded and logged. The Contractor shall submit a sample log sheet to the Engineer for approval. On completion of installation of lining and before re-commissioning the pipeline, a CCTV post-installation survey shall be carried out. The Contractor shall provide two copies of a video record of the CCTV confirmatory survey and the post-installation survey, where required to be carried out, and two copies of log sheets to the Engineer within 2 working days of completion of the lining works.  (4) The method of installation shall follow the manufacturer’s recommendations, or approved by the Engineer. The Contractor shall produce a smooth, corrosion-resistant and durable internal lining of adequate strength with its outer surface in close and firm contact with the pipeline interior after completing the installation.  (5) For in-situ internal sleeve lining, the sleeve shall be brought into position in the pipeline/culvert and installed by an inflatable packer, mandrel or other approved remote-controlled method.  (6) During installation, the Contractor shall, where necessary, provide temporary diversion of all existing flow from the pipe/box culvert and its lateral branch connections thus providing dry and workable conditions for the Works.  (7) The annular space between the lining and the existing pipe wall, if any, shall be filled by pressure grouting or other methods recommended by the manufacturer and approved by the Engineer. For linings designed to be close-fit against the existing pipe wall, the Contractor shall still check the ends of the lining for presence of voids between the lining and the existing pipe wall after completion of installation, and seal up such voids by an approved sealant to the satisfaction of the Engineer.  (8) For cured-in-place linings, the finished lining shall, as far as possible, be free of visual defects including foreign inclusions, dry spots, air bubbles, pinholes and pimples. Wrinkling of more than 2% of the internal pipe diameter or the least internal dimension of the box culvert will not be accepted.  (9) After completion of installation of lining, lateral branch connections sealed up by the lining shall be re-opened using a robotic cutting device with CCTV camera, or other trenchless methods approved by the Engineer. The annular gap between the liner and the lateral shall be sealed up. |
| 5.29.6 | Performance tests on internal lining materials | (1) The Contractor shall carry out performance tests on the lining materials to check compliance against the standards/material properties recommended by the manufacturer and approved by the Engineer.  (2) For cured-in-place lining, the wall thickness and the short-term flexural (bending) properties on samples shall be determined as the performance control tests on the finished lining. The method of test shall be proposed by the Contractor for approval by the Engineer, and shall be selected from the following standards (one test for flexural properties and one for wall thickness) :  Test on Standards  Flexural properties BS EN ISO 178: 2003;  ISO 178: 2001;  BS 2782: Part 10: Method 1005: 1977;  EN 63: 1977;  ASTM D790-2000  Wall thickness BS 2782: Part 6: Method 630A: 1994;  ISO 4593: 1993;  BS 2782: Part 6: Method 631A: 1993;  ISO 4591: 1992  The wall thickness shall be determined at a minimum of 5 locations. The measuring device shall be accurate to ± 0.1mm. The wall thickness at all points shall be not less than the specified design thickness and may be up to 15% greater.  If the flexural properties are tested according to BS EN ISO 178 : 1997, BS 2782 : Part 3 : Method 335A :1993, ISO 178 : 1993, the cross head displacement rate shall be 10mm/min.  The 90% lower confidence limits of short term flexural modulus Eo, flexural stress at first break σb and flexural strain at first break εb shall be not less than the respective design values declared by the supplier.  If any result of the above tests on flexural properties of the samples fails to meet the acceptance criteria, the Contractor shall carry out test on samples taken from the finished lining to determine the creep modulus in accordance with Clause 8.7 of Water Industry Specification WIS 4-34-04, March 1995: Issue 2, (1000 hours or as otherwise agreed) for validation against the manufacturer’s creep data.  If any wall thickness determined in the sample testing fails to meet the design thickness but the result of tests on flexural properties is up to the acceptance criteria, the actual wall thickness measured on finished lining shall not be less than the design thickness.  (3) For in-situ internal sleeve lining, the Contractor shall, in addition to other tests specified in this clause, also test the repaired location for leakage by a proprietary joint tester according to the testing procedures recommended by the manufacturer and approved by the Engineer. The test results shall satisfy the compliance criteria equivalent to those stated in clause 5.27.2 (for gravity pipelines) or clause 5.28.2 (for pressure pipelines).  (4) For other types of lining, they shall be sampled and tested according to internationally recognised specifications and their manufacturer’s specifications, and/or as specified by the Engineer as a condition of approval in accordance with sub-clause (1) of clause 5.29.4.  (5) If the result of any performance test on the samples fails to meet the compliance criteria, the Engineer may instruct that the test be repeated on samples taken from the finished lining for validation against the manufacturer’s data. The number of samples of the finished lining to be taken and the positions of taking samples shall be determined by the Engineer.  (6) The Contractor shall propose 3 laboratories capable of carrying out the required tests for selection and approval by the Engineer. The Engineer shall select one laboratory for testing and one laboratory as backup in case the performance of the selected laboratory is unsatisfactory. As required by the Engineer, the Contractor shall provide assistance in delivering the samples to the approved laboratory for carrying out the performance tests based on the Contractor’s approved testing proposal. Test reports and the tested samples shall be sent to the Engineer directly by the approved laboratory.  (7) The maximum number of samples which may be ordered by the Engineer for each type of performance test shall be one per 50m of lined pipe/culvert |
| **6.** | **SECTION 6 EARTHWORKS** |  |
| **6.1** | **GENERAL** |  |
| 6.1.1 | Reclamation | Reclamation shall comply with Section 19 except as stated in this Section. |
| **6.2** | **GLOSSARY OF TERMS** |  |
| 6.2.1 | Areas of fill | Areas of fill are areas within the Site, including areas in embankments, platforms and slopes and in excavations for structures, pits and trenches, in which fill material is deposited and compacted as part of the permanent work. |
| 6.2.2 | Earthworks final surface | Earthworks final surface is the surface to which the work included in Section 6 is finished. |
| 6.2.3 | Inert construction and demolition material | Inert construction and demolition material shall mean rock, rubble, earth, soil, concrete, asphalt, brick, tile and masonry generated from construction and demolition works. |
| 6.2.4 | Earthworks material | Earthworks material may consist of soil, rock, or inert construction and demolition material on or below the Site at the commencement of the Contract, or which is imported to the Site to carry out the Works. |
| 6.2.5 | Formation | Formation is that part of the earthworks final surface on which a pavement, structure or utility, is constructed, or on which the blinding or bedding for a pavement, structure or utility is placed. |
| 6.2.6 | Intermediate areas of fill | Intermediate areas of fill are areas of fill which are stated in the Contract as such, and in which fill material is deposited and compacted directly into shallow water or onto naturally occurring soft ground. |
| **6.3** | **MATERIALS** |  |
| 6.3.1 | Fill material | (1) Fill material shall consist of naturally occurring or processed  material, or inert construction and demolition material, which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill.  (2) Fill material shall not contain any of the following:  Material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils,  Peat, vegetation, timber, organic, soluble or perishable material,  Dangerous or toxic material or material susceptible to combustion, and  Metal, rubber, plastic or synthetic material.  (3) The different types of fill material shall have the particle size distributions within the ranges stated in Table 6.1.  (4) Special fill material shall consist of material which has a liquid limit not exceeding 45%, a plasticity index not exceeding 20% and a coefficient of uniformity exceeding 50.  (5) Granular fill material shall consist of clean, hard and durable material including recycled aggregates, rock and concrete.  (6) Rock fill material shall consist of pieces of concrete or hard and durable rock of which the maximum size shall not be greater than three times the minimum dimension of individual pieces and in the opinion of the Engineer not more than 30% by mass is discoloured or shows evidence of decomposition.  (7) The soluble sulphate content of fill material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as SO3, per litre.  (8) The total sulphate content, expressed as SO3, of fill material placed within 500 mm of metalwork shall not exceed 0.5% by mass.  (9) Well-graded material shall consist of material that has a coefficient of uniformity exceeding 10.  (10) Uniform-graded material shall consist of material that has a coefficient of uniformity of 10 or less. |

Table 6.1: Particle size distributions of fill material

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Type of fill material | Percentage by mass passing | | | | | | |
| Size | | | BS test sieve | | | |
| 400 mm | 200 mm | 75 mm | | 20 mm | 600 µm | 63 µm |
| Fine fill material | - | - | 100 | | - | - | - |
| General fill material | - | 100 | 75-100 | | - | - | - |
| Special fill material | - | - | 100 | | - | - | 0-45 |
| Granular fill material | - | - | 100 | | - | 0-5 | - |
| Rock fill material (Grade 200) | - | 100 | 20-75 | | 0-50 | - | - |
| Rock fill material (Grade 400) | 100 | 20-75 | 10-30 | | 0-25 | - | - |

|  |  |  |  |
| --- | --- | --- | --- |
| **6.4** | **SUBMISSIONS** | |  |
| 6.4.1 | Particulars of earthworks | | (1) The following particulars of the proposed materials and methods of construction for earthworks shall be submitted to the Engineer:  Details of constructional plant and haulage vehicles,  Methods of excavation and of deposition and compaction of fill material,  Use of different types of excavated material and sources of imported fill material,  Arrangements for stockpiling, sorting and separating excavated material, earthworks material and fill material, and for reusing and disposing of such materials,  Methods of controlling the moisture content of fill material,  Methods of controlling surface water and groundwater and of protecting earthworks and earthworks material from damage due to water and from weather conditions which may affect the earthworks or earthworks material,  Methods of monitoring groundwater levels, and  Methods of monitoring the ground and structures for movements.  (2) The particulars shall be submitted to the Engineer at least 14 days before the relevant work starts. |
| **6.5** | **GENERAL EARTHWORKS REQUIREMENTS** | |  |
| 6.5.1 | Ownership of earthworks material | | (1) Earthworks material within the Site at the commencement of the Contract shall remain the property of the Employer except as stated in clause 6.5.1.  (2) Earthworks material that needs to be disposed of by the Contractor shall become the property of the Contractor when it is removed from the Site and shall be disposed of in tips provided by the Contractor, unless otherwise stated in the Contract. |
| 6.5.2 | Temporary Works for earthworks | | (1) The design of Temporary Works associated with earthworks, including temporary slopes, stockpiles and drainage, shall be such that the risk of failure is not more than that which would be adopted if the Temporary Works were to be permanent. Allowance may be made in the design of the Temporary Works for the shorter design life and for the risk to persons and property and the surface water and groundwater conditions that are likely to occur during construction.  (2) The Contractor shall provide details to the Engineer to demonstrate that the design of Temporary Works has been considered and incorporated measures, which minimise excavation of materials. |
| 6.5.3 | Handling and storage of earthworks material | | (1) Earthworks material shall not be handled or stored in a manner which will result in segregation, deterioration, erosion or instability of the material.  (2) Different types of earthworks material shall be kept separate from each other. Earthworks material that is suitable for use as fill material shall be maintained in a suitable condition and shall not be contaminated.  (3) Material handling and storage areas shall be levelled and well drained. Stockpiles of material shall be sprayed with water or a dust suppression chemical to minimize dust generation. |
| 6.5.4 | Protection from water and weather | | (1) Earthworks after site clearance, excavation or filling and earthworks material after excavation shall be kept free of water and shall be protected from damage due to water and from exposure to weather conditions which may affect the earthworks or earthworks material. The measures to be taken shall include the following:  As stated in clauses 1.5.6 and 1.6.1.  Surfaces shall be maintained in a stable condition and shall be formed to falls to shed water and to prevent ponding.  The area of exposed surfaces shall be kept to a minimum.  (2) Excavations for structures, pits and trenches shall not be carried out on or adjacent to slopes unless measures are taken to drain the excavation and to prevent water from the excavation entering the slope. |
| 6.5.5 | Earthworks material allowed to become unsuitable or to deteriorate | | (1) Earthworks material which has been used, or is required for use, in the permanent work and which is allowed to become unsuitable such that in the opinion of the Engineer it no longer complies with the specified requirements for that type of material shall be replaced or dealt with by methods agreed by the Engineer.  (2) Earthworks material which is not stated in the Contract to be excavated and which the Contractor causes or allows to deteriorate such that in the opinion of the Engineer the permanent work will be affected shall be replaced or dealt with by methods agreed by the Engineer.  (3) Material provided to replace earthworks material, which has been allowed to become unsuitable, or which the Contractor causes or allows to deteriorate, shall be an equivalent material approved by the Engineer. The replacement material shall have the same volume after compaction as the material replaced.  (4) The material that is to be replaced shall be disposed of by the Contractor. |
| 6.5.6 | Additional excavation and stabilisation | | (1) Earthworks material which is not stated in the Contract to be excavated but which in the opinion of the Engineer has inadequate strength, durability or stability shall be dealt with by additional excavation or filling or by stabilisation as stated in clause 6.5.7 or by other methods instructed by the Engineer.  (2) Additional excavation shall be carried out and the resulting voids shall be dealt with as follows:  General fill material, fine fill material or special fill material shall be deposited and compacted below areas of fill and below formations other than in rock.  Grade 10 concrete shall be placed and compacted below formations in rock.  Granular fill material shall be deposited below standing water.  (3) Stabilisation shall be carried out using rock fill material (Grade 400) deposited directly into the original unstable material and compacted to form a stable foundation on which to construct the subsequent work. |
| 6.5.7 | Removal of earthworks material | | Earthworks material that is required for use in the permanent work as fill material shall not be removed from the Site unless permitted by the Engineer. The Contractor shall notify the Engineer before any earthworks material is removed from the Site. |
| **6.6** | **EXCAVATION** | |  |
| 6.6.1 | Disposal of excavated material | | (1) The Contractor shall take measures to sort and separate excavated material on site for use in the permanent works as required in the environmental protection measures unless otherwise stated in the Contract. Excavated material, which in the opinion of the Engineer cannot be selected, processed or mixed in a practical manner to make it suitable for use in the permanent works, as fill material shall be disposed of by the Contractor unless otherwise stated in the Contract.  (2) Excavated material that is surplus to the requirements of the permanent work shall be disposed of by the Contractor unless otherwise stated in the Contract. The Contractor shall, unless otherwise stated in the Contract, take all practical measures to sort and separate the surplus material according to its nature before disposal as required in the environmental protection measures and dispose of the material off-site using the Trip-ticket System. |
| 6.6.2 | Use of excavated material | | (1) Excavated material required for use in the permanent work which is capable of being selected, processed and mixed to make it suitable for use as fill material shall not be used for any other purposes unless permitted by the Engineer.  (2) Excavated material that is required for use in the permanent work as fill material and which the Engineer permits to be removed from the Site or used for other purposes shall be replaced by an equivalent material approved by the Engineer. The replacement material shall have the same volume after compaction as the material replaced. |
| 6.6.3 | Obstructions in excavations | | (1) The Contractor shall inform the Engineer without delay of the nature and location of any unforeseen obstruction encountered during excavation.  (2) Boulders that intersect the earthworks final surface or formation shall be dealt with as excavation proceeds by methods agreed by the Engineer. Boulders shall not be left protruding unless permitted by the Engineer. |
| 6.6.4 | Excavation | | (1) Temporary supports or other methods shall be used to maintain excavations in a stable condition and to prevent settlement of structures or utilities due to excavation or dewatering.  (2) Constructional plant or other vehicles shall not be operated or parked adjacent to excavations and earthworks material or other materials shall not be placed adjacent to excavations unless this has been allowed for in the design of the Temporary Works for the support of the excavation. |
| 6.6.5 | Excavations adjacent to structures and utilities | | (1) Excavations shall be carried out by hand adjacent to utilities that are known, proven or suspected to exist.  (2) Unless otherwise permitted by the Engineer excavations next to structures shall be carried out by hand. |
| 6.6.6 | Excavations for structures, pits and trenches | | (1) Excavations for structures, pits and trenches shall be the minimum size necessary to construct the permanent work. The sides of excavations shall be vertical unless otherwise permitted by the Engineer.  (2) The length of trench excavation left open at any one time shall not exceed that agreed by the Engineer.  (3) Unless permitted by the Engineer, trenches for utilities in fill areas shall not be excavated until the fill material has been deposited and compacted up to the earthworks final surface or formation or up to 1 m above the top of the utility, whichever is lower. |
| **6.7** | **BLASTING TRIALS** | **N/A** | |
| **6.8** | **BLASTING** | **N/A** | |
| **6.9** | **DEPOSITION OF FILL MATERIAL** |  | |
| 6.9.1 | Types of fill material | Unless otherwise stated in the Contract, areas of fill shall be formed of general fill material. | |
| 6.9.2 | Sources of fill material | Except in public filling area as stated in clause 6.13.1, fill material shall be obtained from excavation within the Site. If there is insufficient fill material of the required types within the Site, imported fill material shall be provided by the Contractor from sources outside the Site. | |
| 6.9.3 | Surface preparation for fill material | Except as stated in clause 6.12.1, surfaces on which fill material is to be deposited shall be prepared after site clearance in accordance with the following requirements:  Topsoil, grass, and other organic matter shall be removed.  Soft spots, boulders and other materials, which in the opinion of the Engineer are unsuitable or unstable, shall be removed.  Watercourses shall be diverted as stated in the Contract.  Benches shall be cut and sub-soil drainage systems installed as stated in the Contract.  Voids shall be dealt with as stated in the Contract or instructed by the Engineer.  Surfaces other than rock shall be scarified to a depth of 200 mm and compacted to the same standard as the fill material that is to be deposited. | |
| 6.9.4 | Commencement of deposition of fill material | The permission of the Engineer shall be obtained before deposition of fill material starts in any area of fill. | |
| 6.9.5 | Haulage of fill material | Haulage of fill material to an area of fill shall proceed only when the compaction plant operating at the area to be filled is sufficient to achieve the specified requirements for relative compaction of the fill material. | |
| 6.9.6 | Deposition of fill material | (1) Fill material obtained from excavations within the Site shall be deposited in its final location as soon as practicable after it has been excavated.  (2) Fill material shall be deposited in layers of a thickness appropriate to the compaction method to be used. In deposition of fill material, the Contractor shall ensure that a good bond is achieved between layers of fill, and unless otherwise directed by the Engineer, no material shall be placed on previously compacted layers unless the surface has been scarified or otherwise broken up and, if necessary, watered.  (3) Unless otherwise permitted by the Engineer, layers of fill material shall be horizontal, except for any gradient required for drainage, and the thickness of each layer shall be uniform over the area to be filled. The fill material shall be brought up from the bottom in uniform horizontal layers, with the top of each layer graded to enable surface water to drain readily.  (4) Except in excavations for structures, pits and trenches, if the difference in level between adjacent areas to be filled exceeds 1 m, the edge of the higher area shall be benched before fill material is placed against it.  (5) Execution of the Works shall be controlled in such a manner that any compaction of the fill material resulting from the passage of constructional plant or haulage vehicles is uniform.  (6) Except as stated in clause 6.12.1, fill material shall not be deposited by end-tipping, by pushing loose material down slope faces or by other methods which may result in segregation or inadequate compaction of the fill material. | |
| 6.9.7 | Overfilling | In areas of fill formed of material other than rock fill material, earthworks final surfaces sloping at a gradient exceeding 1 vertical to 3 horizontal shall be formed by overfilling and cutting back after compaction. Over-filling shall extend beyond the earthworks final surface by a horizontal distance of 0.5 m or three times the thickness of the compacted layer, whichever is greater. | |
| 6.9.8 | Deposition of fill material adjacent to structures and utilities | (1) Except as stated in clause 6.9.8, fill material deposited within 0.5m of a structure or utility shall be fine fill material unless otherwise stated in the Contract. In addition, the material may contain up to 5% by weight of fresh, slightly decomposed or moderately decomposed rock fragments of up to 200 mm provided that these do not cause any damage to structures, nor do they interfere with the compaction requirements.  (2) Fill material shall not be deposited adjacent to or above structures or utilities until the construction of the structure or utility is sufficiently advanced to accept the imposed forces without disturbance or damage.  (3) Fill material shall be deposited evenly on all sides of structures and utilities and in such a manner that the structure or utility is not disturbed or damaged.  (4) Unless otherwise stated in the Contract, fill material around water, sewage and drainage pipes which are laid as part of the permanent work shall be special fill material. They shall be deposited in layers not exceeding 100 mm thick to a level of 300 mm above the top of the pipe. The fill material shall be deposited in such a manner that the layer on one side of the pipe is not more than 100 mm higher than the layer on the other side. | |
| 6.9.9 | Deposition of rock fill material | (1) The final compacted thickness of each layer of rock fill material shall exceed 1.5 times and shall not exceed twice the nominal Grade size of the rock fill material.  (2) The surface voids of each layer of rock fill material shall be filled with fragments of rock before the next layer is deposited. The final surface of rock fill material shall also be blinded with fine fill material. | |
| 6.9.10 | Deposition of fill material in excavations for structures, pits and trenches | If sheet piling, timbering or other temporary supports to excavations for structures, pits and trenches are not to be left in place, the sheet piling, timbering or supports shall be removed as deposition of fill material proceeds. The supports shall be removed in such a manner that the stability of the adjacent ground is maintained and the compacted fill material is not disturbed. | |
| **6.10** | **COMPACTION OF FILL MATERIAL** |  | |
| 6.10.1 | Compaction of fill material | (1) Fill material in areas of fill shall be compacted in layers to a stable condition as soon as practicable after deposition and in a manner appropriate to the location and to the material to be compacted.  (2) The permission of the Engineer shall be obtained before the next layer is deposited on each layer of compacted fill material.  (3) Except as stated in clauses 6.10.3, 6.10.5, 6.11.2, 6.12.2 and 6.13.9, fill material shall be compacted to obtain a relative compaction of at least 95% throughout unless otherwise stated in the Contract. | |
| 6.10.2 | Moisture content of fill material | Fill material other than rock fill material and material as stated in clause 6.10.5 shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be ±3%, provided that the fill material is still capable of being compacted in accordance with the specified requirements to form stable areas of fill. All necessary measures shall be taken to achieve and maintain the specified moisture content. | |
| 6.10.3 | Compaction of fill material adjacent to structures and utilities | (1) Fill material shall be compacted in such a manner that structures or utilities are not disturbed or damaged.  (2) Fill material around water, sewage and drainage pipes, which are constructed as part of the permanent work, shall be compacted by hand-rammers or manually operated power equipment. Fill material within 300 mm above the top of sewage and drainage pipes shall be compacted to obtain a relative compaction of at least 85% throughout. | |
| 6.10.4 | Compaction of rock fill material | (1) Every layer of rock fill material shall be compacted by at least eight passes of a vibrating roller or by other equivalent compaction method approved by the Engineer. The final surface of rock fill material shall be compacted by at least two additional passes of a vibrating roller or by other equivalent compaction method approved by the Engineer.  (2) Vibratory rollers used for the compaction of rock fill material shall have a static load per 100 mm width of roll of at least 2 kN for layers with a compacted thickness not exceeding 500 mm and at least 4 kN for layers with a compacted thickness exceeding 500 mm. | |
| 6.10.5 | Compaction of general fill material with a large portion of coarse material | (1) For general fill material of which less than 90% passes a 20 mm BS l test sieve, it is difficult to determine of the moisture content and maximum dry density according to clauses 6.17.2, 6.18.2, 6.19.1. This type of material shall be compacted to the requirements of clause 6.10.5.  (2) Each horizontal layer of general fill material shall be spread and levelled with a thickness not less than 1.5 times of the maximum size of the general fill material and not exceeding the maximum depth of compacted layer in accordance with Table 6.2A. If there is a presence of over-sized coarse material in the general fill, the over-sized coarse material shall be removed or broken down to sizes acceptable to the Engineer. Each layer shall be systematically compacted by a vibratory roller with the stipulated minimum number of passes corresponding to the minimum static load per 100 mm width of the roller.  (3) The number of passes of the roller shall only be counted when the roller is travelled on the material to be compacted at a speed of not more than 2 km per hour with full vibration. Plant other than a vibratory roller carrying out material spreading or providing some preliminary compaction, to assist the use of heavier plant, shall be disregarded in counting the number of passes.  (4) Variation from the method or the use of plant different from that specified in Clause 6.10.5 will be permitted only if the Contractor demonstrates at site trials that equivalent compaction is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.  (5) Without prejudice to the provision of the Conditions of Contract and in order that the Engineer may take proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.  (6) When materials of widely divergent grading are used in embankments and fill areas, they shall be spread and compacted in separate clearly defined areas.  (7) If more than one class of material is being used in such a way that in the opinion of the Engineer, it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material that requires the greatest compaction effort is being compacted. | |
| Table 6.2A: Compaction requirement for general fill material with a large portion of coarse material | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Force per 100 mm width | Well-graded material | | Uniform-graded material | |
| (KN) | Maximum depth of compacted layer (mm) | Minimum no. of passes | Maximum depth of compacted layer (mm) | Minimum no. of passes |
| 0.25 – 0.45 | 125 | 12 | 150 | 16 |
| 0.46 – 0.70 | 150 | 12 |
| 0.71 – 1.25 | 150 | 10 |
| 1.26 – 1.75 | 150 | 8 | 200 | 10 |
| 1.76 – 2.30 | 150 | 4 | 225 | 10 |
| 2.31 – 2.80 | 175 | 4 | 250 | 10 |
| 2.81 – 3.50 | 200 | 4 | 275 | 8 |
| 3.51 – 4.20 | 225 | 4 | 300 | 8 |
| 4.21 – 4.90 | 250 | 4 | 300 | 8 |

|  |  |  |
| --- | --- | --- |
| **6.11** | **COMPLETION OF EARTHWORK SURFACES** |  |
| 6.11.1 | Completion of earthwork final surfaces | (1) Earthwork final surfaces shall be completed to a stable condition as soon as practicable after excavation or after deposition and compaction of fill material has been completed. The subsequent permanent work or surface protection shall be carried out as soon as practicable after the earthworks final surface has been completed.  (2) Earthworks final surfaces shall be completed to smooth alignments without abrupt irregularities unless otherwise stated in the Contract. |
| 6.11.2 | Completion of formations | (1) Formations above structures or utilities shall be completed after construction of the structure or utility.  (2) Except in excavations in rock and in areas of fill formed of rock fill material or fill material as stated in clause 6.10.5, formations shall be compacted to obtain a relative compaction of at least 98% to a depth of 200 mm below the formation.  (3) Unless otherwise permitted by the Engineer, proof rolling shall be carried out on formations. The formation shall be rolled in the presence of the Engineer by at least two passes of a non-vibrating rubber tyred roller. The roller shall have a static load per 100 mm width of roll of at least 4 KN and shall travel at a speed not exceeding 2 km/h. Any defect in the formation which is revealed during proof rolling by deformation of the formation which in the opinion of the Engineer is excessive shall be made good as instructed by the Engineer.  (4) After all other formation work and testing have been completed and damage caused by testing reinstated, formations for pavements shall be rolled with one pass of a smooth steel-wheeled non-vibrating roller. The roller shall have a load per 100 mm width of roll of at least 2 KN.  (5) Unless otherwise permitted by the Engineer, formation surfaces that will not be immediately covered by the subsequent permanent works shall be protected by methods agreed by the Engineer. |
| 6.11.3 | Protection of earthwork final surfaces and formations | (1) Earthwork final surfaces and formations shall be maintained in a stable condition and shall be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.  (2) Formation shall not be used by constructional plant or vehicles other than those which, in the opinion of the Engineer, are essential to construct the subsequent work. |
| **6.12** | **INTERMEDIATE AREAS OF FILL** |  |
| 6.12.1 | Deposition of fill material in intermediate areas of fill | Fill material may be deposited in intermediate areas of fill by end-tipping or by pushing into position until, in the opinion of the Engineer, it is sufficient to form a stable foundation on which to construct the subsequent work. |
| 6.12.2 | Compaction of fill material in intermediate areas of fill | Fill material in intermediate areas of fill up to the level stated in clause 6.12.1 shall be compacted to a degree, which in the opinion of the Engineer is practicable. Except as stated in clause 6.10.5, fill material above the level stated in clause 6.12.1 shall be compacted to obtain a relative compaction of at least:  90% throughout,  95% within 1.5 m of earthworks final surfaces and formations, and  98% within 200 mm of formations. |
| **6.13** | **EARTHWORKS IN PUBLIC FILLING AREA** |  |
| 6.13.1 | Public filling area | Public filling area shall mean any area or portion of earthworks/reclamation works to receive inert construction and demolition material, and other materials disposed of by the public as stated in the Contract. |
| 6.13.2 | Public fill | Public fill shall mean inert construction and demolition material that is disposed of at a public filling area. |
| 6.13.3 | Combined reception and exit offices | (1) Combined reception and exit offices for the operation of a public filling area shall be provided at the location shown on the Drawings.  (2) The Contractor shall design and provide the combined reception and exit office in accordance with the schematic layout shown on the Drawings. The combined reception and exit office shall comply with the following requirements:  Each shall consist of two floors and shall be constructed on a 1300mm high raised hollow platform. The upper floor is an inspection cabin, which shall be designed to withstand at least 5kPa live load and equipped with staircases and guard railings.  Windows of sliding type with locks and security bars shall be provided at the sides to enable a clear view of the approaching traffic. All windows shall be provided with venetian blinds.  Collision barriers, collision bollards, separation barriers, red/green light type automatic signalling system and drop-bars shall be provided as shown on the Drawings.  An overhead water-spraying system shall be installed at each of the reception hallways. It shall consist of groups of nozzles and shall be supported firmly with posts standing on the ground. Each overhead water-spraying system shall be capable of emitting 100 litres of water in 30 seconds.  The roof and all walls shall be fully lined, well insulated, waterproof and painted.  All doors shall have secure and efficient locks.  A surveillance system shall be installed in each combined reception and exit office at locations agreed by the Engineer. The surveillance system shall consist of closed circuit digital colour video camera, closed circuit video duplex multiplexer and the accessories with schedule as stated in the Contract. The surveillance system shall be operated in accordance with clause 6.13.3.  Weighbridge system shall be installed at each combined reception and exit office at locations as agreed with the Engineer to measure and record the weight of each and every dump truck using the public filling area. The weighbridge system shall be calibrated by a suitable method and at frequency as agreed with the Engineer.  (3) The surveillance system shall be operated as follows:  The camera of the surveillance system shall allow continuous recording and close surveillance of activities within the public filling area during the operation hours.  Images captured by the cameras shall be continuously recorded by DVD recorders. Each recorded DVD shall be kept for at least 6 months. The Contractor shall insert and replace the DVD for the surveillance system so as to ensure the continuous recording of the operation activities.  The position and angle of each camera of the surveillance system shall be as instructed by the Engineer. The Contractor shall be responsible for any relocation and/or adjustment required.  (4) Detailed proposals for the combined reception and exit offices shall be submitted by the Contractor to the Engineer for approval within 14 days of the date for commencement of the Works. The proposal shall include locations, layouts, associated facilities and construction details.  (5) Within 28 days of the date of approval by the Engineer, the Contractor shall complete the construction of the combined reception and exit offices that shall be ready for occupation and operation.  (6) The combined reception and exit offices shall be maintained in a clean, stable and secure condition daily.  (7) Equipment provided for the use of the Engineer shall be maintained in a clean and serviceable condition and all consumables shall be replenished as instructed by the Engineer.  (8) The permission of the Engineer shall be obtained before the combined reception and exit office or equipment is removed. The combined reception and exit office or equipment which are to be left in position or become the property of the Employer after completion of the Works shall be repaired, repainted and serviced as instructed by the Engineer. |
| 6.13.4 | Reception areas, queuing areas and access roads | (1) Reception areas, queuing areas and access roads shall be provided in accordance with the Drawings.  (2) The Contractor shall operate and maintain reception areas, queuing areas and access roads complying with the following requirements:  The riding surfaces shall be kept in good condition without excessive bumps and depressions,  The surfaces shall be kept in wet condition so as to minimize dust generation,  The surfaces shall be kept free of grease, debris and the like, and  Measures shall be taken to prevent ponding and flooding. |
| 6.13.5 | Management of dump truck movements | (1) The Contractor shall manage entry to and exit from the public filling area to:  Maintain orderly traffic conditions at the reception areas, queuing areas and access roads,  Ensure all dump trucks are inspected and weighed at the combined reception and exit offices before and after deposition. In the event that the materials carried by a dump truck are inspected as not acceptable, the Contractor shall direct the dump truck to leave the Site as instructed by the Engineer, and  Direct dump trucks to the designated deposition point for deposition.  (2) The maximum speed of dump trucks within the public filling area shall be restricted to 10km per hour.  Upon instruction by the Engineer, the Contractor shall within three hours tow away any broken down dump truck from an operation area to a safe area within the Site as agreed with the Engineer so as not to disrupt the operation of the public filling area.  (3) The Contractor shall supply and erect temporary traffic signs, including speed limit signs, for directing dump trucks and traffic diversion within the public filling area. |
| 6.13.6 | Temporary haul roads and drains | (1) The Contractor shall provide and maintain temporary haul roads and drains to suit the programme of deposition and shall remove all temporary drainage systems after the Works. Lighting facilities shall be provided along the temporary haul roads and at each deposition point to ensure safe operation.  (2) The Contractor shall design the temporary haul roads and drains to ensure good riding condition and safety. All temporary haul roads shall be paved with granular material. The Contractor shall submit the details of the proposed temporary haul roads and drains to the Engineer for agreement 14 days before implementation or commencement of associated work whichever is earlier.  (3) The Contractor shall grade, regulate and compact all temporary haul roads as instructed by the Engineer to prevent undulation. |
| 6.13.7 | Handling and storage of wet soil | (1) Public fill may consist of wet soil. Wet soil may be any naturally occurring or processed material, which at the time of deposition is unable to be compacted in accordance with the specified requirements to form a stable area of fill.  (2) The Contractor shall plan the Works by allowing stockpiling space as agreed with the Engineer for handling wet soil. The Contractor shall process the wet soil received including mixing it with pubic fill to make it suitable for compaction and use in the Works. The processed material shall be handled and stored in accordance with clause 6.5.3. The proposed method of processing and mixing shall be agreed with the Engineer at least 7 days before any processing and mixing starts. |
| 6.13.8 | Deposition of public fill | Clauses 6.9.6, 6.9.7, and 6.12.1 shall apply to deposition of public fill. |
| 6.13.9 | Compaction of public fill | (1) In addition to Clauses 6.10.1 and 6.10.3, public fill shall be compacted to the requirements of Clauses 6.13.9. The Contractor shall submit the proposed method of compaction including the proposed compaction plant, thickness of compacted layer and minimum number of passes to the Engineer for approval at least 7 days before any compaction starts.  (2) Each horizontal layer of public fill shall be spread and levelled with a thickness not exceeding the maximum depth of a compacted layer in accordance with Table 6.2B. Each layer shall be systematically compacted by the compaction plant with the minimum number of passes approved by the Engineer.  (3) Definitions and requirements associated with Table 6.2B are as follows:  Where combinations of different types or categories of plant are used, the compaction requirements shall be:  The depth of layer shall be that for the type of plant requiring the least depth of layer; and  The number of passes shall be that for the type of plant requiring the greatest number of passes.  The number of passes of the roller shall only be counted when the roller is travelled on the materials to be compacted at a speed of not more than 2 km per hour with full vibration where appropriate.  The plant other than the approved compaction plant by the Engineer as stated in Clause 6.13.9 to carry out material spreading or to provide some preliminary compaction only to assist the use of heavier plant shall be disregarded in counting the number of passes.  The force per 100 mm width is the total weight on the roll divided by the total roll width. Where a smooth-wheeled roller has more than one axle the machine will be assessed on the basis of the axle giving the highest value of force per 100 mm width.  Wheel load is the total weight of the roller divided by the number of wheels.  Vibratory rollers are machines having means of applying mechanical vibration to one or more rolls.  The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine and a towing speed of 1800 - 2400 m/hour for a towed machine. If higher gears or speed are used, an increased number of passes shall be provided in proportion to the increase in speed of travel.  Vibratory rollers operating without their vibration mechanism in use will be classified as smooth-wheeled rollers.  Vibratory rollers shall only be operated with their vibration mechanism operating at the frequency of vibration recommended by the manufacturers. All such rollers shall be equipped with a device automatically indicating the frequency at which the mechanism is operating.  Vibrating-plate compactors are machines having a base-plate to which a source of vibration consisting of one or two eccentrically weighted shafts is attached.  The static pressure under the plate of a vibrating-plate compactor is calculated by dividing the total weight of the machine in working order by the area in contact with compacted material.  Vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturer. They shall normally be operated at travelling speeds of less than 900 m/hour but, if higher speeds are necessary, the number of passes shall be increased in proportion to the increase in speed of travel.  Vibro-tampers are machines in which an engine-driven reciprocating mechanism acts on a spring system, through which oscillations are set up in a base-plate.  Power rammers are machines that are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.  (4) Variation from the methods or the use of plant different from that specified in Clause 6.13.9 will be permitted only if the Contractor demonstrates by site trials that equivalent compaction effect is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.  (5) Without prejudice to the provision of the Conditions of Contract and in order for the Engineer to make proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so. |

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| Table 6.2B: Compaction requirement |

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| Type of compaction plant | Category | Maximum depth of compacted layer (mm) | Minimum no. of passes |
| Smooth-wheel roller | Force per | 125 | 10 |
| 100 mm width |
| 2.1 – 2.6 kN |
| 2.61 – 5.2 kN | 125 | 8 |
| More than 5.2 kN | 150 | 8 |
| Grid-roller | Force per | 125 | 12 |
| 100 mm width  5.3 – 7.8 kN |
| More than 7.8 kN | 150 | 12 |
| Pneumatic-tyre roller | Wheel load | 125 | 12 |
| 2 - 2.5 tonnes |
| 2.6 - 4 tonnes | 125 | 10 |
| 4 - 6 tonnes | 125 | 10 |
| 6 - 8 tonnes | 150 | 8 |
| 8 - 12 tonnes | 150 | 8 |
| More than 12 tonnes | 175 | 6 |
| Vibratory roller | Force per | 100 | 12 |
| 100 mm width |
| 0.71 – 1.25 kN |
| 1.26 – 1.75 kN | 125 | 8 |
| 1.76 – 2.3 kN | 150 | 4 |
| 2.31 – 2.8 kN | 175 | 4 |
| 2.81 – 3.5 kN | 200 | 4 |
| 3.51 – 4.2 kN | 225 | 4 |
| 4.21 – 4.9 kN | 250 | 4 |
| Vibratory-plate compactor | Static pressure under | 100 | 6 |
| base plate (kN/m2) |
| 13.8 - 17.2 |
| 17.3 - 20.7 | 150 | 6 |
| More than 20.7 | 200 | 6 |
| Vibro-tamper | Mass (kg) | 100  125 | 3  3 |
| 50 – 65  66 – 75 |
| More than 75 | 150 | 3 |
| Power rammer | Mass (Kg) | 150 | 6 |
| 100 |
| More than 500 | 275 | 12 |

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| 6.13.10 | Use of fill material adjacent to structures and utilities in public filling area | Fill material shall be used adjacent to structures and utilities in public filling areas as stated in the Contract. Fill material shall comply with Clause 6.09. The use of fill material shall comply with Clauses 6.9.8, 6.9.10 and 6.10.3. |
| **6.14** | **TOLERANCES** |  |
| 6.14.1 | Tolerances: earthworks final surfaces and formations | (1) Earthworks final surfaces and formations shall be within the tolerances of the specified lines and levels stated in Table 6.3. The tolerances for formations do not apply to pipes or preformed structures that require to be supported over their complete length or area.  (2) In excavation, a positive tolerance refers to insufficient excavation and a negative tolerance refers to excess excavation. In areas of fill, a positive tolerance refers to excess fill material and a negative tolerance refers to insufficient fill material. |

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| Table 6.3: Tolerances for earthworks final surfaces and formations |

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| Type of surface | Method of forming surface | Tolerance (mm) | |
| + | - |
| Formations for structures and utilities | Excavation except in rock | 0 | 25 |
| Excavation in rock | 0 | 150 |
| Deposition and compaction of fill material | 0 | 25 |
| Formations for pavements, including carriageways, footways, cycletracks, paved areas, aircraft pavements and railway trackbeds. | Excavation except in rock | 0 | 50 |
| Excavation in rock | 0 | 150 |
| Deposition and compaction of fill material | 0 | 50 |
| Earthworks final surfaces other than formations, with a gradient not exceeding 1 vertical to 10 horizontal | Excavation except in rock | 0 | 100 |
| Excavation in rock | 0 | 200 |
| Deposition and compaction of fill material | 0 | 100 |
| Other earthworks final Surfaces | Excavation except in rock | 100 | 100 |
| Excavation in rock | 100 | 200 |
| Deposition and compaction of fill material | 100 | 100 |

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| **6.15** | **TESTING: FILL MATERIAL - GENERAL REQUIREMENTS** |  |
| 6.15.1 | Batch: fill material | A batch of fill material is any quantity of fill material of the same type and which in the opinion of the Engineer has similar properties throughout. For the purpose of testing for moisture content and relative compaction a batch shall, in addition to the above, be fill material which is deposited in a single layer in any area of fill presented by the Contractor for testing on one occasion. |
| 6.15.2 | Samples: fill material | (1) Each sample of fill material shall consist of at least four increments taken from different parts of the batch. The increments shall be combined and thoroughly mixed and shall then be divided by quartering or by using a riffle box to obtain specimens of an appropriate size to carry out the individual tests.  (2) The size of samples of fill material other than rock fill material shall be in accordance with Table 2.1. Each sample of rock fill material of Grade size not exceeding 200 shall have a mass of at least 250 kg and each sample of rock fill material of Grade size exceeding 200 shall have a mass of at least 1000 kg. |
| 6.16 | TESTING: FILL MATERIAL - PARTICLE SIZE DISTRIBUTION, LIQUID LIMIT, PLASTICITY INDEX, COEFFICIENT OF UNIFORMITY AND SULPHATE CONTENT |  |
| 6.16.1 | Samples: particle size distribution liquid limit, plasticity index, coefficient of uniformity, sulphate content | Samples of fill material to be tested for particle size distribution, liquid, limit, plasticity index, coefficient of uniformity and sulphate content shall be delivered at least 14 days, or such shorter period agreed by the Engineer, before deposition of the fill material starts. The number of samples to be provided from each batch shall be as stated in Table 6.4. |

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| Table 6.4: Number of samples to be tested for particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content, optimum moisture content and maximum dry density |

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| Description | Size of batch | No. of samples per batch |
| Special fill material | 0 - 3,000 m3 | 3 |
| Exceeding 3,000 m3 | 1 for each 1,000 m3 or part thereof |
| Fill material other than special fill material | 0 - 15,000 m3 | 3 |
| Exceeding 15,000 m3 | 1 for each 5,000 m3 or part thereof |

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| 6.16.2 | Testing: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content | (1) Each sample of fill material taken as stated in Clause 6.16.1 shall be tested to determine the particle size distribution. In the case of special fill material, testing shall include calculation of the coefficient of uniformity as stated in Clause 6.16.2. Unless otherwise agreed by the Engineer, each sample of fill material other than rock fill material shall be tested to determine the liquid limit and the plasticity index of that portion of the fill material passing a 425µm BS test sieve. Each sample of fill material, which will be deposited within 500 mm of concrete, cement, bound material, cementitious material or metalwork shall be tested to determine the soluble sulphate content.  (2) The method of testing shall be in accordance with the actual Maldivian standards or similar, whichever as instructed by the Engineer. The size of particles of fill material, which do not pass a 75 mm BS test sieve, shall be taken as the largest dimension measured in any plane.  (3) The coefficient of uniformity (Cu) shall be calculated from the equation:  Cu = D60/D10  where: D60 and D10 are the equivalent sieve sizes in millimetres, interpolated from the particle size distribution curve, through which 60% and 10% of the fill material would pass respectively. |
| 6.16.3 | Non-compliance: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content | (1) If the result of any test for soluble sulphate content of fill material does not comply with the specified requirements for soluble sulphate content, each sample shall be tested to determine the total sulphate content.  (2) If the result of any test for particle size distribution, liquid limit, plasticity index, coefficient of uniformity or total sulphate content of fill material does not comply with the specified requirements for the property, additional samples shall be provided from the same batch and additional tests for the property shall be carried out. The number of additional samples shall be as stated in Table 6.4. |
| **6.17** | **TESTING: FILL MATERIAL - OPTIMUM MOISTURE CONTENT AND MAXIMUM DRY DENSITY** |  |
| 6.17.1 | Samples: optimum moisture content, maximum dry density | (1) Samples of fill material to be tested for optimum moisture content and maximum dry density shall be delivered at least 72 hours, or such shorter period agreed by the Engineer, before deposition of the fill material starts. The number of samples to be provided from each batch shall be as stated in Table 6.4.  (2) The Contractor shall inform the Engineer of the exact location in which the fill material from which each sample is taken is to be deposited.  (3) Samples to be tested for optimum moisture content and maximum dry density shall also be taken after the fill material has been deposited in its final position, at intervals of not more than 28 days.  (4) Samples shall not be provided from:  Fill material including rock fill material which contains an insufficient proportion of particles passing a 20 mm BS test sieve to permit determination of the moisture content and maximum dry density, and  Fill material that is to be deposited as stated in Clause 6.12.1 |
| 6.17.2 | Testing: optimum moisture content, maximum dry density | (1) Each sample of fill material taken as stated in Clause 6.17.1 shall be tested to determine the optimum moisture content and the maximum dry density.  (2) The method of testing shall be in accordance with actual Maldivian standards or similar, whichever is instructed by the Engineer.  (3) If agreed by the Engineer, the Hilf method may be used instead of the methods stipulated in Clause 6.17.2 to determine the optimum moisture content and maximum dry density.  (4) If in the opinion of the Engineer there is any undue discrepancy between the results of tests for optimum moisture content of fill material using methods stipulated in Clause 6.17.2 and the results of tests using the Hilf method, the results of tests using methods stipulated in Clause 6.17.2 shall prevail. |
| 6.17.3 | Consistency: optimum moisture content, maximum dry density | If the result of any test for optimum moisture content or maximum dry density of fill material indicates that the batch contains material which in the opinion of the Engineer, differs to such an extent that subsequent tests for relative compaction may be affected, the batch shall be divided into smaller batches. Each of the smaller batches shall comprise material with similar properties throughout. Additional samples shall be provided from each of the smaller batches and additional tests for optimum moisture content and maximum dry density shall be carried out. The number of additional samples shall be as stated in Table 6.4. |
| **6.18** | **TESTING: FILL MATERIAL - MOISTURE CONTENT:** |  |
| 6.18.1 | Samples: moisture content | (1) Samples of fill material to be tested for moisture content shall be taken during deposition and compaction of fill material and shall be delivered not more than 1 hour after the fill material has been deposited in its final position.  (2) The number of samples to be provided from each batch shall be as stated in Table 6.5. Samples shall not be provided if, in accordance with Clause 6.17.1 the optimum moisture content has not been determined. |
| 6.18.2 | Testing: moisture content | (1) Each sample of fill material taken as stated in Clause 6.18.1 shall be tested to determine the moisture content.  (2) The method of testing shall be in accordance with the Maldivian standards or similar, whichever is instructed by the Engineer or Method 2 : Microwave oven drying method  Method 1 shall be used unless otherwise agreed by the Engineer. |
| 6.18.3 | Compliance criteria: moisture content | If in the opinion of the Engineer there is any undue discrepancy between the results of tests for moisture content of fill material using Method 1 and the results of tests using Method 2 in Clause 6.18.2, the results of tests using Method 1 shall prevail. |
| 6.18.4 | Non-compliance: moisture content | If the result of any test for moisture content of fill material differs from the optimum moisture content by more than the specified amount and if instructed by the Engineer, the moisture content of the whole of the batch of fill material shall be adjusted. Additional samples shall be provided from the same batch and additional tests for moisture content shall be carried out. The number of additional samples shall be as stated in Table 6.5. |

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| Table 6.5: Number of samples to be tested for moisture content and number of tests for relative compaction |

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| Description | Size of area of fill in batch | No. of samples/No. of tests per batch |
| Areas of fill in excavations for structures, pits and trenches and on formations | 0 - 100 m2 | 3 |
| 100 - 500 m2 | 2 for each 100 m2 or part thereof |
| exceeding 500 m2 | 1 for each 100 m2 or part thereof |
| Other areas of fill | 0 - 1 ha | 4 for each 1000 m2 or part thereof |
| 1 - 10 ha | 3 for each 1000 m2 or part thereof |
| exceeding 10 ha | 2 for each 1000 m2 or part thereof |

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| **6.19** | **TESTING: FILL MATERIAL RELATIVE COMPACTION** |  |
| 6.19.1 | Testing: relative compaction | (1) Unless otherwise agreed by the Engineer, each batch of fill material shall be tested to determine the relative compaction. Tests shall be carried out after the fill material has been deposited and compacted in its final position. The number of tests on each batch shall be as stated in Table 6.5. Tests shall not be carried out on:  Fill material including rock fill material which contains an insufficient proportion of particles passing a 20 mm BS test sieve to permit determination of the relative compaction, and  Fill material that has been deposited as stated in Clause 6.12.1.  (2) Tests shall be carried out at positions, which in the opinion of the Engineer are representative of the batch of compacted fill material as a whole.  (3) Testing will be carried out by the Engineer.  (4) The relative compaction of fill material shall be determined in accordance with one of the following methods:  Method 1: Geospec 3, Test Method 11.4  RC = IDD/MDD x 100%  where:  IDD is the in-situ dry density determined as stated in Clause 6.19.1  MDD is the maximum dry density determined as stated in Clause 6.17.2  Method 2: The relative compaction (RC) shall be calculated from the equation:  RC = IBD/MCBD x 100%  where:  IBD is the in-situ bulk density  MCBD is the maximum converted bulk density determined by the Hilf method  Method 1 shall be used unless otherwise permitted by the Engineer.  (5) The in-situ bulk density and the in-situ dry density of fill material shall be determined in accordance with Maldivian standards or similar or Method 2: Nuclear densometer method. Method 1 shall be used unless otherwise permitted by the Engineer.  (6) The maximum converted bulk density of fill material of which more than 5% is retained on a BS 20 mm test sieve, shall be adjusted as stated in existing standards or similar. |
| 6.19.2 | Compliance criterion: relative compaction | If in the opinion of the Engineer there is any undue discrepancy between the results of tests for relative compaction of fill material using Method 1 and the results of tests using Method 2 in Clause 6.19.1, the results of tests using Method 1 shall prevail. |
| 6.19.3 | Non-compliance: relative compaction | If the result of any test for relative compaction of fill material does not comply with the specified requirements for relative compaction, additional tests for relative compaction shall be carried out on the same batch. The number of additional tests shall be as stated in Table 6.5. |
| **7.** | **SECTION 7 GEOTECHNICAL WORKS** | **N/A** |
| **8.** | **SECTION 8 CARRIAGEWAYS: SUB-BASE MATERIAL AND BITUMINOUS MATERIALS** | **N/A** |
| **9.** | **SECTION 9 CONCRETE CARRIAGEWAYS** |  |
| **9.1** | **GENERAL** |  |
| 9.1.1 | General requirements | The works and materials specified in Clauses 9.1.2 to 9.1.6 shall comply with the sections stated, unless otherwise stated in this Section. |
| 9.1.2 | Formwork and finishes | Formwork and finishes to concrete for concrete carriageways shall comply with Section 13. |
| 9.1.3 | Reinforcement | Steel reinforcement for concrete carriageways shall comply with Section 14. |
| 9.1.4 | Concrete | Concrete for concrete carriageways shall comply with Section 15. |
| 9.1.5 | Curing compound | Curing compound for concrete carriageways shall comply with Section 15. |
| 9.1.6 | Earthworks | Earthworks for concrete carriageways shall comply with Section 6. |
| **9.2** | **MATERIALS** |  |
| 9.2.1 | Reinforcement | (1) Fabric reinforcement shall be steel fabric complying with BS 4483. The fabric shall be manufactured from steel wire which complies with BS 4482 and which has a type 2 bond classification.  (2) Dowel bars, tie bars, cradles and tie bars for cradles shall be Grade 250 plain round steel bars complying with actual Maldivian standards or similar.. Dowel bars and tie bars shall be straight. Both ends of dowel bars and one end of tie bars shall be sawn square with all burrs removed. |
| 9.2.2 | Cement mortar for cradles | Cement mortar for supporting cradles shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for the required work. Fine aggregates shall be sand or crushed rock to BS 1200 and shall pass a 5 mm BS test sieve. |
| 9.2.3 | Fine aggregate | Fine aggregate for concrete shall be natural river-deposited sand consisting of at least 95% by mass of quartz grains or clean, hard and durable crushed rock in accordance with Section 15. |
| 9.2.4 | Polyethylene sheeting | Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm. |
| 9.2.5 | Joint filler | Joint filler shall be of a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler. |
| 9.2.6 | Joint sealant | (1) Joint sealant shall be of a grade suited to the climatic conditions of the Maldives and shall perform effectively over a temperature range of 0°C to 60ºC.  (2) Joint sealant shall be a cold poured two-part polymer-based sealant complying with BS 5212, Type N.  (3) Primers and caulking material for use with joint sealant shall be of a proprietary types recommended by the joint sealant manufacturer and approved by the Engineer. |
| 9.2.7 | Bond breaker tape | Bond breaker tape shall be of a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer. The tape shall be a polyethylene film with adhesive applied on one side and shall be the full width of the groove. |
| 9.2.8 | Groove forming strip | (1) Groove forming strip shall be of a proprietary type approved by the Engineer. The strip shall be a firm compressible strip of either ethylene vinyl acetate foam with a density of at least 90 kg/m3 or synthetic rubber. The strip shall be 25 mm deep and 5 mm thick and shall be sufficiently rigid to remain in position during concreting without deforming or stretching.  (2) Adhesive for groove forming strip shall be of a proprietary type recommended by the groove forming strip manufacturer and approved by the Engineer. |
| 9.2.9 | Sleeves for dowel bars and tie bars | Sleeves for dowel bars and tie bars shall be uPVC and shall have a nominal wall thickness not exceeding 1.5 mm. The sleeves shall fit tightly to the bars. |
| 9.2.10 | Epoxy resin grout | Epoxy resin grout shall be of a proprietary type approved by the Engineer. |
| **9.3** | **CONCRETE** |  |
| 9.3.1 | Concrete mix | Concrete for concrete carriageways shall comply with the following requirements:  Concrete shall be Grade C 30/37 and shall be a designed mix.  The concrete mix shall contain either PFAC or a minimum of 265 kg of PC plus a minimum of 85 kg of PFA per m3 of compacted concrete.  The percentage by mass of fine aggregate to total aggregate shall be at least 30%.  The workability in terms of designed slump value shall not exceed 30 mm. |
| 9.3.2 | Cementitious content of concrete | The minimum cementitious content of concrete for concrete carriageways shall be 350 kg/m3. |
| **9.4** | **SUBMISSIONS** |  |
| 9.4.1 | Particulars of materials for joints | (1) The following particulars of the proposed materials for joints in concrete carriageways shall be submitted to the Engineer:  Manufacturer’s literature and a certificate for joint filler showing the manufacturer's name, the date and place of manufacture and showing that the joint filler complies with the requirements stated in the Contract and including results of tests for:  Disintegration and shrinkage  Recovery value and reduction in mass  Extrusion,  Manufacturer’s literature for joint sealant, including details of the method and time required for mixing the different components, and a certificate showing the manufacturer's name, the date and place of manufacture and showing that the sealant complies with the requirements stated in the Contract and including results of tests for:  Application life  Tack-free time  Resistance to flow  Recovery  Adhesion and cohesion in tension and compression  Resistance to heat ageing,  Manufacturer’s literature and a certificate for groove-forming strip showing the manufacturer's name, the date and place of manufacture and showing that the groove forming strip complies with the requirements stated in the Contract and including results of tests for density, and  Particulars of primers and caulking material for joint sealant, adhesive for groove forming strip, bond breaker tape and sleeves for dowel bars and tie bars.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 9.4.2 | Particulars of methods of construction | Particulars of proposed methods of construction for concrete carriageways shall be submitted to the Engineer at least 7 days before the trial length is constructed. |
| 9.4.3 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:  Polyethylene sheeting,  Joint filler,  Bond-breaker tape,  Groove-forming strip, and  Sleeves for dowel bars, including compressible filler, and for tie bars. |
| **9.5** | **TRIALS** |  |
| 9.5.1 | Compliance criteria: trial-mix concrete | The results of the tests on trial-mix concrete for concrete carriageways shall comply with the following requirements:  Each of the six slump values shall not exceed 40 mm, and the average of the six slump values shall not exceed 35 mm. |
| 9.5.2 | Trial length | (1) A trial length of concrete carriageway shall be constructed to demonstrate that the proposed materials, mix design, methods of production and methods of construction will produce a concrete carriageway which complies with the specified requirements.  (2) The trial length shall be constructed using the materials, mix design, methods of production and methods of construction submitted to the Engineer.  (3) If it is not stated in the Contract that the trial length is to be constructed in a location separate from the permanent carriageway, the trial length shall be the first 30 m of the permanent carriageway, or such other length agreed by the Engineer. The trial length shall be constructed over a width of two bays and shall include at least one expansion joint, one contraction joint and the longitudinal joint between the bays.  (4) The Contractor shall inform the Engineer at least 48 hours, or within a shorter period agreed by the Engineer, before constructing the trial length.  (5) The trial length shall be completed in sufficient time before the permanent carriageway is constructed to allow the Engineer a period of at least 7 days to determine if the specified requirements have been complied with in the trial length.  (6) The trial length shall be protected from damage and shall be left in position unless the Engineer instructs its removal. A trial length which forms part of the permanent carriageway and which complies with the specified requirements shall not be removed. |
| 9.5.3 | Testing: trial length | (1) The trial length shall be tested to determine the accuracy of the alignment and level, the surface regularity and the texture depth. The method of testing the surface regularity shall be as stated in Clause 9.16.1. The method of testing the texture depth shall be as stated in Clause 9.17.1.  (2) Concrete cores shall be cut from the trial length to determine the thickness of the slab, the positions of the reinforcement and joint components, the amount of segregation of the constituents and the presence of voids. The method of taking, preparing, inspecting and testing concrete cores shall be as stated in Clauses 9.19.1 and 10.63. |
| 9.5.4 | Compliance criteria: trial length | The results of tests on trial lengths shall comply with the following requirements:  The alignment, levels and thickness of the carriageway shall comply with Clauses 9.15.7 and 9.15.8.  The surface regularity shall comply with Clause 9.16.2.  The texture depth shall comply with Clause 9.17.2.  The positions of the reinforcement and joint components shall comply with Clauses 9.15.3, 9.15.4, 9.15.5 and 9.15.7.  The amount of segregation of the constituents and the presence of voids shall comply with Clause 9.19.3 |
| 9.5.5 | Non-compliance: trial length | (1) If the result of any test on the trial length does not comply with the specified requirements for the trial length, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer. Further trial lengths shall be constructed until the result of every test on the trial length complies with the specified requirements for the trial length. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial length was not due to the concrete mix.  (2) Unless otherwise permitted by the Engineer, trial lengths, or parts of trial lengths, which do not comply with the specified requirements for the trial length shall be removed. |
| 9.5.6 | Commencement of concreting | (1) Concrete shall not be placed in the permanent carriageway other than in a trial length until the result of every test on the trial length complies with the specified requirements for the trial length.  (2) Concrete may be placed in the permanent carriageway before the results of tests for compressive strength of the trial mix are available provided that the result of every other test on the trial mix and trial length complies with the specified requirements for trial mix concrete and for the trial length. |
| 9.5.7 | Changes in materials and methods of construction | Unless permitted by the Engineer, the materials, mix design, methods of production and methods of construction used to produce a trial length which complies with the specified requirements shall not be changed. |
| **9.6** | **STORAGE OF MATERIALS** |  |
| 9.6.1 | Storage of materials for joints and polyethylene sheeting | (1) Joint sealant, primer for joint sealant and adhesive for groove forming strip shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions that may adversely affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.  (2) Polyethylene sheeting, joint filler, bond breaker tape, groove forming strip and sleeves for dowel bars and tie bars shall be stored in accordance with the manufacturers' recommendations in a dry, weatherproof store with a raised floor. Joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air. |
| **9.7** | **PRELIMINARY WORK** |  |
| 9.7.1 | Installation of utilities | (1) Pipes, cables, manholes, chambers, gullies and other utilities below concrete carriageways shall be completed and fill material shall be deposited and compacted in trenches before the carriageway is constructed. Openings to manholes, chambers and gullies shall be protected by temporary covers or by other methods agreed by the Engineer.  (2) Box-outs shall be formed in concrete carriageways for covers, frames and other hardware. The covers, frames and other hardware shall be fixed in position after the main slab has been concreted and before the infill slab is concreted. |
| 9.7.2 | Preparation of formation and sub-base | Construction of concrete carriageways shall start as soon as practicable after the formation or sub-base has been completed. The formation shall be protected as stated in Clause 6.10.5 and the sub-base shall be protected as stated in Clause **Fehler! Verweisquelle konnte nicht gefunden werden.** until construction of the carriageway starts. |
| 9.7.3 | Laying polyethylene sheeting | Polyethylene sheeting below concrete carriageways shall be laid flat without creases. Laps shall be at least 300 mm and there shall be no gaps at the edges of bays. |
| **9.8** | **FORMWORK** |  |
| 9.8.1 | Formwork | (1) Unless otherwise approved by the Engineer, formwork for concrete carriageways shall be steel. The finish to concrete surfaces for transverse and longitudinal joints shall be Class F3. The finish to concrete surfaces for other edges of the carriageway shall be Class F2.  (2) Concrete shall not be placed against excavated surfaces or against kerbs unless permitted by the Engineer.  (3) Formwork shall not be loosened or removed until at least 7 hours after concreting has been completed. |
| **9.9** | **FORMING JOINTS** |  |
| 9.9.1 | Forming joints | (1) Materials for joints in concrete carriageways shall be used in accordance with the manufacturers' recommendations or as otherwise stated in the Contract.  (2) Dowel bars, tie bars and their sleeves shall be securely fixed in position through holes in the formwork before concreting. The bars shall be parallel to the top surface of the slab and to each other. Bars at transverse joints shall be parallel to the adjacent longitudinal joint or to the longitudinal axis of the carriageway if there is no longitudinal joint or to other lines instructed by the Engineer.  (3) Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and the formation. Holes in joint filler for dowel bars shall be cut to form a sliding fit to the sleeved bar.  (4) Joints shall be formed perpendicular to the top surface of the slab. |
| 9.9.2 | Transverse joints | (1) Unless otherwise permitted by the Engineer, transverse joints in concrete carriageways shall be straight and perpendicular to the longitudinal axis of the carriageway.  (2) Transverse expansion joints and transverse contraction joints shall be formed only at the specified positions. The joints shall be continued across longitudinal joints and shall be in line and of the same type on both sides of the longitudinal joint. The joints shall be continued through kerbs, edgings and quadrants and their foundation and backing. The joint dimensions and materials shall be the same as the transverse joints with the omission of dowel bars. The location of additional contraction joints in accordance with Clause 10.23.2 shall be as instructed by the Engineer.  (3) The joint filler and groove for joint sealant at transverse expansion joints shall provide complete separation of adjacent slabs. |
| 9.9.3 | Longitudinal joints | Longitudinal joints in concrete carriageways shall be formed only at the specified positions. |
| 9.9.4 | Isolation joints | Isolation joints shall be formed in concrete carriageways at manholes and chambers. |
| 9.9.5 | Forming grooves | (1) Grooves in concrete carriageways for joint sealant shall be straight, shall have parallel sides and shall be perpendicular to the top surface of the slab. The bottom of the groove shall be flat and shall be parallel to the top surface of the slab.  (2) Grooves at transverse expansion joints and at isolation joints at manholes and chambers shall be formed by sawing the groove to the specified width and depth not less than 7 days after concreting. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove.  (3) Grooves at transverse contraction joints shall be formed using one of the following methods:  Method 1: An initial groove shall be sawn as soon as practicable after concreting without causing spalling of the edges. The width of the initial groove shall be less than the specified width of the final groove and the depth of the initial groove shall be between 1/4 and 1/3 of the thickness of the slab. The final groove shall be sawn to the specified width and depth not less than 7 days after concreting. The center-lines of the initial and final grooves shall coincide.  Method 2: The final groove shall be sawn to the specified width and depth as soon as practicable after concreting without causing spalling of the edges.  (4) Grooves at transverse construction joints shall be formed by fixing groove-forming strip with adhesive to the concrete already placed before concreting the adjacent slab. |
| 9.9.6 | Protection of grooves | Before permanent sealing, grooves in concrete carriageways for joint sealant shall be protected from contamination by a temporary sealing strip or by other methods agreed by the Engineer. |
| 9.9.7 | Sealing joints | (1) The permanent sealing of joints in concrete carriageways shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.  (2) Immediately before permanent sealing, groove forming strips, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.  (3) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.  (4) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.  (5) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer's recommendations.  (6) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air. The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.  (7) The groove shall be clean and dry at the time of applying the primer and joint sealant.  (8) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the surface of the slab. |
| **9.10** | **PLACING AND COMPACTING CONCRETE** |  |
| 9.10.1 | Placing and compacting concrete | (1) Concrete shall be placed continuously between the joints in concrete carriageways unless otherwise permitted by the Engineer.  (2) Concrete in unreinforced slabs shall be placed and compacted to the full thickness of the slab in one operation.  (3) Unless otherwise permitted by the Engineer, concrete in reinforced slabs shall be placed and compacted to the specified level of the fabric reinforcement. The fabric reinforcement shall be placed in position and concrete shall be placed and compacted to the remaining thickness of the slab. The time between compaction of the first layer and placing of the remaining layer shall not exceed 30 minutes unless in the opinion of the Engineer the concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed as stated in Clause 15.12.1. Concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer.  (4) Concrete in infill slabs at covers, frames and other hardware shall be placed and compacted after the covers, frames and hardware have been fixed in position and shall not be placed at the same time as the concrete in the main slab. |
| **9.11** | **CONSTRUCTION JOINTS** |  |
| 9.11.1 | Construction joints | (1) Construction joints shall be formed in concrete carriageways only where approved by the Engineer or in cases of emergency if concreting is interrupted by adverse weather, plant breakdown or similar circumstances. Construction joints shall not be formed within 2.5 m of an existing or planned expansion or contraction joint.  (2) Transverse construction joints shall be formed by either:  Using formwork and cast-in tie bars, or  Breaking back from an unformed edge and fixing the tie bars and sleeves with epoxy resin grout in drilled holes. |
| **9.12** | **SURFACE FINISH** |  |
| 9.12.1 | Surface regulation | (1) Unless combined double beam compactor-levellers are being used, then after compaction, the concrete in concrete carriageways shall be struck off to slightly above the levels of the formwork and the surface shall be regulated by a regulating machine or a vibrating beam.  (2) Regulating machines shall be purpose made and shall span the full width of the slab either transversely or obliquely. The machine shall be equipped with at least two oscillating-type transverse screeds and shall be supported on a carriage.  (3) Vibrating beams shall have a steel or aluminium surface and shall be mounted on a separate carriage. The beam shall be driven by a motor to provide a vibration frequency of at least 3500 cycles per minute.  (4) After regulation by the regulating machine or vibrating beam, the surface of the carriageway shall be regulated by at least two passes of a scraping straight edge with a blade length of at least 1.8 m. Scraping straight edges that operate in conjunction with regulating machines shall pass across the surface at right angles to the longitudinal axis of the carriageway. If the surface is torn by the straight edge, the surface shall be regulated again by the regulating machine or vibrating beam and by the scraping straight-edge.  (5) Wooden floats may be used to tamp and regulate small areas of the carriageway as agreed by the Engineer. Steel floats or trowels shall not be used. |
| 9.12.2 | Surface texturing | (1) After the surface of the concrete carriageway has been regulated and before the curing compound is applied, the surface, other than the surface of channels and edges of slabs that do not require to be textured, shall be textured by brushing with a wire broom.  (2) The wire broom shall be at least 450 mm wide and shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in each row shall be at 10 mm centres and in line with the centre of the gaps between the tufts in the other row. The tufts shall contain an average of 14 wires, each of 32 gauge and initially 100 mm long. The broom shall be replaced if any tuft wears down to a length of 90 mm.  (3) The surface texture shall be produced by brushing evenly across the slab in one direction at right angles to the longitudinal axis of the carriageway. Brushing shall be carried out after the moisture film has disappeared from the concrete surface and before the initial set is complete. |
| **9.13** | **CURING CONCRETE** |  |
| 9.13.1 | Curing concrete | The surface and edges of concrete carriageways shall be protected by one of the methods stated in Clause 15.13.1 except that covering with hessian, sacking, canvas or other absorbent material as stated in Method 2 shall not be used. If Method 1 is used, the curing compound shall be applied to the surface immediately after the surface has been textured and shall be applied to the edges immediately after the formwork has been removed. |
| **9.14** | **PROTECTION OF CONCRETE CARRIAGEWAY** |  |
| 9.14.1 | Protection of concrete carriageway | (1) Immediately after the curing system has been applied, the concrete carriageway shall be fenced off from pedestrian traffic and covered with protective sheeting for at least 24 hours. The sheeting shall be lapped and securely held in position in such a manner that the surface of the carriageway will not be damaged.  (2) Loads from materials not forming part of the permanent work or from Constructional Plant or other vehicles shall not be applied to the concrete carriageway until at least 7 days after concreting has been completed and until all grooves at joints have been temporarily or permanently sealed or protected. |
| **9.15** | **TOLERANCES** |  |
| 9.15.1 | Tolerances: sub-base | The level of the sub-base below concrete carriageways shall not be more than 10 mm higher, and shall not be more than 20 mm lower, than the specified level. |
| 9.15.2 | Tolerances: formwork | (1) The line of formwork for concrete carriageways shall be within 10 mm of the specified line of the concrete carriageway.  (2) The level of the top of the formwork shall be within 3 mm of the specified level of the concrete carriageway.  (3) Abrupt irregularities in the line of the formwork and in the level of the top of formwork shall not exceed 3 mm. |
| 9.15.3 | Tolerances: reinforcement | The cover to fabric reinforcement in concrete carriageways shall be within 10 mm of the specified cover. |
| 9.15.4 | Tolerances: dowel bars and tie bars | (1) Dowel bars at joints in concrete carriageways shall be within 20 mm of the mid-depth of the slab.  (2) Dowel bars shall be parallel to within 3 mm in half the length of the bar to:  The longitudinal joint, or the longitudinal axis of the concrete carriageway if there is no longitudinal joint,  The top surface of the slab, and  Adjacent dowel bars. |
| 9.15.5 | Tolerances: grooves | Unless otherwise recommended by the manufacturer of the joint sealant the depth of grooves for joint sealant in concrete carriageways shall be within 3 mm of the specified depth. |
| 9.15.6 | Tolerances: covers, frames and other hardware | The level of covers, frames and other hardware shall not be higher than, and shall not be more than 3 mm lower than, the surface of the adjacent carriageway. |
| 9.15.7 | Tolerances: alignment of concrete carriageway | (1) The best-fit straight line of straight joints and of straight edges of concrete carriageways shall be within 25 mm of the specified line. The line of straight joints and of straight edges of concrete carriageways shall be within 10 mm of the best-fit straight line.  (2) The best fit curved line of curved joints and of curved edges of concrete carriageways shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints and of curved edges of concrete carriageways shall be within 10 mm of the best-fit curved line.  (3) Joints in concrete carriageways shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint. |
| 9.15.8 | Tolerances: level of concrete carriageway | (1) The levels of the surface of concrete carriageways shall be determined 200 mm from the edges of each bay at 10 m centres in the longitudinal direction and at 2 m centres in the transverse direction.  (2) The level of the surface of concrete carriageways shall be within 6 mm of the specified level. In low lying and flat areas the Contractor shall pay special attention to level control to ensure that falls on the surface of the carriageway are in the specified direction.  (3) The difference in level of the surface of concrete carriageways across joints shall not exceed 3 mm.  (4) The thickness of concrete carriageway slabs shall not be less than the specified thickness minus 10 mm. |
| **9.16** | **TESTING: SURFACE REGULARITY** |  |
| 9.16.1 | Testing: surface regularity | (1) The surface regularity of concrete carriageways shall be determined by measuring the number of irregularities in the surface. An irregularity means that the gap between the surface of the carriageway, and a 3 m straight-edge placed on the surface of the carriageway, exceeds the specified amount. Irregularities shall be measured in millimetres perpendicular to the straight edge.  (2) The longitudinal surface regularity of carriageways with a total length of 75 m or more may be measured using a rolling straight-edge of the type designed by the UK Transport and Road Research Laboratory. The longitudinal surface regularity of carriageways with a total length of less than 75 m and the transverse surface regularity of carriageways shall be measured using a 3 m straight edge.  (3) The longitudinal surface regularity shall be measured along lines parallel to the longitudinal axis of the carriageway and approximately 1 m from the nearside edge of each carriageway lane. The transverse surface regularity shall be measured along lines at right angles to the longitudinal axis of the carriageway at 10 m intervals along the length of the carriageway.  (4) Testing to determine the surface regularity will be carried out by the Engineer. |
| 9.16.2 | Compliance criteria: surface regularity | The results of tests for surface regularity of carriageways shall comply with the following requirements:  The size and number of irregularities in the longitudinal direction shall not exceed the size and permitted number of irregularities stated in Table 9.1.  There shall be no irregularity exceeding 4 mm in a 3 m length in the transverse direction for Category A roads and there shall be no irregularity exceeding 7 mm in a 3 m length in the transverse direction for Category B roads. |

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| Table 9.1: Permitted irregularities in the longitudinal direction |

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| --- | --- | --- | --- | --- |
| Total length of carriageway | Size of irregularity | | Permitted number of irregularities (Category A road) | Permitted number of irregularities (Category B road) |
| < 75 m | > 4 mm | | (9 x total length)/75 | (18 x total length)/75 |
| > | 7 mm | 1 | 2 |
| 75 m - 300 m | > | 4 mm | 9 in any 75 m length | 18 in any 75 m length |
| > | 7 mm | 1 in any 75 m length | 2 in any 75 m length |
| > 300 m | > | 4 mm | 20 in any 300 m length | 40 in any 300 m length |
| 9 in any 75 m length | 18 in any 75 m length |
| > | 7 mm | 2 in any 300 m length | 4 in any 300 m length |
| 1 in any 75 m length | 2 in any 75 m length |

|  |  |  |
| --- | --- | --- |
|  |  | Category A roads are roads with a legal speed limit greater than 70 kilometre per hour. All other roads are Category B roads.  Irregularities greater than 7 mm shall also be counted as greater than 4 mm. No irregularity greater than 10 mm shall be permitted. |
| **9.17** | **TESTING: TEXTURE DEPTH** |  |
| 9.17.1 | Testing: texture depth | (1) The texture depth of concrete carriageways shall be determined by the sand patch test. Tests shall be carried out at least 2 days after the surface texturing has been carried out and before the area is used by Constructional Plant or other vehicles.  (2) Each carriageway lane shall be divided into sections of equal length not exceeding 150 m. Tests shall be carried out at ten locations on each Section at approximately equal spacing as instructed by the Engineer. No measurement shall be taken within 300 mm of the longitudinal edges of the sections.  (3) Testing to determine the texture depth will be carried out by the Engineer. The method of testing shall be in accordance with existing standards or similar |
| 9.17.2 | Compliance criteria: texture depth | The results of tests for texture depth for each Section of concrete carriageway lane shall comply with the following requirements:  The average texture depth shall not be less than 0.70 mm, and  Not more than one out of the ten measured texture depths shall be less than 0.6 mm. |
| **9.18** | **TESTING: CONCRETE** |  |
| 9.18.1 | Testing: workability and compressive strength of concrete | Testing to determine the workability and compressive strength of concrete in concrete carriageways shall be as stated in Clauses 15.17.1 to 15.19.5 except as stated in Clauses 15.19.3 and 15.19.4. |
| 9.18.2 | Compliance criteria: workability of concrete | The average slump value of the two specimens taken from one sample of concrete shall not exceed the approved slump value by more than 10 mm. |
| 9.18.3 | Samples: compressive strength of concrete | One sample of concrete shall be provided from each 25 m3 or 25 batches of concrete or from the amount of concrete produced each day, whichever is less. |
| **9.19** | **TESTING: CONCRETE CORES FROM TRIAL LENGTHS** |  |
| 9.19.1 | Samples: concrete cores from trial lengths | (1) Two concrete cores shall be provided from each bay, and one core shall be provided from each joint, of concrete carriageway in the trial length. The positions from which the cores are taken shall be as instructed by the Engineer.  (2) Concrete cores shall be 150 mm diameter unless otherwise permitted by the Engineer and shall be the full depth of the slab. Cores shall be taken as soon as the concrete has hardened sufficiently for the core to be taken.  (3) The method of taking concrete cores shall be in accordance with actual Maldivian standards or similar..  (4) Holes formed by taking concrete cores from trial lengths that form part of the permanent carriageway shall be reinstated using the approved concrete mix. Joints shall be repaired as instructed by the Engineer. |
| 9.19.2 | Testing: concrete cores from trial lengths | (1) Each concrete core from trial lengths in concrete carriageways shall be inspected to determine the thickness of the slab and the positions of the reinforcement and joint components. Each core shall be inspected for evidence of segregation of the constituents and for the presence of voids.  (2) The method of preparing and inspecting concrete cores shall be in accordance with actual Maldivian standards or similar.. |
| 9.19.3 | Compliance criteria: concrete cores from trial lengths | The concrete core shall be considered as non-compliant if it exhibits honeycombing which means interconnected voids arising from, for example, inadequate compaction or lack of mortar. |
| **9.20** | **TESTING: MATERIALS FOR JOINTS** |  |
| 9.20.1 | Batch: joint filler, joint sealant | A batch of joint filler or joint sealant shall comply with Clause 15.28.1. |
| 9.20.2 | Samples: joint filler, joint sealant | Samples of joint filler or joint sealant shall comply with Clause 15.28.2. |
| 9.20.3 | Testing: joint filler, joint sealant | Testing of joint filler and joint sealant for joints in concrete carriageways shall be as stated in Clauses 15.28.3 and 15.28.4 except as stated in Clause 9.20.4. |
| 9.20.4 | Testing: joint sealant | Each sample of joint sealant shall be tested to determine the application life, tack-free time, resistance to flow, recovery, adhesion and cohesion in tension and compression and resistance to heat ageing. The method of testing shall be in accordance with BS 5212. |
| **10.** | **SECTION 10 MISCELLANEOUS ROADWORKS** |  |
|  | ***PART 1: GENERAL REQUIREMENTS*** |  |
| **10.1** | **GENERAL** |  |
| 10.1.1 | General requirements | The works and materials specified in Clauses 10.1.2 to 10.1.8 shall comply with the sections stated, unless otherwise stated in this Section. |
| 10.1.2 | Earthworks | Earthworks shall comply with Section 6. |
| 10.1.3 | Sub-base material and bituminous materials | Sub-base material and bituminous materials shall comply with Section 8. |
| 10.1.4 | Joints in concrete | Joints in concrete shall comply with Section 9. |
| 10.1.5 | Formwork | Formwork and finishes to concrete shall comply with Section 13. |
| 10.1.6 | Reinforcement | Steel reinforcement shall comply with Section 14. |
| 10.1.7 | Concrete | Concrete shall comply with Section 15. |
| 10.1.8 | Steelwork | Steelwork shall comply with Section 16. |
| **10.2** | **MATERIALS** |  |
| 10.2.1 | Cement mortar | Cement mortar shall consist of one part of cement to three parts of fine aggregate by volume together with the minimum amount of water necessary to achieve a consistency suitable for the required work. Fine aggregates shall be sand or crushed rock to BS 1200 and shall pass a 5 mm BS test sieve. |
| 10.2.2 | Polyethylene sheeting | Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm. |
|  | ***PART 2: CONCRETE PROFILE BARRIERS*** |  |
| **10.3** | **MATERIALS** |  |
| 10.3.1 | Concrete mix | Concrete for concrete profile barriers shall be Grade 30/20. |
| **10.4** | **SUBMISSIONS** |  |
| 10.4.1 | Particulars of concrete profile barriers | (1) The following particulars of the proposed methods of construction for concrete profile barriers shall be submitted to the Engineer:  Particulars of formwork as stated in Clause 13.4.1 for in-situ construction using fixed forms,  Details of slip-form machine for in-situ construction between sliding forms, and  Methods of manufacture, handling, transport, storage and fixing in position of precast units.  (2) The particulars shall be submitted to the Engineer for information at least 14 days before construction of concrete profile barriers starts. |
| **10.5** | **TRIALS** |  |
| 10.5.1 | Trial length | (1) A trial length of concrete profile barrier shall be constructed to demonstrate that the proposed materials, mix design, methods of production and methods of construction will produce a concrete profile barrier which complies with the specified requirements. If it is not stated in the Contract that the trial length is to be constructed in a location separate from the permanent concrete profile barrier, the trial length shall be the first 25 m of the permanent barrier.  (2) The trial length shall be constructed in sufficient time before the permanent barrier is constructed to allow the Engineer a period of at least 7 days to determine if the specified requirements have been produced in the trial length.  (3) The Contractor shall inform the Engineer at least 24 hours, or such shorter period agreed by the Engineer, before constructing the trial length.  (4) The trial length shall be constructed using the materials, mix design, methods of production and methods of construction submitted to the Engineer.  (5) The trial length shall be used as a means of comparison against which the Engineer shall determine the compliance or otherwise of the permanent concrete profile barrier. The trial length shall be protected from damage and shall be left in position unless the Engineer instructs its removal. A trial length which forms part of the permanent barrier and which complies with the specified requirements shall not be removed. |
| 10.5.2 | Testing: trial length | (1) The trial length shall be tested to determine the accuracy of the alignment and level and the finish of the concrete surface.  (2) Concrete cores shall be cut from the trial length to determine the amount of segregation of the constituents and the presence of voids. The method of taking, preparing, inspecting and testing concrete cores shall be as stated in Clause 10.11.1. |
| 10.5.3 | Compliance criteria: trial length | The results of tests on trial lengths shall comply with the following requirements:  The alignment and levels of the barrier shall comply with Clause 10.10.1.  The finish of concrete surfaces shall comply with Clause 13.13.2.  The amount of segregation of the constituents and the presence of voids shall comply with Clause 9.19.3 for concrete carriageways. |
| 10.5.4 | Non-compliance: trial length | (1) If the result of any test on the trial length does not comply with the specified requirements for the trial length, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer. Further trial lengths shall be constructed until the result of every test on the trial length complies with the specified requirements for the trial length. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial length was not due to the concrete mix.  (2) Unless otherwise permitted by the Engineer, trial lengths, or parts of trial lengths, which do not comply with the specified requirements for the trial length shall be removed. |
| 10.5.5 | Commencement of concreting | (1) Except as stated in Clause 10.5.5 concrete shall not be placed in the permanent barriers until the result of every test on the trial length complies with the specified requirements for the trial length.  (2) Concrete may be placed in the permanent barriers before the results of tests for compressive strength of the trial mix are available provided that the result of every other test on the trial mix and trial length complies with the specified requirements for trial mix concrete and for the trial length. |
| 10.5.6 | Changes in materials and methods of construction | Unless permitted by the Engineer, the materials mix design, methods of production and methods of construction used to produce a trial length that complies with the specified requirements shall not be changed. Further trial lengths shall be constructed to demonstrate any proposed changes unless otherwise permitted by the Engineer. |
| **10.6** | **FORMWORK AND FINISHES TO CONCRETE** |  |
| 10.6.1 | Formwork | (1) Formwork for concrete profile otherwise permitted by the Engineer.  barriers shall be steel unless  (2) Formwork shall not be loosened or removed until at least 7 hours after concreting has been completed. |
| 10.6.2 | Finishes to concrete | (1) The finish to unformed concrete surfaces of concrete profile barriers shall be Class U5.  (2) The finish to concrete surfaces for transverse joints shall be Class F3 and the finish to exposed concrete surfaces shall be Class F5. |
| **10.7** | **JOINTS IN CONCRETE PROFILE BARRIERS** |  |
| 10.7.1 | Joints in concrete profile barriers | (1) Joints shall be formed in concrete profile barriers at locations which coincide with expansion or construction joints in the adjoining structure or carriageway or at intervals not exceeding 12 m, whichever is less.  (2) Joints in concrete profile barriers shall comply with Section 15. |
| **10.8** | **CONSTRUCTION OF CONCRETE PROFILE BARRIERS** |  |
| 10.8.1 | Construction by slip-form machine | Construction of concrete profile barriers by slip-form machine between sliding forms shall be carried out in accordance with BS 5931. Slip-form machines shall comply with BS 5931, Appendix A. |
| 10.8.2 | Construction using precast units | Precast concrete profile barriers shall be laid on a cement mortar regulating layer of between 10 mm and 40 mm thick. |
| **10.9** | **PROTECTION OF CONCRETE PROFILE BARRIERS** |  |
| 10.9.1 | Protection of concrete profile barriers | Immediately after the formwork has been removed or the curing compound has been applied, concrete profile barriers shall be protected by polyethylene sheeting for at least 24 hours from exposure to conditions that may affect the concrete. The sheeting shall be lapped and securely held in position in such a manner that the surface of the concrete will not be damaged. |
| **10.10** | **TOLERANCES** |  |
| 10.10.1 | Tolerances: concrete profile barriers | Concrete profile barriers shall comply with the following requirements:  The horizontal dimensions of cross-sections shall be within 5 mm of the specified dimensions.  The vertical dimensions of cross-sections shall be within 10 mm of the specified dimensions.  The horizontal alignment along the centreline shall be within 10 mm of the specified centreline.  The level of the formation shall be within 10 mm of the specified level.  The level of the top of the barriers shall be within 10 mm of the specified level.  The barriers shall form a smooth alignment. |
| **10.11** | **TESTING: CONCRETE CORES FROM TRIAL LENGTHS** |  |
| 10.11.1 | Testing: concrete cores from trial lengths | (1) Two concrete cores shall be provided from each trial length of concrete profile barriers. The positions from which the cores are taken shall be as instructed by the Engineer.  (2) Samples, testing and compliance criteria for concrete cores from trial lengths shall be as stated in Clauses 9.19.1, 9.19.2 and 9.19.3 for concrete carriageways. |
|  | ***PART 3: PEDESTRIAN GUARD-RAILING*** |  |
| **10.12** | **GENERAL** |  |
| 10.12.1 | Design of pedestrian guard-railing | Pedestrian guard-railing which is proposed by the Contractor as an alternative to that stated in the Contract or which is erected as Temporary Works shall be designed in accordance with BS 3049, Table 1, Class C. |
| **10.13** | **MATERIALS** |  |
| 10.13.1 | Steel | Steel for pedestrian guard-railing shall comply with the following:  Hot finished seamless tubes : BS 6323: Part 3  Steel tubes and tubulars  suitable for screwing to BS 21  pipe threads : BS 1387  Hot rolled sections : BS 4: Part 1  Hot rolled structural steel  sections - equal and  unequal angles : BS 4848: Part 4  Weldable structural steels : BS 4360. |
| 10.13.2 | Stainless steel | Stainless steel for pedestrian guard-railing shall be Grade 316 S 31 and shall comply with the following:  General inspection and testing procedures and specific  requirements for carbon,  carbon manganese and  stainless steels : BS 970: Part 1  Stainless steel tubes suitable  for threading in accordance  with BS 21 : BS 6362. |
| 10.13.3 | Aluminium | (1) Aluminium for pedestrian guard-railing shall be H 30 TF and shall comply with the following:  Wrought aluminium and aluminium alloys for general engineering purposes  plate, sheet and strip : BS 1470  drawn tube : BS 1471  bars, extruded round  tubes and sections : BS 1474.  (2) Aluminium shall be anodised to Grade AA 25 in accordance with BS 1615. |
| 10.13.4 | Bolts, nuts, screws, washers and rivets | (1) Bolts, nuts, screws, washers and rivets for pedestrian guard-railing shall comply with the following:  ISO metric black hexagon bolts, screws and nuts : BS 4190  ISO metric black cup and  countersunk head bolts and screws with hexagon nuts: BS 4933  Metal washers for general  engineering purposes : BS 4320  Rivets for general engineering  purposes : BS 4620  Wrought aluminium and aluminium  alloys for general engineering purposes  - rivet, bolt and screw stock : BS 1473.  (2) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.  (3) Rag, indented and expansion bolts and resin bonded bolts shall be of proprietary types approved by the Engineer and shall be capable of withstanding the design loading.  (4) Galvanized bolts, nuts, screws, washers and rivets shall be used with galvanized pedestrian guard-railing. Aluminium materials shall be insulated from ferrous materials by a non-conductive insulator at least 2 mm thick of a type approved by the Engineer. |
| 10.13.5 | Mesh infill | Mesh infill for pedestrian guard-railing shall comply with BS 4483. The mesh infill shall be free of surface defects, surface irregularities and mesh misalignment. |
| **10.14** | **FABRICATION OF PEDESTRIAN GUARD-RAILING** |  |
| 10.14.1 | Galvanizing to steel | (1) Steel components forming pedestrian guard-railing shall be hot-dip galvanized in accordance with BS EN ISO 1461..  (2) Galvanizing to steel shall be applied after welding, drilling and cutting are complete. |
| 10.14.2 | Welding steel | (1) Welding for fabrication of pedestrian guard-railing shall be fillet welds. Welded surfaces shall be clean and flush before application of the protective coating.  (2) Steel shall not be welded after galvanizing unless permitted by the Engineer. If permitted, the welded areas shall be free of scale and slag and shall be treated with an alternative zinc-coating system approved by the Engineer. |
| **10.15** | **SUBMISSIONS** |  |
| 10.15.1 | Particulars of pedestrian guard-railing | (1) The following particulars of the proposed pedestrian guard-railing shall be submitted to the Engineer:  A certificate from the manufacturer showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract, and  Details of alternative designs proposed by the Contractor, including drawings, showing the proposals and that the pedestrian guard-railing has been designed in accordance with Clause 10.12.1  (2) The particulars shall be submitted to the Engineer at least 28 days before fabrication of the pedestrian guard-railing starts. |
| 10.15.2 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer for approval of the source and type of each material at the same time as particulars of the pedestrian guard-railing are submitted:  Each type of pedestrian guard-railing,  Mesh infill, and  Each type of bolt, nut, and washer. |
| **10.16** | **STORAGE OF MATERIALS** |  |
| 10.16.1 | Storage of pedestrian guard-railing | Pedestrian guard-railing shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner which will not result in damage or deformation to the guard-railing or in contamination of the guard-railing. Pedestrian guard-railing shall be protected from damage and damaged guard-railing shall not be used in the permanent work unless permitted by the Engineer. Measures to protect the materials from the effects of weather shall be submitted to the Engineer for approval. |
| **10.17** | **INSTALLATION OF PEDESTRIAN GUARD-RAILING** |  |
| 10.17.1 | Installation of pedestrian guard-railing | (1) Pedestrian guard-railing shall be installed to a smooth alignment to within 10 mm of the specified position and height.  (2) Pedestrian guard-railing which is to be installed to a radius of less than 45 m shall be curved in the workshop and shall not be made up of a series of straight lengths.  (3) Pedestrian guard-railing shall be fixed to concrete using rag, indented, expansion or resin bonded bolts and shall be bolted to metalwork. Bolts for fixing to concrete shall be fitted into pockets filled with cement mortar or resin grout. |
|  | ***PART 4: UNTENSIONED BEAM BARRIERS*** |  |
| **10.18** | **MATERIALS** |  |
| 10.18.1 | Beams | (1) Beams for untensioned beam barriers shall be formed from steel plates complying with BS 1449: Part 1, type BHR, Grade 43/25.  (2) The beams shall be capable of withstanding a tensile force of at least 300 kN and shall not deflect by more than 40 mm when loaded centrally with a point load of 1 t over a simply supported span of 3 m.  (3) Beams shall comply with the following requirements:  The base metal thickness shall be within 0.2 mm of the specified thickness.  The strip width shall be within + 2.5 mm and - 0 mm of the specified width.  The camber of the strip length shall be within 8 mm of the specified camber.  The beam shall be straight to within 1.5 mm in a 1.5 m length.  Angles at bends shall be within 2° of the specified angle.  (4) Bolt slots in beams for connection to posts shall be prepared in the workshop by cold saw-cutting. The spacing of the slots shall be such that posts will be spaced at either 4 m or 2 m.  (5) Beams shall be hot-dip galvanized to BS EN ISO 1461:1999 :1999.  (6) Welds for end beam sections shall be full-penetration butt welds. |
| 10.18.2 | Posts | (1) Posts for untensioned beam barriers shall be formed from Grade 43A steel complying with BS 4360.  (2) Posts shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.  (3) Posts fabricated from hollow sections shall be sealed by welding mild steel sealing plates over the open ends. The plates shall be at least 3 mm thick.  (4) Posts shall be within the tolerances stated in BS 4. |
| 10.18.3 | Cleats and struts | (1) Cleats and struts for untensioned beam barriers shall be fabricated from angle sections complying with BS 4 and shall be weldable structural steel complying with BS 4360, Grade 43A.  (2) Cleats and struts shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.  (3) The dimensional tolerances of steel angles for cleats and struts shall comply with BS 4. |
| 10.18.4 | Bolts and nuts | (1) Bolts for untensioned beam barriers shall be M 16 size and strength Grade 4.6 complying with BS 4190. Bolts for beam splicing, bolts for connecting beams to posts and bolts for connecting beams to cleats shall be round or button-headed with oval shoulders. Other bolts shall be ISO metric black hexagon type.  (2) Nuts for untensioned beam barriers shall be strength Grade 4 or 5 complying with BS 4190.  (3) Bolts and nuts shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.  (4) Nuts shall be tapped 0.4 mm oversize to accommodate the galvanized coating.  (5) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.  (6) Rag, indented and expansion bolts and resin bonded bolts shall be of a proprietary type approved by the Engineer and shall be capable of withstanding the design loading. |
| 10.18.5 | Washers | (1) Washers for untensioned beam barriers shall be black mild steel and shall comply with BS 4320, Form E, F or G. Washers shall be manufactured from steel complying with BS 1449: Part 1, Grade 250.  (2) Plain washers shall be 2 mm thick and shall be of dimensions suitable for use with M 16 bolts and nuts.  (3) Plain washers shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.  (4) Shaped washers shall have a thickness of at least 5 mm and shall be cast iron complying with BS 3468. The washers shall be shaped to fit the curvature of circular hollow sections used as posts. |
| ***10.19*** | ***SUBMISSIONS*** |  |
| 10.19.1 | Particulars of untensioned beam barriers | (1) The following particulars of the proposed materials and methods of construction for untensioned beam barriers shall be submitted to the Engineer:  A certificate from the manufacturer for beams in the format stated in BS 4360 showing the manufacturer's name, the date and place of manufacture and showing that the beams comply with the requirements stated in the Contract and including carbon equivalent values, and  Details of method of installation.  (2) The particulars, including certificates, shall be submitted to the Engineer for approval of the source and type of materials at least 14 days before installation of the beams starts. Certificates shall be submitted for each batch of beams delivered to the Site. |
| 10.19.2 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer for approval of the source and type of each material at the same time as particulars of the material are submitted:  Beams,  Posts, cleats and struts, and  Bolts, nuts and washers. |
| ***10.20*** | ***STORAGE OF MATERIALS*** |  |
| 10.20.1 | Storage of beams and posts | Beams and posts for untensioned beam barriers shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner that will not result in damage or deformation to the beams and posts or in contamination of the beams and posts. Beams and posts shall be protected from damage and damaged beams and posts shall not be used in the permanent work unless permitted by the Engineer. Measures to protect the materials from the effects of weather shall be submitted to the Engineer for approval. |
| ***10.21*** | ***CONSTRUCTION OF UNTENSIONED BEAM BARRIERS*** |  |
| 10.21.1 | Installation of untensioned beam barriers | (1) Untensioned beam barriers shall be ready for assembly when delivered to Site. Beams and posts shall be free of blisters, flux, uncoated spots and other defects.  (2) Untensioned beam barriers shall be installed to a smooth alignment to within 10 mm of the specified position and height. Transition sections shall provide a smooth and uniform transition.  (3) Beams which are to be installed to a radius of less than 45 m shall be curved in the workshop.  (4) Untensioned beam barriers shall be fixed to concrete using rag, indented, expansion or resin bonded bolts and shall be bolted to metalwork. Bolts for fixing to concrete shall be fitted into pockets filled with cement mortar or resin grout. |
| 10.21.2 | Compacted earth footings | (1) Sub-base material shall be deposited and compacted in the bottom 250 mm of pits for foundations of untensioned beam barriers with compacted earth footings. Fine fill material shall be deposited and compacted to the remainder of the pit. The sub-base material and fill material shall be compacted to obtain a relative compaction of at least 95% throughout.  (2) Posts for untensioned beam barriers shall be securely fixed in position during deposition and compaction of fill material. |
| 10.21.3 | Concrete footings | (1) Concrete for concrete footings shall be Grade 20/20.  (2) The top surface of concrete footings shall be finished level with the adjoining ground. The finish to the concrete surface shall be Class U5.  (3) Posts shall be surrounded with polyethylene sheeting before concrete is placed and shall be securely fixed in position during concreting. |
| 10.21.4 | Anchor blocks | (1) Concrete for anchor blocks shall be Grade 20/20.  (2) The finish to concrete surfaces of anchor blocks shall be Class F5 for formed finishes and Class U5 for unformed finishes. |
|  | ***PART 5: KERBS, EDGINGS AND QUADRANTS*** |  |
| **10.22** | **MATERIALS** |  |
| 10.22.1 | Concrete kerbs, edgings and quadrants | (1) Concrete for kerbs, edgings and quadrants shall be Grade 30/20. Concrete for foundations and backings to kerbs, edgings and quadrants shall be Grade 20/20.  (2) Precast concrete kerbs, edgings and quadrants shall comply with BS 7263: Part 1 except that the requirement for testing of water absorption shall not be applied. The nominal length of kerbs shall be 1 m and the nominal length of edgings shall be 750 mm. |
| 10.22.2 | Granite kerbs, edgings and quadrants | (1) Granite kerbs, edgings and quadrants shall be worked straight or circular. Corners shall be square and the top front and back edges shall be parallel. The length of granite kerbs and edgings shall be at least 600 mm.  (2) The ends of the kerbs, edgings and quadrants shall be chisel-dressed square to form a close butt-joint with adjacent kerbs. Kerbs shall be chisel-dressed to a depth of at least 140 mm on the front face, at least 75 mm on the back face and for the full width of the top face. |
| **10.23** | **CONSTRUCTION OF KERBS, EDGINGS AND QUADRANTS** |  |
| 10.23.1 | Construction of precast concrete and granite kerbs, edgings and quadrants | (1) Precast concrete and granite kerbs, edgings and quadrants shall be laid and bedded on a regulating layer of cement mortar. The thickness of the layer shall be at least 10 mm and shall not exceed 40 mm.  (2) Except as stated in this clause, joints between each kerb, edging and quadrant shall not exceed 10 mm in width and shall be filled and flush pointed with cement mortar. Joints in kerbs, edgings and quadrants at expansion joints on bridge decks shall be as stated in the Contract. Transverse expansion and contraction joints in kerbs, edgings and quadrants laid on or adjacent to concrete carriageways shall be in accordance with Clause 9.9.2  (3) Radius kerbs shall be used for curves less than 10 m external radius. |
| 10.23.2 | Construction of in-situ kerbs, edgings and quadrants | (1) In-situ concrete kerbs, edgings and quadrants shall be constructed in accordance with BS 5931 and shall be laid by an automatic extrusion machine of a type approved by the Engineer.  (2) In-situ concrete kerbs, quadrants and edgings shall have regular sides, edges, arrises and chamfers. The finish to the concrete surface shall be Class U5. Kerbs, edges and quadrants shall not be finished or dressed with cement mortar.  (3) Contraction joints shall be formed at intervals not greater than approximately 4 m. Transverse expansion and contraction joints in kerbs, edgings and quadrants which are laid on or adjacent to concrete carriageways shall be in accordance with Clause 9.9.2. Joints shall be flush pointed with cement mortar. |
| **10.24** | **TOLERANCES** |  |
| 10.24.1 | Tolerances: kerbs, edgings and quadrants | (1) The line of kerbs, edgings and quadrants shall be within 3 mm of the specified line.  (2) The level of the top of kerbs, edgings and quadrants shall be within 3 mm of the specified level. |
|  | ***PART 6: FOOTWAYS, CYCLETRACKS AND PAVED AREAS*** |  |
| **10.25** | **MATERIALS** |  |
| 10.25.1 | Concrete for footways, cycletracks and paved areas | Concrete for footways, cycletracks and paved areas shall be Grade 30/20. |
| **10.26** | **CONSTRUCTION OF FOOTWAYS, CYCLETRACKS AND PAVED AREAS** |  |
| 10.26.1 | In-situ concrete footways, cycletracks and paved areas | In-situ concrete for footways, cycle tracks and paved areas shall be laid in areas not exceeding 20 m2. The finish to the concrete surface shall be Class U4. |
| 10.26.2 | Flexible surfacing to footways, cycletracks and paved areas | (1) Bituminous materials for footways, cycletracks and paved areas shall be laid and compacted with steel-wheeled and pneumatic-tyred rollers. Compaction shall start before the temperature of the newly laid material falls below 1000C and shall continue until all roller marks have been removed. For locations where rollers cannot operate effectively, the bituminous material can be compacted by hand-operated mechanical compaction plant approved by the Engineer.  (2) Cores shall be taken in accordance with Clause **Fehler! Verweisquelle konnte nicht gefunden werden.** for the checking of air void content and compacted layer thickness of the bituminous material for works with area of not less than 200m2. For works with area smaller than 200m2 but greater than 50m2, at least 2 cores shall be taken from each layer of bituminous material laid. For works with area less than 50m2, no coring is required unless otherwise instructed by the Engineer.  (3) The cores taken in accordance with Clause 10.26.2 shall be tested to determine the air void content. The average air void content of the cores shall be not less than 3% nor greater than 9%. If the test result does not comply with the specified requirement, 2 additional cores shall be taken at locations agreed by the Engineer and the average air void content determined from these 2 cores shall replace the original value for compliance checking. Notwithstanding this, no cores shall have an air void content of less than 2.5% nor greater than 10%.  (4) Each core taken from the final surfacing layer shall also be measured to determine the compacted layer thickness that shall not deviate by more than 5mm from the specified thickness. If the measured thickness does not comply with the requirement, 2 additional cores shall be taken at locations agreed by the Engineer and the average thickness determined from these 2 cores shall replace the original measured value for compliance checking.  (5) If no bulk sample is taken for determination of the Rice’s specific gravity, the corresponding value obtained from the mix design shall be used in determining the air void content of the core unless other value is suggested by the Contractor and agreed by the Engineer.  (6) If either the air void content or the compacted thickness of the core is outside the specified limits, the sub-area from which the cores were taken shall be considered as not complying with the requirements specified in this clause. |
| **10.27** | **PROTECTION OF FOOTWAYS, CYCLETRACKS AND PAVED AREAS** |  |
| 10.27.1 | Protection of footways, cycletracks and paved areas | Footways, cycletracks and paved areas shall not be used by Constructional Plant or vehicles other than those, which in the opinion of the Engineer are essential to construct the subsequent work. |
|  | ***PART 7: PRECAST CONCRETE UNITS FOR PAVING*** |  |
| **10.28** | **GLOSSARY OF TERMS** |  |
| 10.28.1 | Unit | (1) Unit is a term used to describe a precast concrete paving slab, block  or sett unless otherwise specified by the Engineer.  (2) Depending on their quality, units are classified as either Grade A or Grade B as follows:  Grade A units shall comply with all the clauses of this PS.  Grade B units shall comply with all the clauses of this PS except those stipulated for Grade A units only. |
| **10.29** | **MATERIALS** |  |
| 10.29.1 | Units | (1) The dimensions of units shall be within 3 mm of the specified dimensions unless otherwise stated. Chamfers shall not exceed 5 mm in width and depth or shall be round unless otherwise approved by the Engineer.  (2) Units may incorporate integral spacer nibs to aid the laying but these spacer nibs shall not be included in the size of the units.  (3) Units shall come in wide ranges of colours to facilitate pavement design by the Engineer. The colours of units shall be consistent over the area to be paved, stable and fade resistant under any outdoor climate situations.  (4) Units shall not exhibit defects such as cracking or flaking.  (5) Units shall be free of any surface sealant unless otherwise directed by the Engineer. |
| 10.29.2 | Precast concrete paving slabs | (1) Paving slabs shall be square or rectangular of metric size 200 mm x 300 mm or 300 mm x 300 mm unless otherwise specified by the Engineer.  (2) Paving slabs shall be 60 mm thick for footpaths. Paving slabs of other thickness may be used if approved by the Engineer. |
| 10.29.3 | Precast concrete paving blocks | (1) Paving blocks shall be as shown in relevant Standard and Drawings, unless otherwise specified by the Engineer. 200 x 200 x 60 mm paving units shall be considered as paving blocks.  (2) Paving blocks shall be 60 mm thick for footpaths and 80 mm thick for carriageways and vehicular accesses. Paving blocks of other thickness may be used if approved by the Engineer. |
| 10.29.4 | Precast concrete paving setts | (1) Paving setts shall be square of metric size 100 mm x 100 mm unless otherwise specified by the Engineer.  (2) Paving setts shall be 60 mm thick for footpaths and 80 mm thick for carriageways and vehicular accesses. Paving setts of other thickness may be used if approved by the Engineer. |
| 10.29.5 | Concrete | (1) Concrete for units in footways and cycle tracks shall be Grade 30. Concrete for units in carriageways or areas to which vehicles will have access shall be Grade 45.  (2) The nominal maximum aggregate size for concrete in precast units shall be 10 mm. |
| 10.29.6 | Additional requirements for Grade A units | (1) Grade A units shall have an abrasion resistance of not more than 23 mm to BS 6717.  (2) Colour Pigments for Grade A units shall comply with BS 1014. They shall be UV-stable and shall be iron oxides, chrome oxide, titanium oxide or cobalt aluminium oxide unless otherwise approved by the Engineer. |
| 10.29.7 | Sand | (1) Sand for bedding units shall have the particle size distribution stated in Table 10.1. The sand shall have a moisture content exceeding 4% and not exceeding 8% at the time of laying.  (2) Sand for filling joints between precast units shall have the particle size distribution stated in Table 10.2. The sand shall have a moisture content of less than 0.5% at the time of filling joints. |

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| Table 10.1: Particle size distribution of sand for bedding units |

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| --- | --- |
| BS test sieve size | Percentage by mass passing |
| 10 mm | 100 |
| 5 mm | 85 - 100 |
| 2.36 mm | 65 - 100 |
| 1.18 mm | 40 - 98 |
| 600 µm | 25 - 72 |
| 300 µm | 10 - 35 |
| 150 µm | 0 - 15 |
| 75 µm | 0 - 10 |

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| Table 10.2: Particle size distribution of sand for filling joints between units |

|  |  |
| --- | --- |
| BS test sieve size | Percentage by mass passing |
| 2.36 mm | 100 |
| 1.18 mm | 90 - 100 |
| 600 µm | 60 - 90 |
| 300 µm | 30 - 60 |
| 150 µm | 15 - 30 |
| 75 µm | 5 - 10 |

|  |  |  |
| --- | --- | --- |
| **10.30** | **SUBMISSIONS** |  |
| 10.30.1 | Particulars of paving | (1) The Contractor shall submit the following particulars of the proposed Units materials and methods of construction for the paving units to the Engineer:  Name and address of manufacturer,  A certificate from the manufacturer showing the source and the particle size distribution of the aggregates,  A certificate from the manufacturer showing the manufacturer’s name, the date and place of manufacture, and results of tests for:  compressive strength of concrete cubes at 28 day,  bending strength of paving slabs to BS 7263-1; and  compressive strength of paving blocks and setts  Drawings showing the layout of the units within the paved area.  (2) The particulars as required under Clause 10.30.1 shall be submitted to the Engineer for approval of the source, type and layout of the units at least 14 days before laying of units starts. |
| 10.30.2 | Particulars of units additional requirements for Grade A units | (1) The following particulars of the proposed materials for Grade A units shall be submitted to the Engineer:  A certificate from the manufacturer showing the results of tests for:  Dimensional deviations of paving slabs to BS 7263-1: ;  Dimensional deviations of paving blocks and setts to BS6717;  Slip/skid resistance value of paving slabs to BS EN 1344;  Slip/skid resistance value of paving blocks to BS EN 1344, or unpolished slip/skid resistance value of paving blocks to BS 6717;  Slip/skid resistance value of paving setts to BS EN 1342;  24-hour cold water absorption value of paving slabs, blocks and setts to BS or similar; and  Abrasion resistance of paving slabs, blocks and setts to BS 6717. |
| 10.30.3 | Samples of materials | Samples of each type of units shall be submitted to the Engineer for approval of the source and type of each unit at the same time as particulars of the units are submitted. |
| 10.30.4 | Samples of materials - additional requirements for Grade A units | (1) Samples of each type of Grade A units showing the actual size, colour, variation in colour, finish/texture as specified, and general characteristics of the appearance shall be submitted to the Engineer for approval at the time as particulars of the units are submitted.  (2) Samples submitted to the Engineer shall be subject to a visual inspection by the Engineer and shall comply with the following requirements:  When examined in accordance with BS 6717, there shall not be significant visible differences in colour and texture between any samples;  When examined in accordance with BS 6717, the samples shall not exhibit defects such as cracking, flaking or dislodging of aggregates;  Fine materials shall not be easily dislodged from the surfaces of any samples during gentle manual handling; and  The edges of all samples shall be sharp and straight without any defect. |
| **10.31** | **HANDLING AND STORAGE OF MATERIALS** |  |
| 10.31.1 | Handling and storage of units | Units shall be handled and stored on pallets to avoid damage to corners and chamfer edges. Pallets shall be stored on a levelled, well drained and maintained hard-standing ground and in a manner which will not result in damage or contamination to the units. The units shall be protected from damage and damaged units shall not be used unless permitted by the Engineer. |
| 10.31.2 | Storage of sand | Sand for filling joints between units shall be stored off ground in waterproof bags and shall be kept under cover on a levelled, well drained and maintained hard-standing ground on level supports until use. |
| **10.32** | **LAYING UNITS** |  |
| 10.32.1 | Laying units | (1) Units shall not be laid until the layout of the units within the paved area has been approved by the Engineer.  (2) Kerbs and edgings shall be completed before the units are laid. The compressive strength of the concrete used for in-situ concrete kerbs and edgings shall be at least 20 MPa before units are laid.  (3) Measures shall be taken to prevent water draining across or through the area during laying, bedding and compaction of the units.  (4) Laying of units shall start as soon as practicable after the formation has been completed. The formation shall be protected as stated in Clause 6.11.3 until laying starts.  (5) Paving blocks for carriageways and paved areas to which vehicles will have access shall be laid in a herringbone pattern unless otherwise stated in the Contract.  (6) Units shall be cut to size where required using mechanical cutting devices. The cut edge shall be true to line and free of chips and cracks.  (7) The units shall be laid to any design or pattern specified by the Engineer. The design or pattern may involve a single colour or a combination of different colours. |
| 10.32.2 | Laying sand | (1) A layer of sand shall be laid and shall be screeded and tamped to a uniform depth over the complete width of the area to be paved. The quantity and thickness of sand shall be appropriate to the methods of preparation of the sand layer, and shall be sufficient to give the required nominal thickness of the sand layer after compaction of the sand and units.  (2) The sand layer shall not be disturbed by additional compaction, footmarks or other damage after the layer has been screeded and tamped to the required level and before the units are laid. |
| 10.32.3 | Bedding paving slabs | (1) Paving slabs shall be laid on the prepared sand layer immediately after screeding and tamping in such a manner that the sand is not disturbed.  (2) Paving slabs shall be adjusted to form uniform joints between 2 mm and 3 mm wide and shall be bedded into the final position using a wooden mallet or a plate vibrator fitted with a rubber base-pad.  (3) Paving slabs shall not be bedded within 1 m of an unrestrained edge of the screeded sand layer.  (4) Final levelling of the paving slabs shall be carried out as soon as practicable after bedding and before changes in the moisture content of the prepared sand layer occur.  (5) Damaged paving slabs shall be immediately removed and replaced. |
| 10.32.4 | Bedding paving blocks and setts | (1) Paving blocks and setts shall be laid on the prepared sand layer immediately after screeding and tamping in such a manner that the sand is not disturbed. Paving blocks and setts shall be individually laid on the prepared sand layer by manual methods or in clusters by mechanical methods.  (2) Paving blocks and setts shall be laid in such a manner that the blocks and setts are not in direct contact with each other and that uniform joints of between 2 mm and 3 mm wide are formed. Paving blocks and setts shall be bedded flush by at least two passes of a heavy-duty plate compactor fitted with a rubber base-pad.  (3) Final levelling of the paving blocks and setts shall be carried out as soon as practicable after bedding and before changes in the moisture content of the prepared sand layer occur.  (4) Paving blocks and setts shall not be bedded within 1 m of an unrestrained edge of the screeded sand layer.  (5) Damaged paving blocks and setts shall be immediately removed and replaced. |
| 10.32.5 | Filling joints and compaction of units | (1) After the units have been bedded, sand for filling joints shall be spread over the surface of the units and brushed into the joints in such a manner that all joints are completely filled.  (2) Joints shall be filled as soon as practicable after bedding and on the day the units are laid and bedded.  (3) After all joints are completely filled with sand, units shall be fully compacted by using a plate compactor fitted with a rubber base-pad. Additional sand shall be added to refill the joints as required and compacted into the joints by using the plate compactor with two or more passes.  (4) Carriageways and paved areas with regular heavy traffic shall be compacted by at least ten evenly-spaced passes of a pneumatic tyred roller having a gross weight of between 10 t and 12 t, or by a plate compactor which shall have the following capacity:  Minimum plate area of 0.25 m2;  Minimum effective force per unit area of plate of 75 kN/ m2;  Frequency of 65 –100 Hz; and  Minimum mass of 200 kg.  Other suitable compacting equipment to the approval of the Engineer can be used. Sand shall be added as required and brushed and compacted into the joints.  (5) Units shall not be compacted closer than 1 m behind the laying edge of the units other than on completion of the paved area against a kerb or edging.  (6) Excess sand shall be removed after completion of compaction.  (7) Damaged units shall be immediately removed and replaced. |
| 10.32.6 | Mortar and concrete seal | Pigmented mortar or concrete shall be placed to full depth of the units to fill up the gaps between units and adjacent kerbs, edgings, quadrants, covers, frames and other hardware. The work shall only be carried out upon the approval by the Engineer. Unless otherwise instructed by the Engineer, colour of pigmented mortar or concrete shall match the colour of the adjacent units. |
| **10.33** | **REINSTATEMENT OF UNITS** |  |
| 10.33.1 | Reinstatement of units | (1) If excavation is to be carried out in areas paved with units, the units shall be extracted by manual methods for a distance of at least 300 mm beyond the limit of the excavation.  (2) Unbroken units shall be thoroughly cleaned to remove all sand and deleterious material. The units shall be stacked on pallets for re-use.  (3) Units to be re-used shall be re-laid in accordance with Clauses 10.32.1 to 10.32.6 |
| **10.34** | **TOLERANCES** |  |
| 10.34.1 | Levels | The level of paved areas constructed using units shall be within 3 mm of the specified level. The difference in level of adjacent units shall not exceed 2 mm. |
| **10.35** | **TESTING** |  |
| 10.35.1 | Batching | (1) A batch of units shall be any quantity of paving slabs, blocks, or setts of the same type, size, and finish, of the same concrete grade, manufactured in the same place, covered by the same certificates and delivered to the Site at any one time. Paving slabs, blocks, or setts of different colours can be grouped together to form their respective batches provided that they are manufactured with the same type of materials and production methods.  (2) Sampling shall be carried out at random. The sample shall comprise units that are distributed throughout the batch. |
| 10.35.2 | Testing requirements for units | (1) Paving slabs shall be tested for bending strength as stated in Clause 10.35.3  (2) Paving blocks shall be tested for compressive strength as stated in Clause 10.35.4.  (3) Paving setts need not be tested for bending strength, compressive strength or slip/skid resistance unless otherwise required by the Engineer. |
| 10.35.3 | Bending strength *test* of paving slabs | (1) One sample of units in a batch shall be provided from every 1000 m2 of units or part thereof. A batch with units for area(s) less than 1000 m2 may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 8.  (2) Each sample of paving slabs shall be tested to determine the bending strength to BS 7263-1. |
| 10.35.4 | Compressive strength test of paving blocks | (1) One sample of units in a batch shall be provided from every 1000 m2 of units or part thereof. A batch with units for area(s) less than 1000 m2 may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 8. For paving blocks of size 200x200x60mm, specimens of size 200x100x60mm shall be cut from these blocks in accordance with Clause 10.32.1 to form samples.  (2) Each sample of paving blocks shall be tested to determine the characteristic compressive strength at 28 days.  (3) The method of testing shall be as stated in existing national standards or similar  (4) The characteristic compressive strength of a sample of paving blocks shall be:  30 MPa for paving blocks in footways and cycle tracks, and The mean bending strength of a sample of paving slabs shall not be less than 3.7 MPa with bending strength of individual paving slabs not less than 3.0 MPa.  45 MPa for paving blocks in carriageways and paved areas to which vehicles will have access. |
| 10.35.5 | Additional testing for Grade A units: dimensional deviation of paving slabs, blocks and setts | (1) One sample of units in a batch shall be provided from every 1000 m2 of units or part thereof. A batch with units for area(s) less than 1000 m2 may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 8. The sample can be used for other tests.  (2) The overall dimensions and thickness of each sample of paving slabs shall be measured in accordance with BS 7263-1.  (3) The overall dimensions and thickness of each sample of paving blocks and setts shall be measured in accordance with BS 6717.  (4) The tolerances for the dimensions of each individual units shall be within ±2 mm for length and width, and ±3 mm for thickness. |
| 10.35.6 | Additional testing for Grade A units: slip/ skid resistance of paving slabs and blocks | (1) One sample of units in a batch shall be provided from every 1000 m2 of units or part thereof. A batch with units for area(s) less than 1000 m2 may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 5. The sample can be used for other tests.  (2) Each sample of paving slabs shall be tested to determine the slip/ skid resistance to BS EN 1344.  (3) Each sample of paving blocks shall be tested to determine the slip/skid resistance to BS EN 1344.  (4) The mean slip/skid resistance of a sample shall not be less than 45 Skid Resistance Value for units in footways and cycle tracks.  (5) Notwithstanding sub-clause (4) above, if considered appropriate by the Engineer for application on steep roads, pavements with steep pedestrian crossings or exceptional high cross fall, or other difficult site conditions, the required slip/skid resistance of the units in footways and cycle tracks may be increased up to 60 Skid Resistance Value. |
| 10.35.7 | Additional testing for Grade A units: water absorption value of paving slabs and blocks | (1) One sample of units in a batch shall be provided from every 1000 m2 of units or part thereof. A batch with units for area(s) less than 1000 m2 may be added to the untested previous or following batch (es) as the case may be for testing purposes. The number of specimens in each sample shall be 10. The sample can be used for other tests.  (2) Each sample of paving slabs and blocks shall be tested to determine the 24-hour cold water absorption value to BS or similar.  (3) The sample shall have a characteristic water absorption value not more than 6% by 24-hour cold immersion method to BS or similar.  (4) The characteristic water absorption value (Wc) shall be calculated from the following equation:  Wc = Wm + 1.65 Xs %  where:  Wm is the average water absorption rate of the sample  Xs is the unbiased standard deviation. |
| **11.** | **SECTION 11 TRAFFIC SIGNS, ROAD MARKINGS AND ROAD STUDS** |  |
|  | ***PART 1: TRAFFIC SIGNS GENERAL*** |  |
| **11.1** | **GENERAL** |  |
| 11.1.1 | General requirements | The works and materials specified in Clauses 11.1.2 to 11.1.3 shall comply with the sections stated, unless otherwise stated in this Section. |
| 11.1.2 | Temporary traffic arrangements and control | Temporary traffic arrangements and control shall comply with Section 1. |
| 11.1.3 | Steelwork | Steelwork shall comply with Section 16. |
| 11.1.4 | Traffic signs | (1) Traffic signs shall comply with the Maldivian Road Traffic regulations, and its subsidiary legislation.  (2) The design of traffic signs, including letters, characters, numbers, symbols and borders, shall be in accordance with conditions and restrictions imposed by the relevant authority for Transport.  (3) Traffic signs shall comply with BS EN 12899: Part 1: 2001 except that the requirements for marking signs shall not apply.  (4) Traffic signs shall be externally illuminated, internally illuminated, retroreflective, non-retroreflective or a combination of these types as stated in the Contract. |
| **11.2** | **MATERIALS** |  |
| 11.2.1 | Steel | Steel for traffic signs shall comply with the following:  Hot finished seamless tubes : BS 6323: Part 3  Hot rolled sections : BS 4: Part 1  Hot rolled structural steel sections - equal and unequal  angles : BS 4848: Part 4  Weldable structural steels : BS 4360 |
| 11.2.2 | Stainless steel | Stainless steel for traffic signs shall be Grade 304 S 11 and shall comply with the following:  General inspection and testing  procedures and specific  requirements for carbon,  carbon manganese and stainless  steels : BS 970: Part 1  Stainless steel tubes suitable for  threading in accordance with BS 21 : BS 6362 |
| 11.2.3 | Aluminium alloy | (1) Aluminium alloy for traffic signs shall be EN AW-6082 in the T6, T651 or T62 tempers and shall comply with the following table:  Wrought aluminium and Standards aluminium alloys for general  engineering purpose  Plate, sheet and strip BS EN 485: Part 1: 1994, BS  EN 485: Part 2: 2004, BS EN  485 Part 3: 2003 and BS EN  485: Part 4: 1994  Drawn tube BS EN 754: Part 1: 1997, BS  EN 754: Part 2: 1997, BS EN  754: Part 3: 1996, BS EN 754:  Part 4:1996, BS EN 754: Part 5:  1996, BS EN 754: Part 6: 1996,  BS EN 754: Part 7: 1998 and BS  EN 754: Part 8: 1998  Bars, extruded round BS EN 755: Part 1: 1997, BS EN  755: Part tubes and sections 2:  1997, BS EN 755: Part 3: 1996,  BS EN 755: Part 4: 1996, BS EN  755: Part 5: 1996, BS EN 755:  Part 6:1996, BS EN 755: Part 7:  1998, BS EN 755: Part 8: 1998  and BS EN 755: Part 9: 2001  (2) Aluminium alloy shall be anodized to Grade AA 25 in accordance with BS EN 12373: Part 1: 2001.  (3) Aluminium alloy sheet shall be free of twisting, warping and buckling and the surfaces shall be free of blemishes and other defects. |
| 11.2.4 | Bolts, nuts, screws, washers and rivets | (1) Bolts, nuts, screws, washers and rivets for traffic signs shall comply with the following:  ISO metric black hexagon  bolts, screws and nuts : BS 4190  ISO metric black cup and  countersunk head bolts and  screws with hexagon nuts : BS 4933  Metal washers for general  engineering purposes : BS 4320  Rivets for general engineering  purposes : BS 4620  Wrought aluminium and aluminium  alloys for general engineering  purposes - rivet, bolt and screw stock : BS 1473  General inspection and testing  procedures and specific requirements  for carbon, carbon manganese and  stainless steels : BS 970: Part 1  (2) The length of bolts shall be such that after assembly the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.  (3) Rag and indented bolts shall comply with BS 1494: Part 2. Expansion bolts and resin bonded bolts shall be of a proprietary type approved by the Engineer and shall be capable of withstanding the design working load.  (4) Galvanised bolts, nuts, screws, washers and rivets shall be used with traffic signs secured to galvanised pedestrian guard-railing. Aluminium materials shall be insulated from ferrous materials by a non-conductive insulator at least 2 mm thick of a type approved by the Engineer. |
| 11.2.5 | Materials for faces of traffic signs | (1) Retroreflective sheeting shall be Class Ref 1 or Class Ref 2 material complying with BS EN 12899: Part 1: 2001, Tables 8 and 9 or Type IX material complying with ASTM D4956-05.  (2) Non-retroreflective sheeting shall comply with BS EN 12899: Part 1: 2001.  (3) Plastic sheeting shall be of a proprietary type approved by the Engineer.  (4) All materials and finishes shall be mutually compatible. |
| **11.3** | **FABRICATION OF TRAFFIC SIGNS** |  |
| 11.3.1 | Posts for traffic signs | (1) Posts for beacons at zebra crossings shall be painted with alternate black and white stripes. Other posts shall be painted grey in accordance with BS 5252F, Code 18B19 or shall be galvanized in accordance with BS EN ISO 1461:1999.  (2) Galvanized areas affected by cutting and drilling shall be treated using a method approved by the Engineer.  (3) Posts other than posts supporting an external luminaire shall not protrude above the top of signs. The length of posts supporting external luminaries protruding above the top of signs shall be as short as practicable. |
| 11.3.2 | Backing plates for traffic signs | (1) Backing plates for traffic signs shall be fabricated from 3 mm aluminium sheet. Backing plates for traffic signs not exceeding 1200 mm high x 2400 mm wide shall be fabricated from a single sheet. If more than one sheet is used, the number of sheets shall be kept to a minimum. The separate sheets shall be rectangular and shall be approximately the same size.  (2) Holes in backing plates shall be drilled before the plate is painted and before retroreflective or non-retroreflective sheeting is applied. |
| 11.3.3 | Spill screens for traffic signs | (1) Top and bottom light spill screens shall be fabricated from the same material as the backing plate. The spill screens shall extend for the complete width of the backing plate and the corners shall be cut to the same radius as the corners of the backing plate.  (2) Spill screens shall be considered as part of the backing plate and stiffeners and mountings shall be designed to accommodate the combined size. |
| 11.3.4 | Faces for traffic signs | (1) Faces for traffic signs shall be formed using retroreflective or non-retroreflective plastic sheeting. Unless otherwise permitted by the Engineer, a single piece of sheeting shall be used. If more than one sheet is used, the number of sheets shall be kept to a minimum. Sheeting shall be fixed in accordance with the manufacturer's recommendations.  (2) Materials for faces of traffic signs, including the background, letters, characters, numerals, symbols and borders, shall be matched for colour in accordance with the sheeting manufacturer's recommendations at the time of fabrication to provide a uniform appearance by day and by night.  (3) Letters, characters, numerals, symbols and borders shall be clear cut and sharp-edged and shall have no cracks.  (4) Sheeting material, including letters, characters, numerals, symbols and borders shall be fully fixed using adhesive. There shall be no air bubbles, creases, cracks or other blemishes.  (5) The back of traffic sign shall be marked with the manufacturer’s name and manufacturing date in month/year as shown in the following manner:  Manufacturer’s name  Month/year  The marking shall either be printed on non-retroreflective self-adhesive material in accordance with BS EN 12899: Part 1: 2001 or stamped by a punch without damaging the front face of traffic sign or other method approved by the Engineer. The letter size shall not be smaller than 12 mm (h) x 8 mm (w).  (6) For each colour of externally illuminated and transilluminated signs, the uniformity of luminance, determined by the ratio of the lowest to the highest level measured at any part of the sign, shall be as shown in the following and in accordance with BS EN 12899: Part 1: 2001, Table 12.  Illuminated face area Uniformity of luminance  ≤ 1.5 m2 U2  > 1.5 m2  U1 |
| 11.3.5 | Lacquer coatings | Lacquer coatings to faces for traffic signs shall be uniform and continuous and shall be applied at the time of manufacture of the face. |
| 11.3.6 | Painting to faces for traffic signs | (1) Faces of traffic signs to which a painted or stoved finish is to be applied shall be thoroughly cleaned and pre-treated before painting and stoving.  (2) Pre-treatment shall be by anodising or by using an etching primer or by a process approved by the Engineer.  (3) At least one undercoat and at least one finishing coat of paint shall be applied and stoved to a thickness of between 0.0315 mm and 0.0375 mm of enamel over a minimum thickness of 0.025 mm of primer. If light colours are to be applied over dark colours, at least two coats of the light colour shall be applied. The final surface shall have a uniform thickness and an egg-shell flat finish and shall be smooth and free of defects.  (4) The colour of the finished coating shall be uniform. The colours, including white, shall comply with the chromaticity and luminance factors of BS EN 12899: Part 1: 2001, Tables 3 and 5 and, for comparative purposes, shall comply with the following gloss paint colours in accordance with BS 381C: 1996:  Red : No. 537 – signal red,  Orange : No. 557 – light orange  Yellow : No. 355 – lemon yellow,  Blue : No. 109 – middle blue  Green : No. 225 – light brunswick green  (5) Parts of faces coloured black shall be non-retroreflective and shall have a luminance factor not exceeding 0.03 as specified in accordance with BS EN 12899: Part 1: 2001.  (6) The Volatile Organic Compound (VOC) content, in grams per litre, of all paint applied on surfaces of traffic signs shall not exceed:  Water-based Paint : 100g/litre  Solvent-based Paint : 450g/litre  The VOC content of paint shall be determined either by recognised method of calculation or laboratory testing. |
| **11.4** | **SUBMISSIONS** |  |
| 11.4.1 | Particulars of traffic signs | (1) The following particulars of the proposed traffic signs shall be submitted to the Engineer:  Name of manufacturer, and  Details of materials and finishes to be used in the manufacture of the signs.  (2) The particulars shall be submitted to the Engineer at least 14 days before fabrication of traffic signs starts. |
| **11.5** | **STORAGE OF MATERIALS** |  |
| 11.5.1 | Storage of traffic signs | (1) Traffic signs shall be stored in a dry, weatherproof store. Traffic  signs that are stored together shall be separated by slip-sheets.  (2) Traffic signs shall be stored in a manner that will not result in damage or deformation to the signs. |
| **11.6** | **CONSTRUCTION AND ASSEMBLY OF TRAFFIC SIGNS** |  |
| 11.6.1 | Construction and assembly of traffic signs | (1) Fittings for traffic signs shall be non-corrodible material approved by the Engineer.  (2) Joints for framework and stiffeners that are not an integral part of the backing plate shall be welded or joined using brackets, nuts, bolts and washers.  (3) Materials for rivets and other fixings for joining backing plates to framework and stiffeners shall be compatible with the materials to be joined. The spacing of rivets and other fixings shall be uniform. The spacing shall not exceed 150 mm around the outside edge of sheets and shall not exceed 300 mm on cross braces.  (4) An additional washer of neoprene, nylon or other material approved by the Engineer shall be used to protect the faces of traffic signs from metal nuts, bolts, washers and screws.  (5) Backing plates shall be connected to posts by a method approved by the Engineer. Banding systems shall be stainless steel. Drilling of holes in ferrous components shall be completed before finishes are applied.  (6) A lacquer coating shall be applied to the edges of holes drilled in plates with plastic sheeting immediately before rivets and bolts are inserted. The surfaces of rivets and bolts on the faces of traffic signs shall be covered with a material coloured to match the part of the face with which it is in contact.  (7) Fixings for traffic signs erected on road lighting columns shall be compatible with the column cross-section. Columns shall not be drilled.  (8) When backing plates are stiffened with additional reinforcing members, these members shall be fixed to the backing plates in compliance with Class P2 in Table 1 of BS EN 12899: Part 1: 2001.  (9) Protection to sign edges shall be Class E1 in compliance with BS EN 12899: Part 1: 2001, Table 2. |
| 11.6.2 | Covering of traffic signs | (1) Traffic signs which are to be blanked out shall be covered by the following methods:  Plate signs shall be covered using a 1.5 mm thick sheet that is compatible with the material in the sign.  Plate signs that are to be blanked out for a period not exceeding one year may alternatively be covered using a self-adhesive plastic film.  Other signs shall be covered using a loose cover sheet of material approved by the Engineer.  (2) Cover sheets shall be fixed using 5 mm diameter stainless steel bolts, washers and nuts or non-ferrous rivets at spacing not exceeding 600 mm. Bolts shall pass through 5 mm x 12 mm diameter plastic distance pieces between the face of the sign and the cover plate. Holes that remain on the finished face of the sign shall be filled using blocked rivets. The face of the rivets shall be coloured by a method approved by the Engineer.  (3) Self-adhesive plastic film shall be compatible with the material in the face of the sign and shall be fixed and removed in accordance with the manufacturer's recommendations.  (4) Loose covers shall be securely fastened to the back of the sign. Tape or other adhesive material shall not be applied to the faces of signs.  (5) Coverings to traffic signs shall be sufficiently opaque to prevent reflection from the covered sign and shall not be removed until the Engineer so instructs.  (6) Unless otherwise permitted by the Engineer, the faces of traffic signs which have been erected and which do not relate either wholly or in part to the traffic situation which applies at that time shall be blanked out as stated in this Clause. |
| **11.7** | **TESTING: TRAFFIC SIGNS** |  |
| 11.7.1 | Testing: | (1) The number of traffic signs to be tested shall be as stated in the Contract or as instructed by the Engineer.  (2) The number and type of tests to be carried out on the traffic signs shall be as stated in the Contract as instructed by the Engineer.  (3) Testing shall be carried out in such a manner that the traffic sign will not be damaged.  (4) Testing shall be carried out by the Contractor at a laboratory approved by the Engineer. |
| 11.7.2 | Compliance criteria: | he compliance criteria for testing traffic signs shall be in accordance with BS 873: Part 1: 1983. |
|  | ***PART 2: ROAD MARKINGS*** |  |
| **11.8** | **GLOSSARY OF TERMS** |  |
| 11.8.1 | Road Markings | Road markings are white or yellow continuous or intermittent lines, letters, characters, figures, arrows or symbols marked on the carriageway to guide road users and pedestrians. |
| **11.9** | **MATERIALS** |  |
| 11.9.1 | Hot-applied thermoplastic material | (1) Hot-applied thermoplastic material shall comply with BS EN 1871:2000. In particular,  The luminance factor when tested in accordance with Annex E of BS EN 1871: 2000 shall be Class LF4 for white material and Class LF2 for yellow material.  The softening point when tested in accordance with Annex F of BS EN 1871: 2000 shall be Class SP2.  (2) Solid glass beads shall be included in the supplied mixture of hot applied thermoplastic material.  (3) Thermoplastic material shall be of a solvent-free marking substance supplied in block, granular or powder forms, which can be heated to a molten state and then applied with an appropriate hand or mechanical applicator, and form a cohesive film by cooling.  (4) Thermoplastic material shall belong to either of the following types:  Type ‘A’-Standard hot applied thermoplastic material.  Type ‘B’-Alkyd resin hot applied thermoplastic material. |
| 11.9.2 | Cold-applied preformed material | (1) Cold-applied preformed material for road markings shall be of a proprietary type approved by the Engineer  (2) Solid glass beads shall be applied to cold-applied preformed material at the place of manufacture. |
| 11.9.3 | Cold plastic road marking | Cold plastics road marking material shall comply with BS EN 1871: 2000. In particular, when applied at the manufacturer’s stated thickness and tested in accordance with Annex A of BS EN 1871: 2000, the luminance factor shall be Class LF4 for white material and Class LF2 for yellow material. |
| 11.9.4 | Paint for road markings | Road-marking paint material, including water-based road-marking paint, shall comply with BS EN 1871: 2000. In particular,  The luminance factor when tested in accordance with annex A of BS EN 1871: 2000 shall be Class LF6 for white material and Class LF2 for yellow material.  The difference in luminance factor after UV ageing shall be Class UV1.  The difference in luminance factor after bleed resistance test shall be Class BR1. |
| 11.9.5 | Solid glass beads | (1) Drop-on glass beads shall comply with BS EN 1423: 1998. In particular, the refractive index of the glass beads shall conform to Class A when determined in accordance with Annex A of BS EN 1423: 1998.  (2) Premix glass beads shall comply with BS EN 1423: 1998. In particular, the refractive index of the glass beads shall conform to Class A when determined in accordance with Annex A of BS EN 1423: 1998. |
| 11.9.6 | Functional life of the material | The functional life of the road-marking material as defined in BS EN 1436: 1998 shall be not less than 1 year after laying is carried out. |
| **11.10** | **SUBMISSIONS** |  |
| 11.10.1 | Test certificate and routine testing | (1) When required by the Engineer, the Contractor shall submit the test certificate prepared and signed by a local or overseas independent laboratory to the Engineer before commencing the Works in order to certify that the samples taken from the materials to be used in the Contract comply with BS EN 1871: 2000.  (2) The Contractor shall supply all samples of materials for testing. He shall render such assistance as may from time to time be required by the Engineer in taking and packing them in bags, which are to be provided by the Contractor, and dispatching them to Public Works Central Laboratory for testing. |
| **11.11** | **DELIVERY AND STORAGE OF MATERIALS** |  |
| 11.11.1 | Delivery and storage of thermoplastic material | Each container for keeping thermoplastic road marking material shall be clearly and indelibly marked with the following information:  The name, trade mark or other means of identification of the manufacturer;  Batch number;  Date of manufacture;  The number and date of the Standard, i.e. BS EN 1871: 2000;  Whether reflectorized;  Color (white, yellow, or black);  Chemical description and type of resin;  Maximum application temperature and maximum safe heating temperature;  Relative density;  If applicable, the class of its contents  If applicable, a warning about the use of lead pigment. |
| 11.11.2 | Storage of road marking paint material | Road-marking paint material shall be discarded after expiry of the shelf life. |
| 11.11.3 | Storage of preformed material | Cold-applied preformed material shall be stored in accordance with the manufacturer's recommendations. |
| **11.12** | **LAYING ROAD MARKINGS** |  |
| 11.12.1 | Preparation of surfaces | (1) Road markings shall not be laid over loose detritus, mud or similar extraneous matter. Oil and grease shall be removed from the surface of carriageways on which road markings will be laid.  (2) Curing compound shall be removed from the surface of new concrete carriageways on which road markings will be laid, by wire brushing or by other methods agreed by the Engineer.  (3) Existing road markings that are to be replaced by a different type of material shall be removed by high pressure water jetting, shot blasting, rotary grinding or by other methods agreed by the Engineer. The existing markings shall not be masked using black paint or similar methods.  (4) Existing road markings that are to be renewed using a similar type of material shall be roughened by a method agreed by the Engineer until the thickness of the existing material is reduced by approximately 50%.  (5) A tack coat shall be applied to the surface of concrete carriageways before hot thermoplastic material is laid. The tack coat shall be compatible with the road marking material and shall be applied in accordance with the manufacturer's recommendations.  (6) Rotary grinding machines shall not be used to remove or roughen existing road markings within 100 mm of longitudinal or transverse joints on concrete carriageways. |
| 11.12.2 | Laying hot-applied thermoplastic material | (1) Hot-applied thermoplastic material shall be prepared and laid in accordance with BS 3262: Part 3, Clauses 4 and 5. The material shall not be laid when the surface of the carriageway is wet, or the air ambient temperature in the shade is less than 10°C.  (2) Hot-applied thermoplastic material shall be laid by machine or by screeding methods. The machine or apparatus shall be capable of producing a marking to a uniform thickness and width. The marking shall have clean edges and shall be free of streaks and blisters.  (3) The thickness of road markings, not including surface applied solid glass beads, shall comply with the following:  Screed markings : 4 mm  Sprayed lines other than yellow edge lines : ≥ 1.5 mm  Sprayed yellow edge lines : ≥ 0.8 mm  The thickness shall be measured in accordance with BS 3262: Part 3, Appendix B. |
| 11.12.3 | Laying cold-applied preformed material | (1) Cold-applied preformed material shall be laid in accordance with the manufacturer's recommendations. The material shall not be laid when the surface of the carriageway is wet.  (2) The thickness of road markings shall be at least 1.5 mm |
| 11.12.4 | Use of road- marking paint | (1) Road-marking paint may only be used on roads or areas where the use of other road marking materials, such as thermoplastic, will affect the functional performance of the road markings and the use shall be subject to written approval of the Engineer.  (2) Road-marking paint shall be applied in accordance with the manufacturer’s recommendations.  (3) Road-marking paint shall not be used for temporary road markings and shall not be used to temporarily cover up existing road markings. |
| 11.12.5 | Road marking performance for road users | Performance of the road marking during its functional life shall comply with BS EN 1436:1998. In particular,  The minimum luminance coefficient under diffuse illumination measured in accordance with Annex A of BS EN 1436: 1998 shall be Class Q2 and Q3 on asphaltic surface and concrete surface respectively for white markings, and shall be Class Q1 for yellow markings.  The minimum coefficient of retroreflected luminance for dry road markings measured in accordance with Annex B of BS EN 1436: 1998 shall be Class R2 and R1 for permanent white and yellow markings respectively, and shall be Class R3 for temporary markings.  The minimum luminance factor for dry road markings measured in accordance with Annex C of BS EN 1436: 1998 shall be Class B3 for white markings and B2 for yellow markings. |
| 11.12.6 | Temporary road markings | (1) Cold-applied preformed material shall be used for temporary road markings. Where existing road markings have to be masked temporarily to facilitate roadwork, the proprietary black tape approved by the Engineer shall be used.  (2) Temporary road markings shall be disposed of by the Contractor after removal. All traces of tape shall be removed from the surface of the carriageway and existing permanent road markings shall be made good such that in the opinion of the Engineer it is safe to allow traffic to use the road. |
| 11.12.7 | Skid resistance level | The minimum skid resistance of the road marking measured in accordance with Annex D of BS EN 1436: 1998 shall be Class S1. |
| **11.13** | **TOLERANCES** |  |
| 11.13.1 | Tolerances | The lengths, thicknesses and widths of road markings shall comply with the following requirements:  The thickness of screed markings shall be within 1 mm of the specified thickness.  The length and width of screed markings and sprayed lines shall be within +10%, -5% of the specified dimension. |
| **11.14** | **REMOVING ROAD MARKINGS** |  |
| 11.14.1 | Shot-Blasting Machine | Where existing road marking is directed by the Engineer to be removed by steel shot-blasting, the removal of road marking materials shall be carried out by a shot-blasting machine approved by the Engineer. The machine shall be self-propelled, and shall have a minimum cleaning path of 350 mm. |
|  | ***PART 3: ROAD STUDS*** |  |
| **11.15** | **MATERIALS** |  |
| 11.15.1 | Road studs | (1) Road studs shall comply with the Maldivian Road Traffic regulations and its subsidiary legislation.  (2) Road studs shall be of a proprietary type approved by the Engineer.  (3) Permanent reflecting road studs to be used as lane line markers on dual carriageway trunk roads and primary distributor roads shall be of a type to which traffic cylinders of a type approved by the Engineer can be attached. The method of attachment shall be such that the traffic cylinder can be easily detached from the road stud.  (4) Temporary reflecting road studs to be used as markers for temporary traffic routes shall be yellow. |
| 11.15.2 | Bitumen grout | (1) Bitumen grout for road studs shall consist of bitumen and filler. The bitumen content shall be 25% to 30% of the total mass.  (2) Bitumen shall be tropical grade filled bitumen, oxidised Grade R 85/25.  (3) Filler shall be hydrated lime. The percentage by mass of hydrated lime passing a 75 µm BS test sieve shall be at least 85%.  (4) The properties of bitumen grout for road studs shall comply with the following requirements:  The penetration at 25°C shall be 12±4.  The softening point shall be 105°C ± 5°C.  The specific gravity shall not exceed 1.80. |
| **11.16** | **INSTALLATION OF ROAD STUDS** |  |
| 11.16.1 | Installation of road studs | (1) Road studs shall be installed in accordance with the manufacturer's recommendations.  (2) Depressible road studs shall be installed using bitumen grout.  (3) Road studs shall not be installed on concrete carriageways until the concrete has reached the specified grade strength.  (4) Surfaces to which bonded road studs are to be fixed shall be clean and all dust, grease and other deleterious material shall be removed immediately before the studs are installed. |
| **12.** | **SECTION 12 WORK FOR ELECTRICAL AND MECHANICAL INSTALLATIONS** |  |
| **12.1** | **GENERAL** |  |
| 12.1.1 | General requirements | The works and materials specified in Clauses 12.1.2 and 12.1.3 shall comply with the sections stated, unless otherwise stated in this Section. |
| 12.1.2 | Earthworks | Earthworks shall comply with Section 6. |
| 12.1.3 | Materials for grout | Materials for grout shall comply with Section 15. |
| 12.1.4 | Galvanization | Galvanization in this Section shall be hot dip galvanization to BS EN ISO 1461: 1999 |
| **12.2** | **GLOSSARY OF TERMS** |  |
| 12.2.1 | Concealed electrical conduit system | Concealed electrical conduit system is an electrical conduit system, including all bends, couplers, bushes, saddles, boxes, covers, plugs, draw wires and other conduit fittings, which is cast into concrete or fixed in chases in brickwork with a minimum cover of 20 mm or which is laid directly in the ground. |
| **12.3** | **MATERIALS** |  |
| 12.3.1 | Electrical conduits and fittings | (1) Electrical conduits and fittings shall comply with BS 4568: Parts 1 and 2 and shall have Class 4 heavy protection inside and outside. Conduits shall be heavy gauge with screw-end construction in steel and shall have an external diameter of at least 20 mm. Conduits shall be longitudinally welded.  (2) Metal boxes for enclosing electrical accessories shall comply with BS 4662 and shall have heavy protection inside and outside. The boxes shall be of preferred sizes and shall be 35 mm or 47 mm deep as appropriate. Circular ceiling boxes of deep pattern shall comply with BS 4568: Part 2 and shall have Class 4 heavy protection inside and outside. The boxes shall be at least 60 mm deep internally.  (3) Circular boxes, dome covers and hook covers shall be cast iron. Bushes and plugs shall be brass. |
| 12.3.2 | Cable ducts and fittings | (1) uPVC cable ducts for installation above ground or for casting into concrete shall be Class 0 uPVC pipes complying with BS 3506. Cable ducts for installation below ground shall be Class B uPVC pipes complying with BS 3506.  (2) Joints and fittings for use with uPVC cable ducts shall comply with BS 4346: Part 1 and BS 4346: Part 2. Solvent cement for uPVC pipes and fittings shall comply with BS 4346: Part 3.  (3) Steel cable ducts shall be steel tubes complying with BS 1387, medium series, screwed and socketted tubes and shall have screwed sockets suitable for screwing to BS 21, Table 2 pipe threads. The tubes, sockets, clamps and saddles for ducts shall be hot dip galvanized in accordance with BS EN ISO 1461:1999. |
| 12.3.3 | Paint for conduit and duct systems | (1) Bituminous paint for steel conduits and steel cable ducts shall comply with BS 3416, type 1.  (2) Anti-rust paint for concealed electrical conduit systems shall be of a proprietary type approved by the Engineer.  (3) Zinc chromate primer for cable duct systems shall comply with BS 4652.  (4) Galvanizing paint for cable duct systems shall be of a proprietary type approved by the Engineer. |
| 12.3.4 | Fire barriers | Internal fire barriers shall be a type offering adequate fire resistance for the application. The material shall be approved by the Engineer in compliance with Fire Services Department’s requirements and shall be resistant to fire, smoke, gas and water. |
| 12.3.5 | Cement grout for electrical and mechanical installations | The different types of cement grout for electrical and mechanical installations shall consist of Portland cement, sand and PFA in the proportions by mass stated in Table 12.1 together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the voids. The mix shall contain a non-shrink admixture of a proprietary type approved by the Engineer. |

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| Table 12.1: Mix proportions of cement grout |

|  |  |  |  |
| --- | --- | --- | --- |
| Type | Mix proportions by mass | | |
| Cement | Sand | PFA |
| G1 | 1 | - | - |
| G2 | 1 | 3 | - |
| G3 | 1 | 10 | - |
| G4 | 1 | - | 7 |

|  |  |  |
| --- | --- | --- |
| **12.4** | **STORAGE OF MATERIALS** |  |
| 12.4.1 | Storage of materials for conduit and cable duct systems | Materials for concealed electrical conduit systems and for cable duct systems shall be stored in accordance with the manufacturers' recommendations in a dry and weatherproof store. |
| **12.5** | **HOLES AND RECESSES FOR ELECTRICAL AND MECHANICAL INSTALLATIONS** |  |
| 12.5.1 | Holes and recesses for electrical and mechanical installations | (1) Holes and recesses shall be left in structures for electrical and mechanical installations. If instructed by the Engineer, holes and recesses shall be cut in structures for electrical and mechanical installations.  (2) Holes and recesses in internal floors, stairways and platforms shall be protected with temporary covers or by other methods agreed by the Engineer until the electrical and mechanical installation starts. Holes and recesses in roofs, external walls and external floors shall be sealed with watertight temporary covers until the electrical and mechanical installation starts.  (3) Holes in structures shall be filled and made good after electrical and mechanical installations are complete. Holes left in structural elements designated as fire barriers shall be sealed to at least the same degree of fire resistance as the structural element. |
| **12.6** | **FIRE BARRIERS** |  |
| 12.6.1 | Fire barriers | Internal fire barriers shall be constructed in service channels, service shafts and service ducts for electrical and mechanical installations at the following locations:  At points of intersection with structural elements designated as fire barriers,  At 5 m centres in vertical and inclined shafts, and at intersections with floor slabs, and  At termination points and open ends. |
| **12.7** | **CONCEALED ELECTRICAL CONDUIT SYSTEMS** |  |
| 12.7.1 | Construction of conduit systems | (1) Concealed electrical conduit systems that are shown diagrammatically in the Contract shall be constructed as stated in Clause 12.7.1  (2) Concealed electrical conduit systems shall be mechanically and electrically continuous and shall be effectively earthed.  (3) Principal conduit runs shall be either vertical or horizontal. Tee pieces and elbows, including those with provision for inspection, shall not be used unless approved by the Engineer.  (4) Joints shall be made using coupler units into which the ends of the conduits shall be inserted and tightened. Running couplings shall not be used unless permitted by the Engineer. If permitted, the couplings shall be made by screwing each of the conduits half way into the coupler with a hexagonal lock nut against each end of the coupler.  (5) Adaptable boxes shall be provided at:  Every second bend,  After a bend and a straight run of 10 m or less, and  Every 15 m in straight runs.  (6) Adaptable boxes for conduits installed in floor screeds shall have the lids set flush with the adjacent floor. The boxes shall be covered with the same material as the remainder of the floor and shall remain accessible at all times.  (7) The clearance between conduits entering adaptable boxes and between adjacent or parallel conduits shall be at least the nominal maximum coarse aggregate size of the concrete plus 5 mm. |
| 12.7.2 | Installation of conduit systems | (1) Concealed electrical conduit systems shall be arranged and installed in accordance with best trade practice and in such a manner that all cables can be drawn with ease and without damage.  (2) Bends in concealed electrical conduit systems shall be formed by using proprietary bending equipment of a type agreed by the Engineer. Connections and other work shall be carried out using purpose made equipment.  (3) Conduits shall not be bent by more than 900 and the internal radius at bends shall be at least 2.5 times the external diameter of the conduit. Conduits shall not be flattened at bends.  (4) Burrs and sharp edges shall be removed from the ends of conduits before installation.  (5) Concealed electrical conduit systems that are to be cast into concrete shall be fastened to the reinforcement with tying wire of the same type used for the reinforcement. The conduit systems shall not be positioned between the reinforcement and the outside face of the concrete unless permitted by the Engineer.  (6) Conduit boxes shall be of a compatible size and shall have a single extension ring of the required depth if the plaster finish exceeds 13 mm thick. Multiple extension rings shall not be used. |
| 12.7.3 | Terminations of conduit systems | Screw fitting couplers shall be provided at each end of conduits which terminate in distribution boards, busbar chambers, motor starters, cable ducts, boxes or similar termination points. The item at which the conduit terminates shall be drilled with an unthreaded clearance hole to receive a brass male bush. The bush shall be screwed into the coupler from the inside of the item in such a manner that the surface of the item is gripped between the coupler and the bush. The threads shall be at least half the length of the coupler. |
| 12.7.4 | Protection of conduit  systems | (1) Concealed electrical conduit systems shall have special arrangements designed by the Contractor to permit movement of conduits to take place on each side of movement joints in structures. A separate circuit protective conductor shall be installed to maintain effective electrical continuity across the joint. The protective conductor shall have a cross-sectional area rated to suit the largest live conductor to be drawn into the conduit.  (2) Steel conduit systems laid in contact with or adjacent to other metal work shall have efficient and permanent metallic connection made between the conduit and the metal work.  (3) Underground steel conduits and conduits in contact with soil shall be painted with two coats of bituminous paint before installation.  (4) Exposed threads and damage to protective coatings of conduit systems shall be painted with two coats of anti-rust paint.  (5) Conduits shall be laid in such a manner that accumulation of condensed moisture in the conduit system is prevented. Measures shall be taken to prevent water from entering the system.  (6) Water, moisture and deleterious material shall be prevented from entering permanent and temporary terminations in concealed electrical conduit systems, including conduit boxes, by using conduit-stopping plugs of a type approved by the Engineer. Paper or rags shall not be used. |
| 12.7.5 | Cleaning of conduit systems | After installation, concealed electrical conduit systems shall be swabbed out with draw-in tapes and absorbent cloth of a type agreed by the Engineer. All obstructions shall be removed and draw wires shall be installed. After cleaning, exposed conduit ends shall be sealed as stated in Clause 12.7.4 |
| **12.8** | **CABLE DUCT SYSTEMS** |  |
| 12.8.1 | Installation of cable duct system | (1) Changes in direction in cable duct systems shall be constructed in such a manner that the cables in the duct will have radii of curvature of at least 800 mm. Ducts entering draw-in pits shall be on the same horizontal plane as the draw-in pit.  (2) uPVC cable ducts shall be jointed in accordance with the manufacturer's recommendations.  (3) Steel cable ducts shall be jointed using screwed hot dip galvanized sockets and spun yarn or by an equivalent method approved by the Engineer such that the jointed pipes abut. The threads shall be painted with two coats of bituminous paint. Internal rags and burrs shall be removed to provide a smooth bore through joints in the cable duct system.  (4) Surface mounted cable ducts shall be secured by hot dip galvanized steel clamps or saddles at spacing not exceeding 3 m. |
| 12.8.2 | Protection of cable duct systems | (1) After jointing, exposed bare metal in cable duct systems shall be cleaned and painted with two coats of zinc chromate primer and two coats of galvanizing paint.  (2) Surface-mounted hot dip galvanized steel cable ducts shall be cleaned and painted after fittings and jointing have been completed. |
| 12.8.3 | Cleaning of cable duct systems | After jointing, cable duct systems shall be cleaned internally by scrubbing with a cylindrical brush of a type agreed by the Engineer. The ends of ducts, including ends of ducts in draw-in pits and spare ducts, shall be fitted with tapered hardwood plugs to prevent water, moisture and deleterious material from entering the system and a 6 mm diameter nylon draw line shall be installed. The plugs shall be centrally drilled for the draw line and the draw line shall be secured by a knot tied on the outer face of the plug to leave at least 1500 mm of surplus line at each plug. |
| **12.9** | **ELECTRICAL EARTHING SYSTEMS** |  |
| 12.9.1 | Electrical earthing systems | (1) Pits and trenches for electrical earthing systems shall be excavated at positions and at the times instructed by the Engineer.  (2) After the electrical earthing systems have been installed fill material shall be deposited and compacted in the pits and trenches to a depth of 300 mm above the electrical earthing system. Fill material shall be sand or fine fill material which has been selected from the excavated material, and which is free of stones retained on a 20 mm BS test sieve. Fill material shall be compacted by handrammers in a manner approved by the Engineer. |
| **12.10** | **GROUTING FOR ELECTRICAL AND MECHANICAL INSTALLATIONS** |  |
| 12.10.1 | Grouting for electrical and mechanical installations | (1) Grouting to structural steelwork, machine bases, crane rails, electrical and mechanical equipment and other electrical and mechanical installations shall comply with the requirements stated in Clauses 12.10.1  (2) Grouting shall be carried out at the times instructed by the Engineer and shall be completed within 7 days of the instruction unless otherwise permitted by the Engineer.  (3) The permission of the Engineer shall be obtained before items or equipment are grouted. The Contractor shall inform the Engineer within 3 days, or a shorter period agreed by the Engineer, before grouting starts and shall allow the Engineer sufficient time to inspect the work that is to be grouted.  (4) Concrete surfaces shall be scabbled to remove laitance and loose material and to expose the aggregate before the item or equipment is installed in position.  (5) The voids to be grouted shall be cleaned and thoroughly wetted immediately before grouting. Excess water shall be removed by using a compressed air jet or by other methods agreed by the Engineer.  (6) Grout shall be mixed and placed by methods agreed by the Engineer.  (7) If grouting is to be carried out in two operations, holding down bolts shall be grouted into preformed pockets and sufficient time shall be allowed for the grout to cure and for the bolts to be tensioned before the remaining voids are grouted.  (8) Exposed grout surfaces shall have a uniform, dense and smooth surface free of trowel marks and which is produced by steel trowelling the surface under firm pressure. The exposed surfaces shall be cured by either:  Using a liquid curing compound applied to the surface by a low-pressure spray until a continuous visible covering is achieved, or  Covering the surface with hessian or sacking. The hessian or sacking shall be lapped and securely held in position and shall be kept damp for at least 4 days. |
| **12.11** | **COMPLETION AND PROTECTION OF WORK FOR ELECTRICAL AND MECHANICAL INSTALLATIONS** |  |
| 12.11.1 | Completion of work for electrical and mechanical installations | (1) Work shall be completed to the conditions stated in Clauses 12.11.1 before structures are made available to others for electrical and mechanical installations.  (2) The structure shall be clean, dry and free of dust. Work that in the opinion of the Engineer will produce large quantities of dust shall be complete.  (3) Holes and recesses, concealed electrical conduit systems and cable duct systems required for the installation shall be complete. Concrete surfaces on which items and equipment are to be installed shall be scabbled.  (4) Plinths, trenches, louvres, openings and similar work shall be complete and shall have hardened sufficiently to allow the installation to proceed.  (5) Floors and slabs shall be complete to the specified finishes except that floor tiles shall not be laid until after the installation is complete.  (6) Plant rooms shall be complete, including fixtures and fittings, to a secure and weatherproof condition. Two sets of door keys for the plant room shall be provided for the Engineer.  (7) Paintwork and similar finishes in plant rooms shall be complete to undercoat level. Final coats shall not be applied until after the installation is complete.  (8) Temporary power supplies and connections required for the installation shall be complete. The supply shall be metered and shall be a 346V, 3-phase supply of 20A maximum rating. Temporary power supplies shall be provided for the periods stated in the Contract. |
| 12.11.2 | Protection of work for electrical and mechanical installations | (1) Structures in which electrical and mechanical installations are being carried out shall be maintained in a clean, dry condition, free of dust, during the installation.  (2) The dust level in plant rooms shall be kept to a minimum by using industrial dust extractors of a type agreed by the Engineer during and after the installation. Temporary screens shall be installed to separate dust-affected areas from the installations or temporary covers shall be installed around the installation. |
| **12.12** | **TOLERANCES** |  |
| 12.12.1 | Tolerances: floors of switchgear rooms | The tolerance in floor levels for switchgear rooms shall be as follows:  ± 2 mm in 1000 mm for high voltage switchgear rooms,  ± 4 mm in 1000 mm for medium voltage switchgear rooms. |
| 12.12.2 | Tolerances: lamp standards | Lamp standards shall be within 0.1 degrees of the vertical. |
| **12.13** | **INSPECTION OF WORK FOR ELECTRICAL AND MECHANICAL INSTALLATIONS** |  |
| 12.13.1 | Inspection of work for electrical and mechanical installations | (1) The Contractor shall allow the Engineer to inspect the following work for electrical and mechanical installations:  Completed concealed electrical conduit systems, cable duct systems, electrical earthing systems and items and equipment which are to be grouted or covered up,  Items and equipment which are to be tested, and  Structures that are to be made available for electrical and mechanical installations.  (2) The Contractor shall inform the Engineer three days, or such shorter period agreed by the Engineer, before work is covered up, tested or made available. |
| **12.14** | **TESTING: EARTHING CONTINUITY** |  |
| 12.14.1 | Testing: earthing continuity | (1) Concealed electrical conduit systems shall be tested to determine the earthing continuity. The system shall be tested:  Before the system is cast in concrete or covered up,  After the system is cast in concrete or covered up, and  After electrical wiring that is installed by the Contractor is complete.  (2) Unless otherwise approved by the Engineer the method of testing shall be in accordance with Appendix 15 to the IEE Wiring Regulations, 15th Edition, 1981 issued by the Institution of Electrical Engineers. |
| 12.14.2 | Compliance criteria: earthing continuity | The results of tests for earthing continuity shall comply with the IEE Wiring Regulations, 15th Edition, 1981 issued by the Institution of Electrical Engineers. |
| **12.15** | **TESTING: LOAD TESTS ON BEAMS AND JOISTS** |  |
| 12.15.1 | Testing: load tests on beams and joists | (1) Load tests shall be carried out on lifting beams, rolled steel joists and lifting hooks that are installed by the Contractor.  (2) Testing shall be carried out by an independent testing consultant approved by the Engineer and by using methods approved by the Engineer.  (3) A certificate showing the results of the load tests and signed by the testing agent shall be submitted to the Engineer within 14 days of the test. |
| 12.15.2 | Compliance criteria: load tests on beams and joists | The results of tests on lifting beams, rolled steel joists and lifting hooks shall comply with the Factories and Industrial Undertakings. |
| **13.** | **SECTION 13 FORMWORK AND FINISHES TO CONCRETE** |  |
| **13.1** | **GENERAL** |  |
| 13.1.1 | General requirements | The works and materials specified in Clauses 13.1.2 and 13.1.3 shall comply with the sections stated, unless otherwise stated in this Section. Hardwood is strictly prohibited for use in the falsework unless approved by the Engineer. |
| 13.1.2 | Concrete carriageways | Surface finish to concrete carriageways shall comply with Section 9. |
| 13.1.3 | Cover spacers | Cover spacers for steel reinforcement shall comply with Section 14. |
| **13.2** | **GLOSSARY OF TERMS** |  |
| 13.2.1 | Class | Class is a term used to identify the different types and standards of formed, unformed and treated finishes. |
| 13.2.2 | Falsework | Falsework is a temporary structure used to support formwork and a permanent structure until the permanent structure is self-supporting. |
| 13.2.3 | Formed finish | Formed finish is the finish of the concrete surface produced by the use of formwork. |
| 13.2.4 | Formwork | Formwork is the mould against which concrete is cast and which gives the shape and finish to the concrete surface. |
| 13.2.5 | Permanent formwork | Permanent formwork is formwork designed to remain in position as part of the permanent work. |
| 13.2.6 | Profiled formwork | Profiled formwork is formwork designed to produce a ribbed or patterned finish on the concrete surface. |
| 13.2.7 | Sealed plywood | Sealed plywood is plywood that has been sealed with a factory-applied film of phenolic resin or plastic material. |
| 13.2.8 | Spatterdash | Spatterdash is a mixture of cement, coarse sand, granite fines and water, used as a rendering on concrete surfaces. |
| 13.2.9 | Treated finish | Treated finish is the finish of the concrete surface produced by a treatment applied to a formed or unformed finish. |
| 13.2.10 | Unformed finish | Unformed finish is the finish of the concrete surface produced without formwork and by working the concrete surface before the concrete has hardened. |
| **13.3** | **MATERIALS** |  |
| 13.3.1 | Formwork | (1) Formwork shall be timber, metal, plastic or other material, which will produce the specified finish. Tropical hardwood is strictly prohibited for use in the formwork. Materials used as formers for profiled formwork, chamfers, splays, rebates and other features shall be such that they produce the same finish as the main formwork.  (2) Plywood for formwork shall have a close, uniform grain and the edges shall be sealed with barrier paint, polyurethane varnish or other impermeable material. Plywood sheathing to formwork shall not be subjected to more than nine uses, irrespective of the use of one or both faces of such sheathing.  (3) The faces of formwork for Class F4 and F5 finishes shall have a uniform texture and a matt, not a shiny or polished, surface. The edges of the formwork shall be straight and square. |
| 13.3.2 | Formwork Class of finish | (1) The characteristics of each class of finish shall be as stated in Tables 13.1, 13.2 and 13.3.  (2) Formwork of the type stated in Table 13.1 will normally produce a concrete surface that complies with the characteristics of finish stated in Table 13.1 but other types of formwork may be used to produce the specified finish.  (3) The Class of formed and unformed finish required for different concrete surfaces shall be as stated in Table 13.4 unless otherwise stated in the Contract. The higher Class of finish shall start at least 150 mm below the finished ground level for concrete surfaces that are partly buried |
| 13.3.3 | Release agents | (1) Release agents shall be of a proprietary type approved by the Engineer. Release agents containing mineral oils shall not be used. Barrier paint, polyurethane varnish, wax or other materials shall not be used instead of a release agent.  (2) Release agents shall be of a type that will not stain or colour the concrete and which will not affect the bond between the concrete and subsequent coverings. Release agents other than those that incorporate a surface retarder to produce a Class T1 finish shall be of a type that will not affect the hardening of the concrete.  (3) Release agents used on formwork for water retaining structures for potable and fresh water shall be non-toxic and shall not impart a taste to the water.  (4) Release agents used on steel formwork shall contain a rust-inhibiting agent.  (5) Release agents used on formwork for Class F4 and F5 finishes shall be a chemical release agent.  (6) On areas of formwork which in the opinion of the Engineer are likely to be affected by pedestrian traffic, rain or dust, release agents for Class F4 and F5 finishes shall be of a type which evaporates to leave a dry film on the formwork, unless protection from such effects is provided. |

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| Table 13.1: Formed finishes |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class of finish | Type of formwork normally used | Characteristics of finish | | | |
| Formwork pattern | Abrupt irregularities permitted | Gradual irregularities permitted | Specific requirements |
| F1 | Sawn timber | Not required | < 10 mm | < 15 mm in 2 m | No specific requirements |
| F2 | Plywood | Pattern of formwork joints and tie holes as stated in Clause 13.7.3 | < 5 mm | < 10 mm in 2 m | Even surface No grout runs |
| F3 | < 3 mm | < 5 mm in 2 m | Even surface No grout runs |
| F4 | Sealed plywood | Uniform, dense and smooth surface  No grout runs No grain pattern No crazing  No major blemishes |
| F5 | < 2 mm | < 3 mm in 2 m | Uniform, dense and smooth surface  No grout runs No grain pattern No crazing  No blemishes No staining or discolouration |

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| Table 13.2: Unformed finishes |

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| --- | --- | --- | --- | --- |
| Class of finish | Method of producing finish | Characteristics of finish | | |
| Abrupt irregularities permitted | Gradual irregularities permitted | Specific requirements |
| U1 | Levelling the surface of the compacted concrete with a screed board | Screed marks  < 5 mm | < 10 mm in 2 m | No specific requirements |
| U2 | Forming a Class U1 finish and  tamping the surface | Tamp marks  < 10 mm | Not applicable | Ridged surface |
| U3 | Forming a Class U1 finish and wood floating or  power floating the surface | Float marks  < 3 mm | < 10 mm in 2 m | Uniform, dense and smooth surface |
| U4 | Forming a Class U3 finish and  brushing the surface with a stiff brush | Brush marks  < 3 mm | < 10 mm in 2 m | Rough texture |
| U5 | Forming a Class U3 finish and  steel trowelling the surface under firm pressure or power floating the surface | Nil | < 5 mm in 2 m | Uniform, dense and smooth surface, free of trowel marks  No staining or discolouration |

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| Table 13.3: Treated finishes |

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| Class of  finish | Type of finish | Method of producing finish | Characteristics of finish |
| T1 | Exposed aggregate | Washing and brushing the concrete surface | Cement matrix removed and coarse aggregate exposed to a depth not exceeding one-third of the nominal maximum coarse aggregate size |
| T2 | Point tooled | Point tooling the concrete  surface | Cement matrix and aggregate surface removed sufficiently to expose the aggregate with a minimum penetration into the matrix between aggregates |
| T3 | Bush hammered | Bush hammering the concrete surface |
| T4 | Broken rib | Hammering or chiselling the edges and faces of the concrete surface | Fragments of concrete ribs removed |
| T5 | Light blasting | Blasting the concrete surface by abrasives and compressed air or by water jetting | Cement matrix removed and coarse aggregate exposed to a minimum depth |
| T6 | Heavy blasting | Cement matrix removed and coarse aggregate exposed to a depth not exceeding one-third of the nominal maximum coarse aggregate size |

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| Table 13.4: Class of finish |

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| Description of surface | | | Class of finish | |
| Formed | Unformed |
| Surfaces to be covered | - screeded | | - | U2 |
|  | - rendered, plastered | | F2 | - |
|  | - tiled | | F2 | U3 |
|  | - painted | | F4 | U5 |
| Surfaces for treated finishes | | | F3 | U3 |
| Surfaces for pedestrian traffic | | | - | U4 |
| Construction joints (for Class T1 finish) | | | F2 | U3 |
| Movement joints | | | F3 | U3 |
| Benching, screeds | | | F3 | U5 |
| Blinding, foundations, pile caps | | | F1 | U1 |
| Piers, blocks, pipe surrounds | | below FGL  above FGL | F1  F2 | U1 U3 |
| Manholes, chambers | | external below FGL  external above FGL  internal | F1  F2  F2 | U1  U3  U3 |
| Culverts, channels | | external below FGL  external above FGL  internal | F1  F2  F4 | U1  U3  U5 |
| Water retaining structures | | external below FGL  external above FGL  internal | F2  F4  F4 | U3  U5  U5 |
| Buildings | | external below FGL  external above FGL  internal | F1  F2  F4 | U1  U3  U5 |
| Bridges, retaining walls, walls | | below FGL  above FGL, not exposed to direct public view  above FGL, exposed to direct public view  internal, not exposed to direct public view | F1  F4  F5  F2 | U1  U5  U5  U1 |

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| 13.3.4 | Formwork ties | (1) Formwork ties and components shall be of a type such that any removable part can be removed without damaging the concrete. Any part left in the concrete shall be at least 40 mm or the specified nominal cover to the reinforcement, whichever is greater, from the concrete surface.  (2) Unless otherwise permitted by the Engineer, formwork ties and components used with profiled formwork shall be of a type such that holes left by the ties and components are small enough to be located completely within the recesses in the concrete surface. |
| 13.3.5 | Cement mortar for concrete surfaces | (1) Cement mortar for filling blowholes shall consist of cement and fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the blowholes.  (2) Cement mortar for filling holes left by formwork ties and components shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for compacting the mortar into the holes. The mix shall contain a non-shrink admixture.  (3) Cement mortar for filling blowholes and holes left by formwork ties and components in concrete surfaces with Class F4 and F5 finishes shall be the same colour as the hardened concrete. Light-coloured sand or white cement may be used for this purpose.  (4) Materials for cement mortar shall comply with Section 15. |
| 13.3.6 | Surface retarders | Surface retarders shall be of a proprietary type approved by the Engineer and shall be of a type that will not stain or colour the concrete. |
| 13.3.7 | Abrasives | Abrasives for blasting shall be grit or other materials approved by the Engineer and shall not contain any iron, clay or other materials which will stain or colour the concrete. |
| **13.4** | **SUBMISSIONS** |  |
| 13.4.1 | Particulars of formwork and finishes to concrete and samples of materials | (1) Particulars and samples of the proposed materials and methods of construction for Class F4, F5, U5 and T finishes shall be submitted to the Engineer as marked 'x' in Table 13.5. The same particulars shall be submitted for other Classes of finish if required by the Engineer. Where the sheathing is timber plywood, details of the method of identifying and recording the number of uses to which the sheathing will be subjected to, including the labour and equipment that are provided for carrying out marking and recording, shall be submitted to the Engineer for approval.  (2) The particulars and samples for formed finishes shall be submitted at least 14 days before the relevant formwork, including formwork for trial panels, is fabricated. The particulars and samples for unformed and treated finishes shall be submitted at least 14 days before the relevant element, including trial panels, is concreted. |

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| Table 13.5: Particulars to be submitted |

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| Particulars to be submitted | | Formed finishes | Unformed finishes | Treated finishes |
| Formwork drawings | : Panel construction Layout and pattern of panels, joints and formwork ties | X  X | -  - | X  X |
| Method statement |  | - | X | X |
| Samples | : Formwork  Formwork ties  Cover spacers | X  X  X | -  -  - | -  X  X |
| Brand name and manufacturer's literature | : Release agent  Curing compound  Surface retarder | X  X  - | -  X  - | X  X  X |
| Programme | : Removing formwork  Applying treated finishes | X  - | -  - | -  X |
| Details | : Sources of formwork, | X | - | X |
|  | formwork ties and cover |
|  | spacers |
|  | Curing | X | X | X |
|  | Filling blowholes | X | - | - |
|  | Filling formwork tie holes | X | - | X |
|  | Protecting finishes | X | X | X |

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| **13.5** | **TRIAL PANELS** |  |
| 13.5.1 | Trial panels | (1) A trial panel shall be constructed for each Class F4, F5, U5 and T finish to demonstrate that the proposed materials, mix design, methods of production and methods of construction, including curing and removal of formwork, will produce the specified finish.  (2) Trial panels for Class F4 and F5 finishes shall be constructed before the relevant formwork for the permanent work is erected, and trial panels for Class U5 and T finishes shall be constructed before the relevant permanent work is concreted. The trial panels shall be constructed at least 4 weeks before the relevant permanent work is carried out.  (3) The Contractor shall inform the Engineer at least 24 hours, or such shorter period agreed by the Engineer, before constructing trial panels.  (4) Trial panels shall be constructed using the materials, mix design, methods of production and methods of construction, including curing and removal of formwork, submitted to the Engineer for approval.  (5) Trial panels shall be horizontal, vertical or inclined as appropriate and shall be constructed at locations agreed by the Engineer. Unless otherwise stated in the Contract each trial panel shall be not less than 2 m by 2 m by 300 mm thick, and shall contain reinforcement representative of the most congested reinforcement that will be used in the permanent works. Trial panels shall incorporate formwork ties and components, horizontal joints, vertical joints, chamfers, splays, rebates and other features representative of those which will be used in the permanent work.  (6) Trial panels shall be protected from damage and shall be left in position until the Engineer instructs the Contractor to remove them. |
| 13.5.2 | Non-compliance: trial panels | If in the opinion of the Engineer the specified finish has not been produced in the trial panel, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer for approval. Further trial panels shall be constructed until the specified finish is produced in the trial panel. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial panel was not due to the concrete mix. |
| 13.5.3 | Commencement of formwork and concreting | Formwork for Class F4 and F5 finishes shall not be erected and elements with Class U5 and T finishes shall not be concreted until in the opinion of the Engineer the specified finish has been produced in the trial panel. |
| 13.5.4 | Changes in materials and methods of construction | Unless permitted by the Engineer, the materials, mix design, methods of production or methods of construction, including curing and removal of formwork, used to produce the specified finish in trial panels shall not be changed. The Engineer may order new trial panels to be constructed if he considers that the changes in materials and/or methods of construction proposed by the Contractor may affect the finished appearance. |
| **13.6** | **STORAGE OF MATERIALS** |  |
| 13.6.1 | Storage of formwork | (1) Formwork shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner, which will not result in damage or deformation to the formwork, or in contamination of the formwork. Measures to protect the formwork against drying and wetting caused by weather shall be submitted to the Engineer for approval.  (2) Formwork for Class F4 and F5 finishes shall be covered and protected from exposure to conditions that may affect the formwork. |
| 13.6.2 | Storage of release agents and surface retarders | Release agents and surface retarders shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions that may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded. |
| **13.7** | **DESIGN AND CONSTRUCTION OF FALSEWORK AND FORMWORK** |  |
| 13.7.1 | Design and construction of falsework and formwork | (1) Falsework and formwork shall be designed and constructed to maintain the position and shape of the formwork so that the hardened concrete surface complies with the characteristics of finish stated in Table 13.1 and with any more stringent tolerances stated in the Contract. Allowance shall be made for cambers.  (2) Falsework and formwork shall be capable of being dismantled and removed without shock, disturbance, damage or loading to the concrete and in such a manner that the specified requirements for removing or leaving in position side formwork, soffit formwork and props will be achieved without disturbing other formwork or props.  (3) Formwork shall be used to form the top surface of concrete inclined at a slope exceeding 15° to the horizontal unless it can be demonstrated that the specified finish will be produced without the use of formwork. Formwork to top surfaces shall be anchored to prevent flotation.  (4) The Contractor shall be responsible for the design of all proposed falsework and formwork and submit the design calculations and drawings to the Engineer at least 14 days before the relevant element is erected. |
| 13.7.2 | Construction of formwork | (1) Formwork shall not have any splits, cracks or other defects. The faces and edges of formwork shall be clean and formwork faces shall be free of projecting nails.  (2) Formwork that has been previously used shall be repaired and the edges resealed before it is erected. Formwork that in the opinion of the Engineer has deteriorated to an extent such that it will not produce the specified finish shall not be used for that Class or a higher Class of finish.  (3) Formwork shall be firmly supported and individual panels shall be rigid. Joints between formwork panels, stop ends and adjoining concrete shall be tight and shall not permit grout loss. Gaps shall be sealed with gaskets, filler, sealant or tape before the application of release agents.  (4) Formwork shall be cut in such a manner that reinforcement and built-in components passing through the formwork are maintained in position. The joints shall be tight and shall not permit grout loss.  (5) Formers for profiled formwork, chamfers, splays, rebates and other features shall be rigidly and evenly fixed to the formwork along the complete length and shall not permit grout loss.  (6) Formwork ties and components shall be fixed in such a manner that they do not touch reinforcement or built-in components. Formwork ties and components shall fit tightly against formwork faces and shall not permit grout loss.  (7) If required for cleaning or inspection, temporary openings shall be provided in the formwork. |
| 13.7.3 | Construction of formwork for Class F2, F3, F4 and F5 finishes | (1) Formwork panels for Class F2, F3, F4 and F5 finishes shall be the same size and shall form a regular pattern approved by the Engineer. The lines of joints between panels shall be straight and continuous, horizontal and vertical, or inclined to suit the pattern of profiled formwork, and shall be coincident with construction joints and other joints and with recesses in the concrete surface. The number of make-up pieces shall be kept to a minimum.  (2) Holes left by formwork ties and components in concrete surfaces with Class F2, F3, F4 and F5 finishes shall be in line horizontally and vertically and shall form a regular pattern approved by the Engineer. Unless otherwise permitted by the Engineer, holes in profiled formwork shall be located in such a manner that the holes are completely within recesses in the concrete surface.  (3) Unless otherwise stated in the Contract or permitted by the Engineer, chamfers shall be provided for all external angles of 90° or less in concrete surfaces with Class F2, F3, F4 and F5 finishes.  (4) Formwork for curved concrete surfaces with Class F2, F3, F4 and F5 finishes shall not be made up of a series of flats unless permitted by the Engineer. |
| 13.7.4 | Construction of formwork for Class F4 and F5 finishes | (1) Each type of formwork for Class F4 and F5 finishes shall be obtained from one source and different types of formwork shall not be mixed unless permitted by the Engineer. Damaged formwork shall not be used unless permitted by the Engineer. Parts of steel formwork that will be in contact with concrete shall be free of rust.  (2) For concrete surfaces with Class F4 and F5 finishes, joints between formwork panels shall be sealed with foamed rubber strips. The foamed rubber strips shall be sufficiently compressible to form a grout-tight joint. The width of the resulting gap between the panels shall not be greater than 1 mm and the sealing strips shall not protrude proud of the surface of the formwork panels. Alternatively, subject to the approval of the Engineer, joints between formwork panels may be sealed with an approved filler provided that the butting edges of the panels are smooth and the resulting gap between the panels is not wider than 1 mm. Joints between formwork panels shall not be sealed by tape fixed to the formwork faces.  (3) Formwork for Class F4 and F5 finishes shall be protected from spillages, rust marks and stains. |
| 13.7.5 | Built-in components | Built-in components, void formers and box-outs shall be fixed in position before concreting. Unless permitted by the Engineer, void formers and box-outs shall not be used instead of built-in components. Polystyrene shall not be used for void formers and box-outs unless permitted by the Engineer. |
| **13.8** | **APPLICATION OF RELEASE AGENTS** |  |
| 13.8.1 | Application of release agents | (1) A release agent shall be used on all formwork other than permanent formwork and formwork on which a surface retarder is used to produce a Class T1 finish. The release agent shall be applied by the method and at the rate of application recommended by the manufacturer or as demonstrated to be satisfactory by use in the trial panel.  (2) Formwork faces shall be cleaned before release agents are applied. Concrete, reinforcement and built-in components shall not be contaminated by release agents.  (3) Each type of release agent used on formwork for Class F4 and F5 finishes shall be obtained from one manufacturer and different types of release agent shall not be used on formwork for the same element.  (4) Release agents shall be applied to formwork for Class F4 and F5 finishes after the formwork has been erected and before the reinforcement is fixed or, if this is not practicable, immediately before the formwork is erected. The release agent covering shall be complete and uniform. |
| **13.9** | **INSPECTION OF FORMWORK AND REINFORCEMENT** |  |
| 13.9.1 | Inspection of formwork and reinforcement | (1) The Contractor shall allow the Engineer to inspect the completed formwork and reinforcement, including trial panels, before carrying out any work, including fixing reinforcement adjacent to formwork and erecting formwork adjacent to reinforcement, which will make access to the formwork faces or reinforcement difficult. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out such work.  (2) The Contractor shall allow the Engineer to inspect formwork for Class F4 and F5 finishes before it is erected and shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before erecting the formwork. |
| **13.10** | **REMOVAL OF FALSEWORK AND FORMWORK** |  |
| 13.10.1 | Times for removal of falsework and formwork | (1) Except as stated in Clause 13.10.1. falsework and formwork shall not be loosened or removed before the minimum times stated in Table 13.6 have elapsed. The times stated are for a minimum ambient temperature of 15°C, for elements without superimposed loads and for concrete containing PC, PFAC or both PC and PFA not exceeding the PC replacement level as specified in Clause 15.4.3. If other conditions apply, particulars of proposed changes to the minimum times shall be submitted to the Engineer for approval.  (2) For the purpose of determining the minimum times for loosening or removing falsework and formwork, copings at the top of columns in water retaining structures shall be classified as slabs and roof slabs in water retaining structures shall be classified as beams.  (3) Falsework and formwork supporting concrete in flexure may be loosened or removed when the strength of the concrete in that element is 10 MPa or twice the stress to which it will be subjected, whichever is greater, provided that deflection which in the opinion of the Engineer is unacceptable will not result and that superimposed loads will not be applied. The strength of the concrete shall be determined from tests on test cubes which have been made with concrete from the same pour and which have been cured by the same method and under similar conditions as the concrete in the element. |

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| Table 13.6: Minimum times for loosening or removing falsework and formwork |

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| --- | --- | --- | --- |
| Type of falsework or | Class F1, F2, F3 and F4 finishes | | Class F5 finish |
| Concrete without PFA | Concrete with PFA | Concrete with or without PFA |
| Vertical (non-profiled)  (profiled) | 12 hours  7 days | 15 hours  7 days | 48 hours  7 days |
| Inclined to top surfaces | 12 hours | 15 hours | 48 hours |
| Soffits of slabs (props left in) | 4 days | 4 days | 10 days |
| Soffits of beams (props left in) | 7 days | 7 days | 14 days |
| Props to slabs | 10 days | 10 days | 10 days |
| Props to beams | 14 days | 14 days | 14 days |

|  |  |  |
| --- | --- | --- |
| 13.10.2 | Removal of falsework and formwork | (1) Formwork shall be removed without hammering or levering to the concrete and in such a manner that there is no shock, disturbance, damage or loading to the concrete. Side formwork shall be removed without disturbing soffit formwork and soffit formwork shall be removed without disturbing props except as provided for in Clause 13.10.2  (2) Individual props may be removed to allow the removal of soffit formwork provided that the formwork has been designed accordingly and that each prop is replaced as soon as the formwork has been removed.  (3) Falsework and formwork for Class F5 finishes shall be loosened and removed in a continuous operation and in accordance with a consistent programme agreed by the Engineer. All formwork shall be loosened before individual panels are removed and all formwork shall be removed within the programmed period. Individual panels or make-up pieces shall not be left in position.  (4) After removal, formwork which is intended for re-use shall be cleaned, repaired and stored as stated in Clause 13.6.1 |
| **13.11** | **UNFORMED FINISHES** |  |
| 13.11.1 | Unformed finishes | (1) Unformed finishes shall be produced by the methods stated in Table  (2) Brushing to produce a Class U4 finish shall be carried out in straight lines in a direction agreed by the Engineer. Brushing shall be carried out when the concrete has hardened sufficiently for the float marks to be removed and for the ridges to be formed without displacing the aggregate.  (3) Floating and trowelling shall not be carried out until the concrete has hardened sufficiently to allow the specified finish to be produced with the minimum amount of floating and trowelling such that excess laitance is not produced. |
| **13.12** | **TREATED FINISHES** |  |
| 13.12.1 | Treated finishes | (1) Treated finishes shall be produced by constructing a concrete surface with a Class F3 or U3 finish as appropriate and applying the treatment to the surface by the methods stated in Table 13.3.  (2) The treatment shall be applied in a continuous operation in accordance with a consistent programme agreed by the Engineer. Tying wire and cover spacers for reinforcement and cast-in component shall be positioned to avoid being exposed by the applied treatment. |
| 13.12.2 | Class T1 finish | (1) Washing and brushing to produce a Class T1 finish shall not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. After washing and brushing have been completed and the concrete surface has hardened, the surface shall be cleaned.  (2) The cement matrix shall not be removed or the aggregate exposed by mechanical methods unless permitted by the Engineer.  (3) Class T1 finishes may be produced by using a surface retarder applied to the formwork or to the concrete surface. The surface retarder shall be applied by the method and at the rate of application recommended by the manufacturer, or as demonstrated to be satisfactory by use on the trial panel.  (4) Plywood to which a surface retarder is to be applied shall be sealed with barrier paint, polyurethane varnish or other impermeable material agreed by the Engineer. The formwork shall be removed in small sections and the coarse aggregate exposed by washing and brushing the concrete surface.  (5) Unless permitted by the Engineer, formwork to which a surface retarder has been applied shall not be re-used unless a surface retarder is to be used again on the formwork. Formwork to which a surface retarder has been applied and which is to be re-used shall be cleaned before the retarder is applied. |
| 13.12.3 | Class T2 and T3 finishes | Point tooling to produce Class T2 finishes and bush hammering to produce Class T3 finishes shall be carried out evenly in small areas and not in distinct lines. Tooling and hammering shall not start until at least 7 days after concreting. |
| 13.12.4 | Class T4 finish | Hammering or chiselling to produce a Class T4 finish shall be applied from only one direction, and only either hammering or chiselling shall be applied, on any one face. Hammering and chiselling shall not start until at least 14 days after concreting. |
| 13.12.5 | Class T5 and T6 finishes | Blasting to produce Class T5 and T6 finishes shall not be carried out until the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. Adjacent surfaces shall be protected from blasting and dust shall be controlled by screens and by water-spraying. |
| **13.13** | **COMPLIANCE OF FINISHES** |  |
| 13.13.1 | Inspection of finishes | (1) Before any subsequent work is carried out on a concrete surface, the surface shall be inspected by the Engineer to determine if the specified finish has been produced. Formed finishes shall be inspected as soon as the formwork has been removed.  (2) Blowholes or holes left by formwork ties and components shall not be filled and spatterdash or other coverings shall not be applied before the inspection. Any such filling or covering carried out before the inspection may be rejected. |
| 13.13.2 | Compliance of finishes | (1) Concrete surfaces shall have the characteristics stated in Tables 13.1 and 13.2 for the different Classes of formed and unformed finish before any subsequent work is carried out on the concrete surface and shall have the characteristics stated in Table 13.3 for the different Classes of treated finish.  (2) The Engineer shall determine if the specified finish has been produced and may use the trial panels as a means of comparison.  (3) Abrupt irregularities shall be measured by direct measurement. Gradual irregularities shall be measured using a 2 m long straight edge on surfaces intended to be flat and by a method agreed by the Engineer on other surfaces. |
| **13.14** | **WORK ON CONCRETE SURFACES** |  |
| 13.14.1 | Remedial and repair work on concrete surfaces | Remedial or repair work shall not be carried out on concrete surfaces unless permitted by the Engineer. Any such work carried out without permission may be rejected. |
| 13.14.2 | Filling blowholes and formwork tie holes | (1) Blowholes exceeding 3 mm in size in water retaining structures and watertight structures, and blowholes exceeding 10 mm in size in other structures shall be filled with cement mortar. The size of blowholes shall be the maximum dimension measured across the hole on the concrete surface. If the number and size of blowholes in concrete surfaces with Class F3, F4 and F5 finishes is in the opinion of the Engineer greater than in the trial panel the blowholes shall be filled, unless in the opinion of the Engineer filling is not required.  (2) Holes left by formwork ties and components shall be cleaned and filled by ramming cement mortar into the holes in layers. Holes in concrete surfaces with a Class F5 finish shall be filled to a level slightly below the concrete surface. The holes shall not be overfilled and rubbed down.  (3) Filling of blowholes and holes left by formwork ties and components shall be carried out as soon as practicable after the Engineer has inspected the finish and with the minimum interruption to curing. |
| 13.14.3 | Spatterdash | (1) Spatterdash shall consist of cement and coarse sand or granite fines in the proportions 1:2 by volume mixed with the minimum amount of water necessary to achieve the consistency of a thick slurry. Spatterdash shall be thrown with a hand trowel onto the surface to a thickness not exceeding 6 mm and shall cover at least 60% of the area, which is to be plastered or rendered. Spatterdash shall be wetted one hour after application and shall be allowed to cure and harden before under coats are applied.  (2) Spatterdash shall be applied as soon as practicable after the Engineer has inspected the finish and after the concrete surface has been cleaned and wetted. |
| **13.15** | **PROTECTION OF FINISHES** |  |
| 13.15.1 | Protection of finishes | (1) Materials, Constructional Plant or other vehicles shall not use or be placed on or against concrete surfaces unless permitted by the Engineer.  (2) Concrete surfaces with Class F4, F5, U5 and T finishes shall be protected from running water, spillages, rust-marks and stains by covering the surface with polyethylene sheeting or timber or by other methods agreed by the Engineer. Protection from rust-marks caused by reinforcement bars shall be by polyethylene sleeves tied to the bars or by coating the bars with cement slurry. The bars shall not be coated with oil or grease.  (3) Concrete surfaces with Class F4, F5, U5 and T finishes shall be protected from damage by securing timber battens to the surface, by erecting barriers or fences or by other methods agreed by the Engineer.  (4) Concrete surfaces with a Class F5 finish shall be protected from exposure to extreme variations in weather conditions for at least 14 days after the formwork has been removed. |
| **14.** | **SECTION 14 STEEL REINFORCEMENT** |  |
| **14.1** | **GLOSSARY OF TERMS** |  |
| 14.1.1 | Reinforcement connector | Reinforcement connector is a coupler or sleeve designed to transmit the force between two bars in tension or compression. |
| 14.1.2 | Bar reinforcement | Bar reinforcement is hot rolled steel bar reinforcement. |
| **14.2** | **MATERIALS** |  |
| 14.2.1 | Bar reinforcement and fabric reinforcement | Except as stated in Clause 14.2.2 below, bar reinforcement and fabric reinforcement shall comply with the following:  Hot rolled steel bars : actual Maldivian standards  or similar.  Cold reduced steel wire : BS 4482  Steel fabric : BS 4483. |
| 14.2.2 | Stainless steel reinforcement | Stainless steel bars for the reinforcement and use in concrete shall be ribbed bar to BS 6744:2001. The steel designation numbers are in accordance with the BS EN 10088-1: 2005 standards. |
| 14.2.3 | Epoxy coatings to reinforcement | (1) Epoxy coatings to reinforcement and patching material for epoxy coatings shall comply with BS ISO 14654:1999 except as stated in Clauses 14.2.3, 14.6.2, 14.10.3, 14.10.5 and 14.10.9. The coatings shall be applied by the electrostatic spray method in accordance with BS ISO 14654:1999 at a factory approved by the Engineer.  (2) The film thickness of the coating after curing shall be at least 0.15 mm and shall not exceed 0.28 mm over the complete periphery including deformations and ribs. The bond classification of coated bars determined in bond performance tests shall not be less than that of uncoated bars. |
| 14.2.4 | Hot dip galvanizing to reinforcement | (1) Hot dip galvanizing to reinforcement shall comply with BS EN ISO 1461:1999. The galvanization shall be applied after cutting and bending of the reinforcement.  (2) Metallic zinc-rich priming paint for repairs to hot dip galvanized reinforcement shall comply with BS 4652. |
| 14.2.5 | Reinforcement connectors | (1) Reinforcement connectors shall be of a proprietary type approved by the Engineer.  (2) Reinforcement connectors for tension joints shall be a cold swaged or threaded type. The connectors shall be capable of developing the full tensile strength of the parent bar and shall comprise high tensile steel studs and seamless steel tubes fitted with protective plastic caps.  (3) Reinforcement connectors for compression joints shall be of a wedge locking or bolted sleeve type. |
| 14.2.6 | Cover spacers | (1) Cover spacers for reinforcement shall be concrete blocks or of a proprietary plastic or concrete type. Proprietary plastic and concrete cover spacers shall be of a type approved by the Engineer.  (2) Cover spacers for Class F3, F4 and F5 finishes shall be of a proprietary plastic or concrete type. Cover spacers for epoxy-coated reinforcement and galvanized reinforcement shall be of a proprietary plastic type.  (3) Cover spacers shall be as small as practicable consistent with their purpose and shall be designed to maintain the specified cover to reinforcement. Cover spacers shall be capable of supporting the weight of reinforcement and construction loads without breaking, deforming or overturning.  (4) The strength and durability of concrete blocks and proprietary concrete cover spacers shall not be less than that of the surrounding concrete.  (5) Cover spacers for Class F3, F4 and F5 finishes shall be of a colour similar to that of the surrounding concrete and shall not cause indentations in the formwork. |
| 14.2.7 | Chairs, supports and Tying wire | Chairs, supports and spacers other than cover spacers for reinforcement shall be steel. The steel shall be coated with nylon, epoxy, plastic or other dielectric material for epoxy-coated reinforcement and shall be hot dip galvanized for galvanized reinforcement. |
| 14.2.8 | Tying wire | Tying wire for reinforcement adjacent to and above Class F4 and F5 finishes shall be 1.2 mm diameter stainless steel wire. Tying wire for epoxy-coated reinforcement shall be 1.6 mm diameter soft annealed steel wire coated with nylon, epoxy, plastic or other dielectric material. Tying wire for galvanized reinforcement shall be 1.6 mm diameter galvanized soft annealed steel wire. Tying wire for other reinforcement shall be 1.6 mm diameter soft annealed steel wire. |
| 14.2.9 | Tying devices and clips | Tying devices and clips for reinforcement shall be of a proprietary steel type approved by the Engineer. Tying devices and clips for reinforcement adjacent to and above Class F4 and F5 finishes shall be stainless steel. Tying devices and clips for epoxy-coated reinforcement shall be coated with nylon, epoxy, plastic or other dielectric material. Tying devices and clips for galvanized reinforcement shall be galvanized. |
| **14.3** | **SUBMISSIONS** |  |
| 14.3.1 | Particulars of bar reinforcement and fabric reinforcement | (1) The following particulars of the proposed bar reinforcement and fabric reinforcement shall be submitted to the Engineer:  For Class 1 bar reinforcement, a certificate from the quality assured stockist in accordance with actual Maldivian standards or similar and a copy of the manufacturer's third party certificate  For Class 2 bar reinforcement, a certificate from the quality assured stockist in accordance with actual Maldivian standards or similar. and a copy of the manufacturer's third party certificate  For Class 3 bar reinforcement, a certificate from the supplier in accordance with actual Maldivian standards or similar.  Upon delivery of bar reinforcement the contractor shall submit a test report containing the details specified in actual Maldivian standards or similar..  For fabric reinforcement, a certificate from the manufacturer showing the manufacturer's name, the date and place of manufacture and showing that the reinforcement complies with the requirements stated in the Contract and including details of:  Bond classification  Cast analysis  Carbon equivalent value  Results of tensile, bend and re-bend tests, including the effective cross-sectional area for tensile tests  Results of bond performance tests  Results of weld tests  (2) The particulars shall be submitted to the Engineer for information for each batch of bar reinforcement and fabric reinforcement delivered to the Site and at least 14 days before fixing of the reinforcement starts. |
| 14.3.2 | Particulars of epoxy coatings to reinforcement | (1) The following particulars of the proposed epoxy coatings to reinforcement shall be submitted to the Engineer:  Name and location of the coating factory,  Mill sheets of the steel reinforcement,  Date and place of the coating application, and  Original Certificate(s) of the coating materials in compliance with BS ISO 14656: 1999, including:  Corrosion resistance  Chemical resistance  Catholic disbonding of coating  Adhesion of coating  Abrasion resistance  Impact strength  Hardness  The above tests shall be carried out once every 5 years or when there are changes in the composition of the coating materials whichever is the earlier.  (2) The particulars, including certificates and test results in Clause 14.3.2, shall be submitted to the Engineer at least 14 days before the first delivery of epoxy-coated reinforcement to the Site. Certificates shall be submitted for each batch of epoxy-coated reinforcement delivered to the Site and at least 14 days before fixing of the reinforcement starts. |
| 14.3.3 | Particulars of galvanized coatings to reinforcement | (1) The following particulars of the proposed galvanized coatings to reinforcement shall be submitted to the Engineer:  Name and location of the coating factory, and  Original certificate from the manufacturer showing the date and place of application of the coating and showing that the galvanized coatings comply with the requirements stated in the Contract and including results of tests carried out by methods as recommended in BS EN ISO 1461:1999 for thickness of coating.  (2) The particulars shall be submitted to the Engineer for each batch of galvanized reinforcement delivered to the Site and at least 14 days before fixing of the reinforcement starts. |
| 14.3.4 | Particulars of reinforcement connectors | Particulars of the proposed materials and methods of installation for reinforcement connectors, including the manufacturer's literature, shall be submitted to the Engineer at least 28 days before fixing of reinforcement connectors starts. |
| 14.3.5 | Bending schedules | Bending schedules complying with BS 4466, Clause 4 shall be prepared by the Contractor and submitted to the Engineer before bending of reinforcement starts. |
| 14.3.6 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:  Bar and fabric reinforcement,  Epoxy-coated bar and fabric reinforcement,  Galvanized bar and fabric reinforcement,  Reinforcement connectors for tension joints and compression joints,  Cover spacers, and  Tying wire, tying devices and clips. |
| **14.4** | **HANDLING AND STORAGE OF MATERIALS** |  |
| 14.4.1 | Handling of reinforcement | (1) Reinforcement shall not be subjected to rough handling, shock loading or dropping from a height.  (2) Nylon, rope or padded slings shall be used for lifting epoxy-coated reinforcement and galvanized reinforcement. Bundles shall be lifted with a strongback or with multiple supports to prevent abrasion. |
| 14.4.2 | Storage of reinforcement | (1) Reinforcement shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner, which will not result in damage or deformation to the reinforcement, or in contamination of the reinforcement. Measures to protect the reinforcement from wetting and rusting caused by weather shall be proposed for the Engineer’s approval. Fabric reinforcement shall be stored horizontally.  (2) Different types and sizes of reinforcement shall be stored separately.  (3) Reinforcement shall not be stored on or adjacent to concrete surfaces that form part of the permanent work.  (4) Epoxy-coated reinforcement and galvanized reinforcement shall be stored on wooden or padded cribbing. |
| **14.5** | **CUTTING AND BENDING REINFORCEMENT** |  |
| 14.5.1 | Cutting and bending reinforcement | (1) Reinforcement shall be cut and bent in accordance with BS 4466 to the specified shapes and dimensions and shall be bent at temperatures of at least 5°C and not exceeding 100°C.  (2) Epoxy-coated reinforcement shall be bent cold. Bar cutting and bar bending equipment for epoxy-coated reinforcement shall have padded supports and contact areas shall be fitted with nylon or plastic mandrels.  (3) Grade 460/425 reinforcement shall not be re-bent or straightened after bending. Grade 250 reinforcement which projects from the hardened concrete may be bent aside and re-bent provided that the internal radius of the bend is at least twice the diameter of the bar and that bending is not carried out by levering against the concrete or by other methods which in the opinion of the Engineer are likely to damage the concrete.  (4) The ends of bars to be used with reinforcement connectors for compression joints shall be sawn square with all burrs removed. |
| **14.6** | **SURFACE CONDITION OF REINFORCEMENT** |  |
| 14.6.1 | Surface condition of reinforcement | (1) Reinforcement shall be clean at the time of fixing and shall be free of loose mill scale, loose rust or any substance that, in the opinion of the Engineer, is likely to reduce the bond or affect the reinforcement or concrete chemically. The reinforcement shall be maintained in this condition until concrete is placed around it.  (2) If the surface condition of the reinforcement deteriorates such that it does not comply with the requirements stated in Clause 14.6.1, the reinforcement shall be cleaned or dealt with by other methods agreed by the Engineer. |
| 14.6.2 | Repairs to epoxy coatings and galvanized coatings | (1) If the coating to epoxy-coated reinforcement is delaminated or split at any point or if the coating to epoxy-coated reinforcement or galvanized reinforcement is damaged,  at any point by an amount exceeding 25 mm2 in area or 50 mm in length, or  at more than three points in a 1 m length by amounts each even not exceeding 25 mm2 in area or 50 mm in length,  that part of the reinforcement shall not be used in the permanent works. If the coating to epoxy-coated reinforcement or galvanized reinforcement is damaged at more than six points in the cut and bent length of a bar by amounts each even not exceeding 25 mm2  in area or 50 mm in length, that length of bar shall not be used in the permanent work.  (2) All damaged areas not exceeding 25 mm2 in area or 50 mm in length and cut ends of epoxy-coated reinforcement shall be repaired using patching material applied in accordance with the manufacturer's recommendations.  (3) Damaged areas not exceeding 25 mm2 in area or 50 mm in length and cut ends of galvanized reinforcement shall be repaired by applying two coats of metallic zinc-rich priming paint. Sufficient paint shall be applied to provide a zinc coating of at least the same thickness as the galvanized coating. The Contractor shall refer to Section 6.3 of BS EN ISO 1461:1999 and also Annex C.5 for advice on repair of damaged areas.  (4) Repairs to epoxy coatings and galvanized coatings shall be carried out within 8 hours of cutting or damage. Traces of rust shall be removed from the surface of the reinforcement before the repair is carried out. |
| **14.7** | **FIXING REINFORCEMENT** |  |
| 14.7.1 | Fixing reinforcement | (1) Bar reinforcement, fabric reinforcement and reinforcement connectors for tension joints from each batch shall not be fixed until testing of the batch has been completed.  (2) Reinforcement shall be fixed rigidly in position and secured against displacement.  (3) A sufficient number of intersecting and lapping bars shall be tied using tying wire, tying devices or clips to prevent movement of the reinforcement. The ends of tying wire, tying devices and clips shall not encroach into the cover to reinforcement.  (4) Laps and joints in reinforcement shall be made only at the specified positions and by the specified method.  (5) Sufficient numbers of cover spacers, chairs, supports and spacers other than cover spacers shall be provided to maintain the reinforcement in the correct location and to maintain the specified cover at all positions. Cover spacers, chairs, supports and spacers other than cover spacers shall be placed at a maximum spacing of 1.5 m. Chairs, supports and spacers other than cover spacers shall be positioned adjacent to or above cover spacers and shall have at least the same cover as that specified for the reinforcement.  (6) Prefabricated reinforcement cages shall be adequately supported and braced before lifting.  (7) Reinforcement which is free-standing shall be secured in position and braced to prevent movement due to wind and other loads.  (8) For treated finishes, all reinforcement shall be positioned in such a way that the specified minimum concrete cover can be achieved after the applied treatment. |
| 14.7.2 | Fixing reinforcement connectors | Reinforcement connectors shall be fixed in accordance with the manufacturer's recommendations and using equipment recommended by the manufacturer. |
| 14.7.3 | Welding of reinforcement | Reinforcement shall not be welded unless approved by the Engineer |
| 14.7.4 | Exposed reinforcement | Reinforcement that is to be left exposed shall be protected by coating with cement slurry or by other methods agreed by the Engineer. |
| 14.7.5 | Access over reinforcement | Reinforcement shall not be contaminated or displaced as a result of access over the reinforcement. Access shall be obtained by using planks and ladders or by other methods agreed by the Engineer. |
| **14.8** | **TOLERANCES** |  |
| 14.8.1 | Tolerances: reinforcement | (1) Tolerances on cutting and bending reinforcement shall comply with BS 4466, Table 2.  (2) The cover to the outermost layer of reinforcement shall not be less than the minimum cover shown on the Drawings plus a tolerance of 5 mm for fixing precision. |
| **14.9** | **INSPECTION OF REINFORCEMENT** |  |
| 14.9.1 | Inspection of reinforcement | The Contractor shall allow the Engineer to inspect the completed reinforcement before carrying out any work, including erecting formwork adjacent to reinforcement, which will make access to the reinforcement difficult. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out such work. |
| **14.10** | **TESTING: REINFORCEMENT** |  |
| 14.10.1 | Batch: reinforcement | (1) For the purpose of testing, the steel bar reinforcement arriving on site is to be subdivided into batches. Each batch shall consist of reinforcement of the same steel grade, the same nominal diameter, same cast number, batch number or lot number.  (2) A batch of fabric reinforcement or reinforcement connectors for tension joints is any quantity of fabric reinforcement or reinforcement connectors for tension joints of the same type, size and grade, manufactured by the same mill, covered by the same mill and testing certificates and delivered to the Site at any one time. In addition, for epoxy-coated reinforcement and galvanized reinforcement, the coatings shall have been applied at the same coating factory and shall be covered by the same original test certificates with original signatures and official authorization chop. |
| 14.10.2 | Samples: reinforcement | (1) Samples of bar reinforcement, fabric reinforcement and reinforcement connectors for tension joints, except for epoxy-coated reinforcement, shall be provided from each batch of the material delivered to the Site and at least 14 days before fixing of the reinforcement starts. The number of samples to be provided from each batch shall be as stated in Table 5.1. For epoxy-coated reinforcement, samples shall be provided at least 20 working days before fixing of the reinforcement starts.  (2) The number of specimens in each sample shall be as follows:  Bar reinforcement (without : In accordance with epoxy coating or galvanized actual Maldivian coating) standards or similar.  Epoxy-coated bar reinforcement : actual Maldivian and galvanized bar reinforcement standards or similar,  additional specimen  to those specified in  Table 9 for  reinforcement  Fabric reinforcement bar (without : 3 epoxy coating or galvanized coating)  Epoxy-coated fabric reinforcement : 4 and galvanized fabric reinforcement  Reinforcement connectors : 3 for tension joints  (3) Each specimen of bar reinforcement shall be 1 m long. Each specimen of fabric reinforcement shall be 1.2 m long by 1.2 m wide and shall contain at least three wires in each direction. Each specimen of reinforcement connectors shall consist of one reinforcement connector joined to two lengths of bar each 500 mm long. The bars shall be of the same type, size and grade as the bars to which the reinforcement connector will be fixed in the permanent work.  (4) Each specimen of bar reinforcement and fabric reinforcement shall be taken from different bars or sheets in the batch. The ends of specimens shall be cut square before delivery to the laboratory.  (5) For epoxy-coated bar reinforcement, two additional specimens shall be selected by the Engineer from each batch of reinforcement for epoxy coating tests on thickness, adhesion and continuity in addition to the requirements of tensile tests, bend tests and re-bend tests. Each specimen shall be a 2 m length piece cut at least 1 m from the ends of a 12 m length bar. Specimens shall be selected from different bundles of the reinforcement batch. |

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| Table 14.1: Rate of sampling of reinforcement |

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| Description | Size of batch | No. of samples per batch |
| Bar reinforcement | All sizes | 1 |
| Fabric reinforcement | 0 - 50 tonnes | 1 |
| exceeding 50 tonnes | 1 for each 50 tonnes or part thereof |
| Reinforcement connectors for tension joints | less than 100 No. | 1 |
| 100 - 500 No. | 2 |
| exceeding 500 No. | 3 |

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| 14.10.3 | Testing: reinforcement | (1) Each sample of bar reinforcement and fabric reinforcement shall be tested to determine the yield stress, elongation, tensile strength, bending and re-bending properties and unit mass. Each sample of fabric reinforcement shall also be tested to determine the weld shear strength. Each sample of epoxy-coated reinforcement shall also be tested to determine the thickness, adhesion and continuity of the coating. Each sample of galvanized reinforcement shall also be tested to determine the thickness of coating.  (2) Each sample of reinforcement connectors for tension joints shall be tested to determine the tensile strength and the permanent elongation in accordance with Clause 14.10.6  (3) The number of tests on each sample shall be as stated in Table 14.2.  (4) The method of testing shall be in accordance with the following:  Hot rolled steel bars : actual Maldivian standards  or similar.  Cold reduced steel wire : BS 4482  Steel fabric : BS 4483  Hot dip galvanized coating : BS EN ISO 1461:1999  (5) Thickness, adhesion and continuity tests on epoxy coatings shall be performed on each additional test specimen as selected in accordance with Clause 14.10.2. The thickness test shall be in accordance with Method No. 6 of BS 3900: Part C5. For thickness test, 15 pairs of readings shall be taken along two opposite sides of each specimen. The adhesion and continuity tests shall be in accordance with BS ISO 14656:1999. Bend tests for adhesion shall be performed at a uniform rate within 15 seconds.  (6) Tests shall be carried out on specimens having a temperature of between 5°C and 30°C. |
| 14.10.4 | Testing: epoxy coating | (1) The thickness test shall be in accordance with Method No. 6 of BS 3900: Part C5: 1992. For bars of 12 mm diameter or below, only instruments which operate on magnetic flux principle – Method 6A(a), can be used. For bars of 16 mm diameter or above, instruments which operate on either magnetic flux principle or magnetic pull-off principle, Method 6A(b), can be used. All measuring instruments shall be calibrated to an accuracy of ±5%.  (2) For thickness test, five recorded measurements shall be obtained approximately evenly spaced along each side of the test specimen (a total of ten recorded measurements per bar). A single recorded thickness measurement is the average of three individual reading obtained in between the ribs of three consecutive deformations.  (3) The adhesion and continuity tests shall be in accordance with BS ISO 14654:1999. |
| 14.10.5 | Compliance criteria epoxy coating to reinforcement | The results of tests for thickness, adhesion and continuity of epoxy coatings to reinforcement shall comply with the following requirements:  Coating thickness: At least 90% of all the recorded thickness measurements of coating shall be within the range of 0.18 mm to 0.30 mm. Thickness measurements below 0.13 mm shall be s considered cause for rejection.  Coating adhesion: The adhesion test shall comply with BS ISO 14654:1999 and BS ISO 14656:1999. The surface of the bent test piece shall not exhibit cracking or ductile tearing when viewed under well-lit conditions using normal or corrected vision. There shall be no de-bonding of the coating from the surface of the bar and the coating shall not contain more than 5 Holidays per meter of bar.  Coating continuity :  The continuity test shall comply with BS ISO 14654:1999 and BS ISO 14656:1999. The continuity of the coating shall contain not more than 5 Holidays per linear metre of bar length, when tested in accordance with BS ISO 14654:1999 and shall be free of holes, voids, cracks and damaged areas discernible to a person with normal or corrected vision. Holiday is defined as a discontinuity in a coating that is not discernible to a person with normal or corrected vision and detected by a discharge from a Holiday detector. |
| 14.10.6 | Compliance criteria: reinforcement connectors for tension joints | The results of tensile tests on specimens of reinforcement connectors for tension joints shall comply with the following requirements:  The tensile strength shall not be less than the specified requirements for the parent bar.  When a test is made of a representative gauge length assembly comprising reinforcement of the size, grade and profile to be used and a reinforcement connector for tension joints of the precise type to be used, the permanent elongation after loading to 0.6 times of the specified characteristic strength and unloading shall not exceed 0.1 mm. The gauge length shall span over the reinforcement connector. |

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| Table 14.2: Number of tests on each sample of reinforcement |

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| Description | Type and number of tests | | | | | | | |
| Tensile | Bend | Re-bend | Unit Mass | Weld Shear Stress | Thickness, Adhesion and Continuity | Thickness and Uniformity of Galvanized Coating | Pitch, Dimension |
| Bar reinforcement | No. of tensile, bend and re-bend tests in accordance with actual Maldivian standards or similar. and one unit mass test accompanied with each tensile test | | | | - | - | - | - |
| Steel fabric  fabric sheet  longitudinal wire  transverse wire | - 3  3 | -  -  - | -  1  1 | 3  -  - | 1  -  - | -  -  - | -  -  - | - 1  1 |
| Epoxy coating | - | - | - | - | - | 2 | - | - |
| Galvanized coating | - | - | - | - | - | - | 2 | - |
| Reinforcement connectors for tension joints | 3 | - | - | - | - | - | - | - |

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| 14.10.7 | Non-compliance: characteristic strength | (1) A batch of bar reinforcement shall be considered as not complying with the specified requirements for characteristic strength if the tensile tests results cannot meet the requirements stated in actual Maldivian standards or similar.  (2) A batch of fabric reinforcement shall be considered as not complying with the specified requirements for characteristic strength if the yield stress in any tensile test carried out on any sample taken from the batch is less than 93% of the specified characteristic strength.  (3) If the yield stress of fabric reinforcement in any tensile test is less than the specified characteristic strength but equal to or greater than 93% of the specified characteristic strength, additional samples shall be provided from the same batch and additional tests for yield stress shall be carried out. The number of additional samples shall be as stated in Table 14.1. The number of fabric reinforcement specimens in each additional sample shall be seven. The number of tests on the longitudinal wires and on the transverse wires of each additional sample of fabric reinforcement shall be seven. The batch shall be considered as not complying with the specified requirements for characteristic strength if the yield stress in any additional test is less than 93% of the specified characteristic strength. |
| 14.10.8 | Non-compliance: elongation, tensile strength, bending, re-bending, unit mass, weld shear strength | (1) If the result of any test for elongation, tensile strength, bending, re-bending, unit mass or weld shear strength of bar reinforcement, fabric reinforcement or reinforcement connectors for tension joints does not comply with the specified requirements for the property, additional samples shall be provided from the same batch and additional tests for the property shall be carried out. The number of additional samples shall be as stated in Table 14.1.  (2) The number of specimens in each additional sample shall be as follows:  Bar reinforcement (test to  determine the elongation,  tensile strength or mass) : 2 additional test  specimens for each test  failed  Bar reinforcement (test to  determine the bending or  re-bending properties) : 2 additional test  specimens for each test  failed  Fabric reinforcement : 6  Reinforcement connectors  for tension joints : 6  (3) The number of tests on each additional sample shall be as follows:  Tensile test  Bar reinforcement : 1 for each specimen  Reinforcement : 6 connectors for tension  joints  Fabric reinforcement  - longitudinal wires : 6 - transverse wires : 6  Bend test : 2  rebind test : 2  Unit mass : 1 for each specimen  Weld shear strength : 2.  (4) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property. |
| 14.10.9 | Non-compliance: thickness, adhesion and continuity of epoxy coatings | In testing the two specimens selected in accordance with Clause 14.10.2, if one test specimen fails to meet the coating thickness, coating adhesion or coating continuity requirements, retests of specimens of the same batch are permitted, and two further specimens from the same batch shall be subjected to the test or tests in which the original specimen failed. If both additional specimens pass the retest, the batch from which they were taken shall be deemed to comply with the specification. If either or both of them fail in the retests, the batch shall be deemed not to comply with the specification, and this batch shall be rejected and removed from Site. |
| 14.10.10 | Non-compliance: thickness and uniformity of galvanized coatings | (1) If the result of any test for thickness of galvanized coatings to reinforcement does not comply with the specified requirements for the property, additional samples shall be provided from the same batch and additional tests for the property shall be carried out. The number of additional samples shall be as stated in Table 14.1.  (2) The number of specimens in each additional sample shall be as follows:  Galvanized bar reinforcement 4  Galvanized fabric reinforcement 2  Galvanized reinforcement connectors  for tension joints 4  (3) The number of tests on each additional sample shall be four.  (4) The batch shall be considered as not complying with the specified requirements for the property if the result of any additional test does not comply with the specified requirements for the property. |
| 14.10.11 | Non-compliance: permanent elongation of reinforcement connectors | (1) If the result of any test for permanent elongation of reinforcement connectors for tension joints does not comply with the specified requirements as stated in Clause 14.10.6, additional samples shall be provided from the same batch and additional tests for permanent elongation as stated in Clause 14.10.6, shall be carried out. The number of additional samples shall be as stated in Table 14.1.  (2) The number of specimens in each additional sample shall be six.  (3) The number of tests on each additional sample shall be six.  (4) The batch shall be considered as not complying with the specified requirements for permanent elongation if the result of any additional test does not comply with the specified requirements as stated in Clause 14.10.6 |
| **15.** | **SECTION 15 CONCRETE AND JOINTS IN CONCRETE** |  |
|  | ***PART 1: CONCRETE WORKS*** |  |
| **15.1** | **GENERAL** |  |
| 15.1.1 | Sprayed concrete | Sprayed concrete shall comply with Section 7 except as stated in this Section. |
| 15.1.2 | Designation of concrete mixes | (1) Designed mix concrete shall be designated by the grade strength in MPa followed by the nominal maximum aggregate size in mm and the suffix D.  (2) Standard mix concrete shall be designated by the grade strength in MPa followed by the nominal maximum aggregate size in mm and the suffix S.  (3) Designed mix concrete or standard mix concrete of the same grade strength but with different constituents, workability or other properties shall be designated as such by the addition of a suitable description. If the grade of concrete is designated by one number only, the number shall be the grade strength in MPa. |
| **15.2** | **GLOSSARY OF TERMS** |  |
| 15.2.1 | Cementitious content | Cementitious content is the mass of cement per cubic metre of compacted concrete or, if cement and PFA are used as separate constituents, the combined mass of cement and PFA per cubic metre of compacted concrete. |
| 15.2.2 | Grade | Grade is a term used to identify the different concrete mixes in terms of grade strength or in terms of grade strength and nominal maximum aggregate size. |
| 15.2.3 | Grade strength | Grade strength is the compressive strength of concrete stated in the Contract. For designed mix concrete, compliance with the grade strength shall be ascertained in accordance with Clause 15.19.3 |
| **15.3** | **MATERIALS** |  |
| 15.3.1 | Cement | (1) Cement shall comply with the following:  Portland cement (PC) : BS EN 197-1  (Type CEM I) Strength  Class of cement used in  structural concrete to be  52.5N, unless otherwise  approved by the Engineer  Sulphate resisting Portland  Cement (SRPC) : BS 4027  Portland fly ash (PFAC) cement : BS EN 197-1  (Types CEM II/A-V and  CEM II/B-V) Strength  Class of cement used in  structural concrete to be  42.5N or higher, unless  otherwise approved by the  Engineer.  (2) The limiting values applicable to acceptance inspection of cement at delivery shall be those given in Table NC.1 of National annex NC of BS EN 197-1 |
| 15.3.2 | Pulverized Fly Ash (PFA) | PFA shall comply with BS 3892: Part 1 except that the criterion for maximum water requirement shall not apply. |
| 15.3.3 | Aggregates | (1) Aggregates shall be obtained from a source approved by the Engineer.  (2) Fine aggregate shall be clean, hard and durable crushed rock, or natural sand, complying with BS 882, except that the NOTE in Table 5 of BS 882 shall not apply.  (3) Coarse aggregate shall be clean, hard, durable crushed rock complying with BS 882. The ten percent fines values shall be at least 100 kN. The water absorption shall not exceed 0.8%. The flakiness index shall not exceed 35%. |
| 15.3.4 | Water | (1) Water for concrete and for curing concrete shall be clean fresh water taken from the public supply.  (2) Wash water from concrete mixer washout operations (recycled water) may be used for mixing concrete of grade strength not exceeding 35MPa provided that:  The density of the recycled water shall not exceed 1030 kg/m3.  The limits for the time of setting (h:min), expressed as deviation from those for control mix, shall comply with Table 15.8. The control mix shall be of the same mix design but clean fresh water shall be used.  The chemical limits of the recycled water shall not exceed those specified in Table 15.8. |
| 15.3.5 | Admixtures | (1) Admixtures shall comply with the following:  Pigments for Portland  cement and Portland  cement products : BS 1014  Accelerating admixtures,  retarding admixtures and  water-reducing admixtures : BS 5075: Part 1  Super plasticising admixtures : BS 5075: Part 3.  (2) The chloride ion content of admixtures for concrete containing embedded metal or for concrete made with SRPC shall not exceed 2% by mass of the admixture or 0.03% by mass of the cementitious content, whichever is less. |
| 15.3.6 | Curing compound | (1) Curing compound shall be a proprietary type approved by the Engineer and shall have an efficiency index of at least 80%. Resin-based curing compound shall not be used unless approved by the Engineer.  (2) Curing compound shall contain a fugitive dye. Curing compounds containing organic solvents shall not be used. The curing compound shall become stable and achieve the specified resistance to evaporation of water from the concrete surface within 60 minutes after application. Curing compound shall not react chemically with the concrete to be cured and shall not crack, peel or disintegrate within one week after application. Curing compound shall degrade completely within three weeks after application and the concrete surface s treated shall not impair the bonding of applied finishes.  (3) Curing compound for use on concrete surfaces against which potable or fresh water will be stored or conveyed shall be non-toxic and shall not impart a taste to the water. |
| **15.4** | **CONCRETE** |  |
| 15.4.1 | Concrete mix | (1) Concrete shall be a designed mix unless the Engineer permits the use of a standard mix. Designed mixes shall be designed by the Contractor.  (2) Unless otherwise permitted by the Engineer, the minimum design slump value for designed mix concrete for reinforced elements, after the addition of superplasticiser if used, shall be 75 mm. Should the Contractor wish to use designed mix concrete with a design slump value less than 75 mm in reinforced elements, the Engineer may require the Contractor to demonstrate that such concrete can be satisfactorily placed and compacted in trial sections simulating the appropriate sections of the Works.  (3) Cement, PFA, aggregates, water and admixtures for concrete shall comply with Clauses 15.3.1 to 15.3.5. All-in aggregate shall not be used.  (4) SRPC shall only be used if stated in the Contract. PFA shall not be used with SRPC.  (5) PFA shall not be used in addition to PFAC.  (6) PFA shall be used in concrete of all pile caps and substructure construction where the concrete member is thicker than 750 mm. |
| 15.4.2 | Chloride content of concrete | The maximum total chloride content of concrete, expressed as a percentage relationship between the chloride ion and the cementitious content by mass in the concrete mix, shall be as stated in Table 15.1. If the concrete is of more than one of the types stated, then the lower value of maximum chloride content shall apply. |

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| Table 15.1: Maximum total chloride content of concrete |

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| Type of concrete | Maximum total chloride content (%) |
| Prestressed concrete. Steam-cured structural Concrete | 0.1 |
| Concrete with reinforcement or other embedded metal | 0.35 |
| Concrete made with SRPC | 0.2 |

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| 15.4.3 | Cementitious content of designed mix concrete | (1) The minimum cementitious content of designed mix concrete of Grade 20 or above using 20 mm nominal maximum aggregate size shall be as stated in Table 15.2. The minimum cementitious contents shall be increased by 40 kg/m3 for 10 mm nominal maximum aggregate size and decreased by 30 kg/m3 for 40 mm nominal maximum aggregate size.  (2) Unless otherwise approved by the Engineer, the maximum cementitious content of designed mix concrete for water retaining structures and water tight structures shall be 400 kg/m 3 for concrete containing PC and shall be 450 kg/m3 for concrete containing either PC and PFA or PFAC. Unless otherwise approved by the Engineer, the maximum cementitious content of designed mix concrete other than for water retaining structures and water tight structures shall be 550 kg/m3.  (3) The cementitious content of designed mix concrete may be varied during routine production at the discretion of the Contractor by an amount not exceeding 20 kg/m3, provided that the total cementitious content is not less than the specified minimum value and does not exceed the specified maximum value.  (4) When PFA is incorporated in the concrete as a separate material, its proportion shall not exceed 35% of the total cementitious content for normal concrete. If other conditions apply, particulars of proposed changes to the proportion of PFA shall be submitted to the Engineer for approval.  (5) When PFA is used in construction of pile caps and substructures, the PFA content shall constitute at least 25% of the cementitious content in the concrete. |

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| Table 15.2: Minimum cementitious content of designed mix concrete of Grade 20 or greater with 20 mm nominal maximum aggregate size |

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| Grade strength (MPa) | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| Minimum cementitious content (kg/m3) | 270 | 290 | 310 | 330 | 350 | 375 | 400 |

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| 15.4.4 | Standard mix concrete | Standard mix concrete shall comply with the following requirements:  Cement shall be PC or PFAC.  The total mass of dry aggregate to be used with 100 kg of PC or with 110 kg of PFAC shall be as stated in Table 15.3.  The percentage by mass of fine aggregate to total aggregate shall be as stated in Table 15.4.  Admixtures other than water-reducing admixtures shall not be used unless permitted by the Engineer. |

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| Table 15.3: Mass of total aggregate for standard mix concrete |

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| Grade strength (MPa) | Nominal maximum aggregate size (mm) | 40 | 20 | 10 |
| Slump value (mm) | 85-170 | 75-150 | 65-130 |
| 10 | Mass of total  aggregate (kg) | 800 | 690 | - |
| 20 | 550 | 500 | 400 |
| 25 | 490 | 440 | 360 |
| 30 | 440 | 380 | 300 |

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| Table 15.4: Percentage by mass of fine aggregate to total aggregate for standard mix concrete |

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| Grade strength (MPa) | Grading of fine aggregate (BS 882:  Table 5) | Nominal maximum aggregate size (mm) | 40 | 20 | 10 |
| 10 | C, M or F | Percentage by mass of fine aggregate to total aggregate  (%) | 30 - 45 | 35 - 50 | - |
| 20, 25  or 30 | C | 30 - 40 | 35 - 45 | 45 - 55 |
| M | 25 - 35 | 30 - 40 | 40 - 50 |
| F | 25 - 30 | 25 - 35 | 35 - 45 |

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| 15.4.5 | No-fines concrete | No-fines concrete shall comply with the following requirements:  Cement shall be PC or PFAC.  The nominal maximum aggregate size shall be 20 mm. Not more than 15% by mass shall be retained on a 20 mm BS test sieve and not more than 10% by mass shall pass a 10 mm BS test sieve.  The aggregate: cement ratio by mass shall be at least 10 and shall not exceed 15.  The cementitious content shall be such that each particle of aggregate is coated with cement paste but the compacted concrete has an open texture that permits the flow of water through the hardened concrete. |
| **15.5** | **SUBMISSIONS** |  |
| 15.5.1 | Particulars of materials for concrete | (1) The following particulars of the proposed cement, PFA and aggregates shall be submitted to the Engineer:  A certificate not older than 6 months for each type of cement showing the manufacturer's name, the date and place of manufacture and showing that the cement complies with the requirements stated in the Contract and including results of tests for:  Composition  Chemical requirement  Compressive strength at 2, 7 and 28 days  Initial setting time  Soundness  A certificate not older than 6 months for PFA showing the source of the PFA and showing that the PFA complies with the requirements stated in the Contract and including results of tests for:  Chemical composition  Fineness  Moisture content, and  A certificate not older than 6 months for each nominal maximum aggregate size showing the source of the aggregate and showing that the aggregate complies with the requirements stated in the Contract and including results of tests for:  Grading  Silt content  Chloride content  Flakiness index of coarse aggregate.  Ten percent fines value  Water absorption  (2) The following particulars of the proposed admixtures shall be submitted to the Engineer:  Manufacturers’ literature,  Description of physical state, colour and composition,  Recommended storage conditions and shelf life,  Method of adding to the concrete mix,  Any known incompatibility with other admixtures or cement,  Recommended dosage,  Effects of under-dosage and over-dosage, and  A certificate not older than 6 months for each type of admixture showing the manufacturer's name, the date and place of manufacture and showing that the admixture complies with the requirements stated in the Contract and including results of tests for:  Uniformity  Chloride content.  (3) The following particulars of the proposed curing compound shall be submitted to the Engineer:  Manufacturer’s literature,  Description of physical state, colour and composition,  Recommended storage conditions and shelf life,  Method of application,  Recommended rate of application, and  A certificate showing the manufacturer's name, the date and place of manufacture and showing that the curing compound complies with the requirements stated in the Contract and including results of tests for efficiency index.  (4) If recycled water is used for mixing concrete, results of the tests specified in Clause 15.16.3 and Table 15.8 shall be submitted to the Engineer.  (5) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site, and thereafter each time the source is changed. |
| 15.5.2 | Particulars of concrete mix | (1) The following particulars of each proposed designed concrete mix shall be submitted to the Engineer:  Quantity of each constituent per batch and per cubic metre of compacted concrete, with required tolerances on quantities of aggregates to allow for minor variations in grading, silt content etc. The maximum permitted variation in the quantity of fine aggregate shall be ± 20 kg of fine aggregate per 100 kg of cement.  Grading of coarse and fine aggregates,  Workability after the addition of superplasticisers, in terms of designed slump value or designed flow value,  Method of placing concrete, Method of controlling the temperature of the concrete, if required,  Test or trial mix data for designed mix concrete of the same grade and with similar constituents and properties, if available, and  Test data for designed mix concrete of the same or other grade produced in the plant or plants proposed to be used, if available.  (2) The particulars shall be submitted to the Engineer for information at least 7 days before trial mixes are made or, if trial mixes are not required, at least 7 days before the mix is placed in the permanent work. |
| 15.5.3 | Particulars of ready-mixed concrete supplier | The name of the suppliers and the location of each plant, including a back-up plant, from which the Contractor proposes to obtain ready-mixed concrete shall be submitted to the Engineer at least 14 days before trial mixes are made or, if trial mixes are not required, at least 14 days before the ready-mixed concrete is placed in the permanent work. |
| 15.5.4 | Particulars of batching and mixing plant | Particulars of the proposed batching and mixing plant to be used on the Site, including a layout plan and the output of the plant, shall be submitted to the Engineer at least 7 days before the plant is delivered to the Site. |
| 15.5.5 | Particulars of precast concrete units | (1) The following particulars of the proposed precast concrete units shall be submitted to the Engineer:  Details of precasting yards,  A certificate showing the manufacturer's name, the date and place of manufacture, the identification numbers of the precast concrete units and including results of tests for:  Compressive strength of concrete cubes at 28 days  Routine tests, including loading tests, carried out at the precasting yards,  Details of lifting points and methods of handling, and  Procedure for testing precast units.  (2) The particulars, other than certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the precast concrete units to the Site. The certificates shall be submitted for each batch of precast concrete units delivered to the Site. |
| 15.5.6 | Particulars of construction joints | Particulars of the proposed positions and details of construction joints in concrete which are not stated in the Contract shall be submitted to the Engineer for approval at least 14 days before the relevant elements are concreted. |
| **15.6** | **TRIALS** |  |
| 15.6.1 | Trial mix concrete | (1) Trial mixes are not required for designed mix concrete of Grade 20 and below, or for standard mix concrete.  (2) If test data for designed mix concrete of the proposed grade and with similar constituents and properties and produced in the plant or plants proposed for being used are submitted in accordance with Clause 15.5.2, and are acceptable to the Engineer, no trials for that designed mix will be required.  (3) If test data for designed mix concrete of the proposed grade and with similar constituents and properties produced in plant other than that proposed to be used are submitted in accordance with Clause 15.5.2, and are acceptable to the Engineer, the Engineer may require Plant Trials to be carried out in accordance with Clause 15.6.2.  (4) If test data for designed mix concrete produced in the plant or plants proposed to be used, but of a grade or with constituents and properties other than those proposed, are submitted in accordance with Clause 15.5.2, and are acceptable to the Engineer, the Engineer may require Laboratory Mix Trials to be carried out in accordance with Clause 15.6.3.  (5) If no test data for designed mix concrete are submitted or if test data submitted in accordance with Clause 15.5.2 do not in the opinion of the Engineer demonstrate the suitability of the proposed plant and mix design, the Engineer may require both Plant Trials and Laboratory Mix Trials in accordance with Clauses 15.6.2 and 16.25 respectively.  (6) Plant Trials and Laboratory Mix Trials shall be completed at least 35 days before the concrete mix is placed in the permanent work.  (7) The Contractor shall inform the Engineer at least 24 hours before conducting Plant Trials or Laboratory Mix Trials. |
| 15.6.2 | Plant Trials | (1) Plant Trials shall be made using the plant or plants proposed and the mix designs and constituents submitted to the Engineer.  (2) One batch of concrete of a proposed designed mix shall be made on each of three days in each plant proposed to be used. The batch shall be at least 60% of the mixer's nominal capacity. If the concrete is batched in a central plant and mixed in a truck mixer, three different truck mixers shall be used.  (3) Three samples of concrete shall be provided from each batch at approximately 1/6, 1/2 and 5/6 of the discharge from the mixer. Each sample shall be of sufficient size to perform a slump test or a flow table test, and make two test cubes.  (4) Each sample taken in accordance with Clause 15.6.2 shall be tested to determine its slump value or its flow value in accordance with actual Maldivian standards or similar.  (5) Two test cubes shall be made from each sample taken in accordance with Clause 15.6.2 and stored, cured and tested to determine the compressive strength at 28 days in accordance with actual Maldivian standards or similar.  (6) The size of the test cube shall be 100 mm for concrete with the maximum aggregate size not exceeding 20 mm and shall be 150 mm with the maximum aggregate size exceeding 20 mm. |
| 15.6.3 | Laboratory Mix Trials | (1) Laboratory Mix Trials shall be made in the Contractor's laboratory using the mix designs and constituents submitted to the Engineer.  (2) Laboratory Mix Trials shall be carried out in accordance with actual Maldivian standards or similar.. Three separate batches shall be made, each of sufficient size to provide samples for two slump tests or two flow table tests, and to make six test cubes.  (3) Two slump tests or two flow table tests in accordance with actual Maldivian standards or similar shall be performed on separate specimens from each batch of Laboratory Trial Mix concrete.  (4) Six test cubes shall be made from each batch of Laboratory Trial Mix concrete, stored, cured and tested for compressive strength at 28 days in accordance with actual Maldivian standards or similar.  (5) The size of the test cube shall be 100 mm for concrete with the maximum aggregate size not exceeding 20 mm and shall be 150 mm with the maximum aggregate size exceeding 20 mm. |
| 15.6.4 | Compliance criteria Plant Trials | The results of tests on concrete taken from Plant Trials in accordance with Clause 15.6.2 shall comply with the following requirements:  The average of the nine slump values shall be within 20mm or 25%, whichever is the greater, of the designed slump value. The average of the nine flow values shall be within +/- 50mm of the designed flow value.  The range of the three slump values for each batch of concrete shall not exceed 20% of the average of the three slump values for that batch. For flow table tests, the range of the three flow values for each batch of concrete shall be within 70mm.  The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 12 MPa for 100 mm test cubes or 10 MPa for 150 mm test cubes. The compressive strength of each individual test cube shall exceed the Grade strength by at least 5 MPa for 100 mm test cubes or 4 MPa for 150 mm test cubes.  The range of the compressive strength of the six test cubes from each batch of concrete shall not exceed 20% of the average compressive strength of the six test cubes from that batch. |
| 15.6.5 | Compliance criteria: Laboratory Mix Trials | (1) When test data relating to the proposed plant or plants submitted in accordance with Clause 15.5.2 show that the plant standard deviation exceeds 5.5 MPa for 100 mm test cubes or 5 MPa for 150 mm test cubes, or in the absence of acceptable data, the results of tests on Laboratory Mix Trial concrete shall comply with the following requirements:  The average of the six slump values shall be within 20mm or 25%, whichever is the greater, of the designed slump value. The average of the six flow values shall be within +/- 50mm of the designed flow value.  The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 14 MPa for 100 mm test cubes or 12 MPa for 150 mm test cubes, and the compressive strength of each individual test cube shall exceed the Grade strength by at least 7 MPa for 100 mm test cubes or 6 MPa for 150 mm test cubes.  (2) When test data relating to the proposed plant or plants submitted in accordance with Clause 15.5.2 show that the plant standard deviation does not exceed 5.5 MPa for 100 mm test cubes or 5 MPa for 150 mm test cubes and the data are acceptable to the Engineer, the results of tests on Laboratory Mix Trial concrete shall comply with the following requirements:  The average of the six slump values shall be within 20 mm or 25%, whichever is the greater, of the designed slump value. The average of the six flow values shall be within +/- 50mm of the designed flow value.  The average compressive strength at 28 days of the 18 test cubes shall exceed the Grade strength by at least 10 MPa for 100 mm test cubes or 8 MPa for 150 mm test cubes, and the compressive strength of each individual test cube shall exceed the Grade strength by at least 3 MPa for 100 mm test cubes or 2 MPa for 150 mm test cubes. |
| 15.6.6 | Trial lengths and trial panels | Trial lengths required in accordance with Clauses 9.5.2 to 9.5.5 and trial panels required in accordance with Clauses 13.5.1 and 13.5.2 shall be constructed for each concrete mix as appropriate. |
| 15.6.7 | Non-compliance: trial mix concrete | (1) If the result of any test for workability or compressive strength of laboratory mix trial and plant trial concrete does not comply with the specified requirements for the property, particulars of proposed changes to the materials, mix design or methods of production shall be submitted to the Engineer. Further laboratory mix trials or plant trials shall be made until the result of every test complies with the specified requirements for workability and compressive strength of laboratory mix trial and plant trial concrete.  (2) If trial lengths or trial panels are constructed using the non-complying trial mix, further trial lengths or trial panels shall be constructed unless in the opinion of the Engineer the changes to the materials, mix design or methods of production will not affect the results of the previous trial lengths or trial panels. |
| 15.6.8 | Approved concrete mix | (1) A concrete mix that complies with the specified requirements for laboratory mix trials, plant trials and for trial lengths or trial panels shall become an approved concrete mix. The designed slump value or designed flow value used to produce an approved concrete mix shall become the approved slump value or approved flow value.  (2) If laboratory mix trials or plant trials are not required, a concrete mix submitted as stated in Clause 15.5.2 and which complies with the specified requirements for trial lengths or trial panels shall become an approved concrete mix. The designed slump value or designed flow value of the concrete mix shall become the approved slump value or approved flow value. |
| 15.6.9 | Commencement of concreting | Concrete shall not be placed in the permanent work until the concrete mix has been approved by the Engineer. |
| 15.6.10 | Changes in materials and methods of construction | Unless permitted by the Engineer, the materials, mix design, methods of production or methods of construction used to produce an approved concrete mix shall not be changed except that the variations of cement content as stated in Clause 15.4.3 and variations in aggregate quantities within the approved tolerances, will be allowed. |
| **15.7** | **HANDLING AND STORAGE OF MATERIALS** |  |
| 15.7.1 | Storage of cement and PFA | (1) Cement in bags shall be stored in a dry, weatherproof store sheltered on the top and 3 sides with a raised floor. Each delivery shall be identified and kept separate and shall be used in the order of delivery.  (2) Bulk cement and PFA shall be kept dry. Cement and PFA of different types and from different sources shall be stored in separate silos clearly marked to identify the different contents of each. |
| 15.7.2 | Handling and storage of aggregates | (1) Aggregates shall not be handled or stored in a manner that will result in mixing of the different types and sizes or in segregation or contamination of the aggregates.  (2) Different types and sizes of aggregates shall be stored in separate hoppers or in separate stockpiles. The stockpiles shall have well drained concrete floors and shall have dividing walls of sufficient height to keep the different aggregates separate. |
| 15.7.3 | Storage of admixtures and curing compounds | Admixtures and curing compounds shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions that may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded. |
| 15.7.4 | Handling and storage of precast concrete units | (1) The identification number, date of casting and lifting points shall be marked on precast concrete units in a manner agreed by the Engineer.  (2) Precast concrete units shall be lifted and supported only at the designed lifting points and shall not be subjected to rough handling, shock loading or dropping.  (3) Precast concrete units shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner that will not result in damage or deformation to the units or in contamination of the units. Precast concrete units and the lifting points shall be protected from damage/rusting and damaged units shall not be used in the permanent works unless permitted by the Engineer. |
| **15.8** | **BATCHING AND MIXING CONCRETE** |  |
| 15.8.1 | Batching concrete | (1) Measuring and weighing equipment for batching concrete shall be maintained in a clean, serviceable condition. The equipment shall be zeroed daily and calibrated when the equipment is set up on the Site and at a frequency of at least once per month. The accuracy of the measuring equipment shall be within 3% of the quantity of cementitious materials, total aggregates or water being measured and within 5% of the quantity of admixtures being measured.  (2) The quantities of cement, PFA and fine and coarse aggregate shall be measured by mass except that cement supplied in bags may be measured by using a whole number of bags in each batch. The mass of aggregates shall be adjusted to allow for the free moisture content of the aggregates.  (3) Separate weighing equipment shall be used for cementitious material and aggregates.  (4) The quantity of water shall be adjusted for the free moisture content of the aggregates and shall be measured by mass or volume.  (5) Liquid admixtures shall be measured by mass or volume and powdered admixtures shall be measured by mass. |
| 15.8.2 | Mixing concrete | (1) The quantities of concrete mixed and the speed of operation of a mixer shall comply with the manufacturer's recommendations.  (2) A mixer shall not be loaded in excess of its rated capacity and shall be emptied before being re-charged. A mixer that has been out of use for more than 30 minutes shall be cleaned before fresh concrete is mixed in it. Mixers shall be cleaned whenever there is a change in the type of cement being used.  (3) Mixing times or the number and rate of revolutions of mixer drums shall not be less than those recommended by the manufacturer unless it is demonstrated in the production of concrete that a shorter time or fewer or slower revolutions are adequate. Constituents shall be thoroughly mixed and admixtures shall be uniformly distributed throughout the concrete  (4) Water shall be added to truck mixed concrete at the batching plant and shall not be added in transit. Water shall not be added at the Site unless approved by the Engineer.  (5) Water shall not be added to partially hardened concrete. |
| **15.9** | **TRANSPORTATION OF CONCRETE** |  |
| 15.9.1 | Transportation of concrete | (1) Concrete shall not be transported in a manner that will result in contamination, segregation, loss of constituents or excessive evaporation.  (2) Concrete batched off the Site shall be transported to the Site in purpose-made agitators operating continuously or in truck mixers. |
| **15.10** | **RECORDS OF CONCRETE** |  |
| 15.10.1 | Records of concrete | (1) Delivery notes shall be provided for each delivery of concrete to the Site. The delivery notes shall be kept on the Site and shall be available for inspection by the Engineer at all times. Delivery notes shall contain the following details:  Serial number of delivery note,  Date,  Name and location of batching and mixing plant,  Registration number of delivery vehicle,  Name of purchaser,  Name and location of the Site,  Designation of concrete mix and approved slump value or approved flow value,  Sources of constituents,  Quantity of concrete, and  Time of introduction of water to the concrete.  (2) Records of concreting operations shall be kept by the Contractor on the Site and shall be available for inspection by the Engineer at all times. Records shall contain the following details:  Date,  Designation of concrete mix and approved slump value or approved flow value,  Total quantity of each concrete mix produced that day,  Serial number of delivery note,  Arrival time of delivery vehicle,  Time of completion of discharge,  Quantity of water added at the Site,  Position where concrete is placed,  Results of flow table tests or slump tests,  details of test cubes made, and  Temperature of concrete if a restriction on the temperature is stated in the Contract. |
| **15.11** | **PLACING AND COMPACTING CONCRETE** |  |
| 15.11.1 | Placing concrete | (1) The permission of the Engineer shall be obtained before concrete is placed in any part of the permanent work. If placing of concrete is not started within 24 hours of permission having been given, permission shall again be obtained from the Engineer. The Contractor shall inform the Engineer before concreting starts and shall allow the Engineer sufficient time to inspect the work that is to be concreted.  (2) Concrete shall be placed and compacted in its final position within 2½ hours of the introduction of cement to the concrete mix.  (3) Concrete that in the opinion of the Engineer is no longer sufficiently workable shall not be placed in the permanent work.  (4) Concrete shall not be placed in water other than by tremie or in bags.  (5) Concrete shall be placed as close as practicable to its final position and shall not be moved into place by vibration. Trunking or chutes shall be used to place concrete which will fall more than 2.7 m unless otherwise permitted by the Engineer. Trunking or chutes, where being used, shall be clean and used in such a way to avoid segregation and loss of constituents of the concrete mix.  (6) Concrete shall be placed in such a manner that the formwork, reinforcement or built-in components are not displaced.  (7) Unless otherwise permitted by the Engineer, concrete other than concrete placed by tremie shall be placed in horizontal layers to a compacted depth of not more than 450 mm if internal vibrators are used and to a compacted depth of not more than 150 mm in other cases.  (8) Concrete shall be placed continuously within the element to be concreted. Fresh concrete shall not be placed against concrete that has been in position for more than 30 minutes unless in the opinion of the Engineer the concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed as stated in Clause 15.12.1. Concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer. |
| 15.11.2 | Placing concrete by pumping | (1) Concrete pumps shall be operated and maintained in accordance with the manufacturer’s recommendations. The pumps and pipelines shall be maintained in a clean condition. Internal surfaces of pipelines shall not be aluminium. Joints in pipelines shall be tightly fixed and shall not permit grout loss.  (2) Concrete pumps shall be positioned such that pipelines are as short and straight as practicable and require as little repositioning as practicable. Bends in pipelines shall be arranged in such a manner that the concrete, formwork, reinforcement or built-in components are not disturbed.  (3) Pipelines shall be lubricated by passing cement grout or concrete through the pipeline before the concrete is pumped. The initial discharge of pumped concrete shall not be placed in the permanent work. |
| 15.11.3 | Placing concrete by tremie | (1) Tremies used to place concrete shall be securely supported in position and the joints shall be watertight. A temporary seal of a type agreed by the Engineer shall be used to keep the water and the concrete separate at the start of concreting. Concrete for tremie placing shall be self-compacting, free flowing and cohesive.  (2) After the concrete is flowing, the tremie shall be raised in a manner agreed by the Engineer. The lower end of the tremie shall be kept immersed in the concrete to a depth of at least 1 m. Water, mud and other deleterious material shall be prevented from entering the tremie after concreting has started.  (3) If the tremie becomes blocked or is removed from the concrete, concreting shall be stopped immediately unless otherwise permitted by the Engineer. Concreting shall not recommence for at least 24 hours unless permitted by the Engineer. Contaminated concrete shall be removed before concreting recommences.  (4) Concrete placed by tremie shall be placed above the specified level by an amount that is sufficient to allow for the removal of contaminated concrete. Contaminated concrete shall be removed. |
| 15.11.4 | Compacting concrete | (1) Concrete shall be compacted to form a dense homogeneous mass.  (2) Unless otherwise permitted by the Engineer, concrete shall be compacted by means of internal vibrators of suitable diameter. A sufficient number of vibrators shall be maintained in serviceable condition on the Site to ensure that spare equipment is available in the event of breakdown.  (3) Vibrators shall be used in such a manner that vibration is applied continuously and systematically during placing of the concrete until the expulsion of air has practically ceased. Vibrators shall not be used in a manner that will result in segregation. Internal vibrators shall be inserted to the full depth of the concrete placed and shall be withdrawn slowly.  (4) Vibration shall not be applied by way of the reinforcement, and contact between internal vibrators and formwork, reinforcement or built-in components shall be avoided as far as possible. Concrete shall be vibrated in such a manner that the formwork, reinforcement or built-in components will not be displaced.  (5) Concrete that has been in position for more than 30 minutes shall not be vibrated except as stated in Clause 15.11.1  (6) No-fines concrete shall be compacted using a minimum amount of punning. |
| **15.12** | **CONSTRUCTION JOINTS** |  |
| 15.12.1 | Construction joints | (1) Construction joints in concrete shall be formed only at the specified positions and by the specified method unless otherwise approved by the Engineer. The position and details of construction joints which are not stated in the Contract shall be arranged in such a manner that the possibility of the occurrence of shrinkage cracks is minimized.  (2) Construction joints shall be normal to the axis or plane of the element being constructed unless otherwise permitted by the Engineer.  (3) Waterstops shall be provided at construction joints in water retaining structures and watertight structures.  (4) Laitance and loose material shall be removed from the surface of construction joints and the aggregate shall be exposed by a method agreed by the Engineer. The work shall be carried out as soon as practicable after the concrete has hardened sufficiently for the cement matrix to be removed without disturbing the coarse aggregate. The surface of the construction joint shall be cleaned after the matrix has been removed.  (5) The surface of the construction joint shall be clean and dry when fresh concrete is placed against it. |
| **15.13** | **CURING CONCRETE** |  |
| 15.13.1 | Curing concrete | (1) Concrete shall be protected against harmful effects of weather, running water and drying out by one of the following methods:  Method 1 : A liquid curing compound shall be applied to  the concrete surface by a low-pressure spray  until a continuous visible covering is achieved.  The application rate shall be applied as  recommended by the manufacturer. For  textured surfaces and fluted surfaces, the  application rate shall be adjusted to ensure  that full covering is achieved. Covering the  adjoining reinforcement or formwork shall be  avoided.  Method 2 : The concrete surface shall be covered with  hessian, sacking, canvas or other absorbent  material agreed by the Engineer or with a layer  of fine aggregate at least 25 mm thick. The  hessian, sacking, canvas, absorbent material  or fine aggregate shall be kept constantly wet.  Method 3 : The concrete surface shall be covered with  polyethylene sheeting. Concrete surfaces  which have become dry shall be thoroughly  wetted before the sheeting is placed.  Method 4 : Unformed concrete surfaces shall be covered  with polyethylene sheeting until the concrete  has hardened sufficiently for water curing to be  carried out. Water curing shall be carried out  by spraying the concrete surface continuously  with cool water or by ponding immediately after  the sheeting is removed. If in the opinion of the  Engineer water curing is impracticable, Method  2 shall be used instead of water curing.  (2) Method 1 shall not be used on concrete surfaces against which concrete will be placed or which will have a Class T1 finish or which will be painted or tiled.  (3) Method 1, 2, 3 or 4 shall be carried out on unformed concrete surfaces immediately after the concrete has been compacted and finished. Method 1, 2 or 3 shall be carried out on formed concrete surfaces immediately after the formwork has been removed.  (4) Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.  (5) Hessian, sacking, canvas, absorbent material and polyethylene sheeting shall be lapped and securely held in position in such a manner that the concrete surface will not be damaged.  (6) Cold water shall not be applied to concrete surfaces or formwork intermittently in large quantities.  (7) The different methods of protection shall be maintained for the minimum periods stated in Table 15.5 after the concrete has been placed. The minimum periods may be reduced by the number of days during which formwork is left in position. |

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| Table 15.5: Minimum periods of protection for concrete |

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| Type of structure | Method of protection | Minimum period of protection (days) | |
| Concrete not containing PFA or PFAC | Concrete containing PFA or PFAC |
| Water retaining structures and water tight structures | 1 | 7 | 7 |
| 2, 3 or 4 | 7 | 9 |
| Others | 1 | 7 | 7 |
| 2, 3 or 4 | 4 | 5 |

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| **15.14** | **INSTALLATION OF PRECAST CONCRETE UNITS** |  |
| 15.14.1 | Installation of precast concrete units | (1) Contact surfaces between in-situ concrete and precast concrete units shall be prepared as stated in the Contract. Dimensional tolerances shall be checked before the precast concrete units are lifted into position.  (2) Temporary supports and connections shall be provided as soon as practicable during installation of precast concrete units.  (3) Final structural connections shall be completed as soon as practicable after the precast concrete units have been installed.  (4) Levelling devices that have no load bearing function in the finished structure shall be slackened, released or removed after the precast concrete units have been installed. |
| **15.15** | **LOADING OF CONCRETE** |  |
| 15.15.1 | Loading of concrete | (1) Loads which will induce a compressive stress in the concrete exceeding one-third of the compressive strength of the concrete at the time of loading or exceeding one-third of the grade strength, whichever is less, shall not be applied to concrete. Allowance shall be made for the weight of the concrete in determining the loading. The strength of the concrete and the stresses produced by the loads shall be assessed by a method agreed by the Engineer.  (2) Loads from materials not forming part of the permanent work or from Constructional Plant or other vehicles shall not be applied to no-fines concrete. |
| **15.16** | **TESTING: CEMENT, PFA, AGGREGATE, ADMIXTURE, CURING COMPOUND, RECYCLED WATER** |  |
| 15.16.1 | Batch: cement, PFA, aggregate, admixture, curing compound | A batch of cement, PFA, aggregate, admixture or curing compound is any quantity of cement, PFA, aggregate, admixture or curing compound of the same type, manufactured or produced at the same time in the same place, covered by the same certificates and delivered to the Site, or stored at the ready-mixed concrete plant, at any one time. |
| 15.16.2 | Samples: cement, PFA, aggregate, admixture, curing compound | (1) One sample of each type of cement, PFA, aggregate, admixture and curing compound shall be provided at the same time as particulars of the material are submitted to the Engineer.  (2) The size of each sample and the method of sampling shall be as stated in Table 15.6. |
| 15.16.3 | Testing: cement compound, recycled water | (1) Each sample of cement, PFA, aggregate, admixture and curing PFA, aggregate, compound shall be tested to determine the properties stated in Table 15.7. admixture, curing  (2) The method of testing shall be as stated in Table 15.7.  (3) The maximum total chloride content of concrete shall be determined on the basis of the results of tests for chloride content of each constituent.  (4) The sampling and testing for acceptance inspection at delivery shall be as stated in National annex NC of BS EN 197-1. The methods of taking and preparing samples of cement shall be as stated in BS EN 196-7.  (5) If recycled water is used for mixing concrete, tests shall be carried out according to the methods and frequency stated in Table 15.8. |

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| Table 15.6: Size of samples and method of sampling cement, PFA, aggregate, admixture and curing compound |

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| Material | Size of sample | Method of sampling |
| Cement | 20 kg | BS EN 196-7 |
| PFA | 20 kg | BS 4550:Part 1 |
| Coarse aggregate | 25 kg | BS 812: Part 102 |
| Fine aggregate | 10 kg | BS 812: Part 102 |
| Admixture (powdered) | 1 kg | BS 5075: Part 1 |
| Admixture (liquid) | 1 L | BS 5075: Part 1 |
| Curing compound | 5 L | BS 5075: Part 1 |

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| Table 15.7: Methods of testing cement, PFA, aggregate, admixture and curing compound |

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| Material | Property | Method of testing |
| PC, SRPC, PFAC | Composition | BS EN 197-1 |
| Chemical properties | BS EN 196-2  BS EN 196-21 |
| Compressive strength at 2, 7 and  28 days | BS EN 196-1 |
| Initial setting time | BS EN 196-3 |
| Soundness | BS EN 196-3 |
| PFA | Chemical composition | By BS 3892:Part 1 |
| Fineness Moisture content | BS 3892: Part 1 |
| Coarse aggregate, fine aggregate | Grading | BS 812: Part 103 |
| Silt content | BS 812: Part 1 |
| Chloride content | BS 812: Part 117 |
| Coarse aggregate | Flakiness index Ten percent fines Water absorption | BS 812: Part 105.1  BS 812: Part 111  BS 812: Part 2 |
| Admixture | Chloride content | BS 5075: Part 1 |
| Curing compound | Efficiency index | existing national standards or similar |

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| Table 15.8: Recycled water testing for each batching plant |

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| Description | Limits | Test method | Test frequency |
| Physical test |  |  |  |
| Density test for recycled water  Initial setting time of cement with recycled water (time of set, deviation from control, h:min) | ≤1030 kg/m3  From 1:00  earlier to 1:30 later | Note 1  BS EN 196-3:1995 | At least once per day  Once every 3 months for the first year and thereafter at half-yearly intervals |
| Chemical test for recycled water  Chloride content (as C1⎯):  prestressed concrete steam-cured structural concrete  concrete with reinforcement or other embedded metal  Sulphate content (as SO4)  Acid-soluble alkali content | 500 ppm  1,000 ppm  3,000 ppm  600 ppm | APHA 4500-C1-B,  18th Edition (1992)  APHA 4500-Cl-B,  18th Edition (1992)  APHA  4500-SO42-C, 18th  Edition (1992)  BS EN 1008:2002 | For all tests:  Once per week for the first 2 months  Once per month for the next 12 months thereafter  In case of a weekly or monthly test indicates that the limits are exceeded, the water shall immediately be suspended for use in concrete mixing until two sets of consecutive test results taken from the same source are satisfactory. In such case, the testing frequency shall be maintained at or reverted back to once per week until two sets of consecutive test results are satisfactory.  The testing frequency shall be subject to review after the 12-month period for the monthly test |
|  | Notes:  Test method to be proposed by the Contractor for the acceptance of the Engineer.  Accredited Laboratories and institutes for the relevant tests shall be used, if available, in which case results shall be issued on an endorsed test reports. | | |

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| **15.17** | **TESTING: CONCRETE - GENERAL REQUIREMENTS** |  |
| 15.17.1 | Batch: concrete | A batch of concrete is any quantity of concrete produced in one cycle of operations of a batch mixer, or conveyed ready-mixed in a delivery vehicle, or discharged during one minute from a continuous mixer. |
| 15.17.2 | Reduction of testing frequency | The number of tests for workability or compressive strength of standard mix concrete may be reduced if in the opinion of the Engineer the standard of quality control is satisfactory. |
| **15.18** | **TESTING: CONCRETE - WORKABILITY** |  |
| 15.18.1 | Samples: workability of concrete | (1) One sample of concrete shall be provided from each batch of concrete to determine the workability of the concrete.  (2) The size of each sample and the method of sampling shall be in accordance with CS1.  (3) The first 0.3 cu. m. concrete discharged from the truck before taking concrete sample for slump test can be used in the Works after the slump value is accepted by the Engineer as in Clause 15.18.3 |
| 15.18.2 | Testing: workability of concrete | (1) Each sample of concrete taken as stated in Clause 15.18.1 shall be divided into two specimens. Each specimen shall be tested to determine the workability of the concrete in accordance with actual Maldivian standards or similar.. Selection of the testing method is given in the table below:  (2) The average of the two workability values shall be calculated and referred to as the average slump value or average flow value. |
|  | Normal Workability (slump value from 10 mm to 200 mm) | High Workability (flow value from 340 mm  to 600 mm) |
|  | Slump Test | Flow Table Test (See Note below) |
|  |  | Note: For concrete with a flow value greater than 600mm, the Engineer shall specify the workability testing method. |
| 15.18.3 | Compliance criteria: workability of concrete | (1) The average slump value of the two specimens taken from one sample of standard mix concrete shall be within the appropriate range stated in Table 15.3.  (2) The average slump value of the two specimens taken from one sample of designed mix concrete shall be within 25 mm or 33% of the approved slump value, whichever is the greater.  (3) The average flow value of the two specimens taken from one sample of designed mix concrete shall be within +/- 50mm of the approved flow value. |
| 15.18.4 | Non-compliance: workability of concrete | A batch of concrete shall be considered as not complying with the specified requirements for workability if the result of any test for workability, carried out on a sample taken from the batch, does not comply with the specified requirements for workability. Concrete that failed to comply with the specified requirements for workability shall not be placed in the permanent works. |
| **15.19** | **TESTING: CONCRETE - COMPRESSIVE STRENGTH** |  |
| 15.19.1 | Samples: compressive strength of concrete | (1) For each concrete mix, one sample of concrete shall be provided from each amount of concrete as stated in Table 15.9 or from the amount of concrete produced each day, whichever is less.  (2) If the Contractor requests, or if the Engineer instructs, that the concrete be tested for compressive strength at ages other than 28 days, additional samples shall be provided. The number of additional samples shall be as stated in Clause 15.19.1  (3) The size of each sample and the method of sampling shall be in accordance with CS1. If a super plasticising admixture is included in the concrete mix, the samples shall be taken after the superplasticiser is added and after the concrete is remixed. |

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| Table 15.9: Rate of sampling of concrete |

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| Type of structure | Amount of concrete |
| Masts  Cantilevers 3 m or more in length Columns  Shear walls Prestressed elements Other critical elements | 10 m3 or 10 batches, whichever is less |
| Solid rafts Pile caps Mass concrete | 100 m3 or 100 batches, whichever is less |
| Other types | 25 m3 or 25 batches, whichever is less |

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| 15.19.2 | Testing: compressive strength of concrete | (1) Two test cubes shall be made from each sample of concrete taken as stated in Clause 15.19.1. Each pair of test cubes shall be tested to determine the compressive strength at 28 days.  (2) The method of making test cubes shall be in accordance with actual Maldivian standards or similar.  (3) The method of storing test cubes shall be in accordance with actual Maldivian standards or similar.. Test cubes which are cured on the Site shall be delivered to the testing laboratory at least 48 hours before the tests are due to be carried out.  (4) The method of testing shall be in accordance with actual Maldivian standards or similar..  (5) For the purpose of assessing compliance of designed mix concrete as stated in Clauses 15.19.4 and 15.19.5, the average of the two compressive strengths of the pair of test cubes shall be calculated and referred to as the test result.  (6) The size of the test cube shall be 100 mm for concrete with the maximum aggregate size not exceeding 20 mm and shall be 150 mm with the maximum aggregate size exceeding 20 mm. |
| 15.19.3 | Non-compliance: compressive strength of standard mix concrete | If the result of any test for compressive strength at 28 days of standard mix concrete is less than the grade strength, the Engineer may instruct that tests as stated in Clauses 15.20.1 to 15.20.4 are carried out on concrete cores or on samples taken from the hardened concrete. |
| 15.19.4 | Compliance criteria: compressive strength of designed mix concrete | (1) The results of tests for compressive strength at 28 days of designed mix concrete shall comply with the following requirements:  Each test result shall not be less than the grade strength by more than the appropriate amount stated in Column A of Table 15.10, and,  The average of any four consecutive test results, or the average of the first two or first three test results if less than four test results are available, shall exceed the grade strength by at least the appropriate amount stated in Column B of Table 15.10. |

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| Table 15.10: Compliance criteria for compressive strength of designed mix concrete |

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| Grade strength (MPa) | Compliance criteria | Column A | | Column B | |
| Maximum amount by which each test result may be below the grade strength (MPa) | | Minimum amount by which the average of any four consecutive test results shall be above the grade strength (MPa) | |
| 100 mm cubes | 150 mm cubes | 100 mm cubes | 150 mm cubes |
| 20 or greater | C1 | 2 | 3 | 7 | 5 |
| C2 | 2 | 3 | 5 | 3 |
| below 20 | C3 | 2 | 2 | 3 | 2 |

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|  |  | (2) If there is a period exceeding 14 days between any two consecutive test results in any group of four consecutive test results and if agreed by the Engineer, the test results immediately before and immediately after the period may be treated separately for the purpose of Clause 15.19.4  (3) If the difference between the compressive strengths of two test cubes made from one sample of designed mix concrete exceeds 15% of the test result:  The higher of the compressive strengths of the two test cubes shall be used to assess compliance as stated in Clause 15.19.4 and  The test result for that sample shall not be used to assess compliance as stated in Clause 15.19.4 and shall not be used to calculate the standard deviation.  (4) For designed mix concrete with grade strength of less than 20 MPa, compliance criteria C3 shall apply.  (5) For designed mix concrete with a grade strength of 20 MPa or greater, until 40 test results are available either:  Compliance criteria C1 shall apply, or  If in the opinion of the Engineer there is sufficient evidence that the standard of quality control using similar materials and plant is such that the standard deviation for at least 40 test results will not exceed 5.5 MPa for 100 mm test cubes or 5 MPa for 150 mm test cubes, compliance criteria C2 shall apply.  (6) For designed mix concrete with a grade strength of 20 MPa or greater, the standard deviation of test results shall be calculated after every test result for each designed mix using the last 40 test results judged by the same compliance criteria. The acceptance criteria shall depend on the calculated standard deviation as follows.  For 100 mm test cubes, if the standard deviation does not exceed 5.5 MPa, compliance criteria C2 shall apply to subsequent test results. If the standard deviation exceeds 5.5 MPa and does not exceed 8.5 MPa, compliance criteria C1 shall apply to subsequent test results.  For 150 mm test cubes, if the standard deviation does not exceed 5 MPa, compliance criteria C2 shall apply to subsequent test results. If the standard deviation exceeds 5 MPa and does not exceed 8 MPa, compliance criteria C1 shall apply to subsequent test results.  If the standard deviation exceeds 8.5 MPa for 100 mm test cubes or 8.0 MPa for 150 mm test cubes, no further concrete shall be placed in the permanent works until an investigation of the materials, mix design, methods of production, sampling and testing has been carried out and measures have been taken which in the opinion of the Engineer will result in restoring a satisfactory standard of quality control.  (7) If the compliance criteria are changed from C1 to C2 or from C2 to C1, the new compliance criteria shall apply from the 35th day after making the last pair of test cubes in the set of 40 on which the decision to change was based. For the purpose of Clause 15.19.4 test results immediately before and immediately after the change shall be treated separately. |
| 15.19.5 | Non-compliance: compressive strength of designed mix concrete | (1) A batch of designed mix concrete shall be considered as not complying with the specified requirements for compressive strength if the test result for the pair of test cubes made from a sample taken from the batch does not comply with the requirements stated in Clause 15.19.4  (2) The batches of designed mix concrete from which the first and last samples in any group of four consecutive test results were taken and all intervening batches shall be considered as not complying with the specified requirements for compressive strength if the group of four consecutive test results does not comply with the requirements stated in Clause 15.19.4  (3) If designed mix concrete is considered as not complying with the specified requirements for compressive strength, the Engineer may instruct that tests as stated in Clauses 15.20.1 to 15.20.4 are carried out on concrete cores or on samples taken from the hardened concrete. |
| **15.20** | **TESTING: HARDENED CONCRETE** |  |
| 15.20.1 | Samples: hardened concrete and concrete cores | (1) The number of samples, including cores, of hardened concrete to be provided for testing shall be as stated in the Contract or, if testing is to be carried out as a result of the concrete not complying with the specified requirements, shall be as instructed by the Engineer. In the latter case, all the concrete being investigated shall be divided as instructed by the Engineer into separate test locations. The number of samples taken from each location shall be as instructed by the Engineer and the quality of concrete at each location shall be assessed separately. The positions from which the samples are taken shall be as instructed by the Engineer.  (2) The size of samples and the method of sampling shall be in accordance with actual Maldivian standards or similar. |
| 15.20.2 | Testing: concrete cores | (1) Each concrete core shall be inspected for evidence of segregation of the constituents and for the presence of voids. Specimens selected from each core shall be tested to determine the compressive strength.  (2) The method of preparing and inspecting concrete cores and of testing the cores to determine the compressive strength shall be in accordance with actual Maldivian standards or similar. Concrete cores shall not be tested for compressive strength until the concrete has reached an age of 28 days. |
| 15.20.3 | Compliance criteria: concrete cores | (1) The concrete core shall be considered as non-compliant if it exhibits honeycombing which means interconnected voids arising from, for example, inadequate compaction or lack of mortar.  (2) The results of tests for compressive strength of concrete cores shall be interpreted in accordance with BS 6089. Adjustments to the measured strength in respect of the age of the core when tested shall not be made unless permitted by the Engineer. The estimated in-situ cube strength of each core specimen shall be calculated in accordance with actual Maldivian standards or similar.. For any set of cores representing a test location, the average estimated equivalent cube strength shall be at least 85% of the specified grade strength, and each individual estimated equivalent cube strength shall be at least 75% of the specified grade strength. |
| 15.20.4 | Analysis of hardened concrete | (1) Each sample of hardened concrete shall be tested to determine the properties or the composition of the concrete as stated in the Contract or, if testing is to be carried out as a result of the concrete not complying with the specified requirements, shall be tested as instructed by the Engineer.  (2) Tests on hardened concrete shall be carried out within 14 days of the Engineer's instruction for the test.  (3) The method of testing shall be in accordance with actual Maldivian standards or similar. |
| **15.21** | **TESTING: PRECAST UNITS** |  |
| 15.21.1 | Batch: precast units | A batch of precast units is any quantity of precast units, including prestressed units, of the same type and size, of the same concrete mix, manufactured in the same place, covered by the same certificates and delivered to the Site at any one time. |
| 15.21.2 | Samples: precast units | The number of precast units to be provided for testing from each batch shall be as stated in the Contract. |
| 15.21.3 | Testing: precast units | (1) Load tests shall be carried out to determine the deflection and recovery of each precast unit, including prestressed units, provided for testing and to determine the resistance to cracking of each prestressed unit provided for testing.  (2) Load tests shall be carried out in accordance with a procedure agreed by the Engineer. The age at which the units are to be tested, the test load, the points at which the loads are to be applied and the points at which the unit is to be supported shall be as stated in the Contract.  (3) The method of testing shall be as stated in existing national standards or similar  (4) Post-tensioned units shall not be tested until at least 7 days after the ducts have been grouted. |
| 15.21.4 | Compliance criteria: precast units | The results of load tests on precast units shall comply with the requirements stated in the Contract. |
|  | ***PART 2: JOINTS IN CONCRETE*** |  |
| **15.22** | **GENERAL** |  |
| 15.22.1 | General requirements | The works and materials specified in Clauses 15.22.2 and 15.22.3 shall comply with the sections stated, unless otherwise stated in this Section. |
| 15.22.2 | Joints in concrete carriageways | Joints in concrete carriageways shall comply with Section 9. |
| 15.22.3 | Construction joints | Construction joints in concrete shall comply with Section 15. |
| **15.23** | **MATERIALS** |  |
| 15.23.1 | Materials for joints in water retaining structures and water tight structures | (1) Materials for joints in water retaining structures and water tight structures for sewage and effluent treatment shall be resistant to aerobic and anaerobic microbiological attack and resistant to attack by petrol, diesel oil, dilute acids and alkalis.  (2) Materials for joints in water retaining structures for potable and fresh water shall comply with the requirements of BS 6920. |
| 15.23.2 | Joint filler | Joint filler shall be of a proprietary type approved by the Engineer and shall be a firm, compressible, single-thickness, non-rotting filler. Joint filler for joints in water retaining structures and watertight structures shall be non-absorbent. |
| 15.23.3 | Bitumen emulsion | Bitumen emulsion for joints in water retaining structures and watertight structures shall comply with BS 3416. Bitumen emulsion for surfaces against which potable or fresh water will be stored or conveyed shall comply with BS 3416, type II. |
| 15.23.4 | Joint sealant | (1) Joint sealant shall be a grade suited to the climatic conditions of the Maldives and shall perform effectively over a temperature range of 0°C to 60°C. Joint sealant for exposed joints shall be grey.  (2) Joint sealant other than cold-applied bitumen rubber sealant shall be:  A gun grade for horizontal joints 15 mm wide or less and for vertical and inclined joints,  A pouring grade for horizontal joints wider than 15 mm.  (3) Polysulphide-based sealant shall be a cold-applied two-part sealant complying with BS 4254. Polysulphide-based sealant for expansion joints in water retaining structures and watertight structures shall have a transverse butt-joint movement range of at least 20%.  (4) Polyurethane-based sealant shall be a cold-applied two-part sealant complying with the performance requirements of BS 4254.  (5) Hot-applied bitumen rubber sealant shall comply with BS 2499, type N1.  (6) Cold-applied bitumen rubber sealant shall be of a proprietary type approved by the Engineer.  (7) Joint sealant for joints in water retaining structures and water tight structures shall be as stated in Table 15.11.  (8) Primers and caulking material for use with joint sealant shall be of a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer.  (9) Different types of joint sealant and primers that will be in contact shall be compatible |

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| Table 15.11 : Joint sealant for water retaining structures and water tight structures |

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| Structure for retaining/excluding | Type of joint | Type of joint sealant |
| Sewage | All joints | Polyurethane-based |
| Other than sewage | Expansion joints | Polysulphide-based or polyurethane-based |
| Horizontal joints other than expansion joints | Hot-applied bitumen rubber, polysulphide-based or polyurethane-based |
| Vertical and inclined joints other than expansion joints | Polysulphide-based, polyurethane-based or  cold-applied bitumen rubber |

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| 15.23.5 | Bond breaker tape | Bond breaker tape shall be of a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer. The tape shall be a polyethylene film with adhesive applied on one side and shall be the full width of the groove. |
| 15.23.6 | Bearing strip for sliding joints | Bearing strip for sliding joints shall consist of two plastic strips of a proprietary type approved by the Engineer. The strips shall be resistant to all weather conditions and to chemicals to which the structure will be subjected without impairing the reaction, durability or function of the strips. The strips shall be of a type that will not require maintenance after installation. The strips shall be capable of withstanding a vertical load of at least 300 kN/m2 and shall have a maximum coefficient of friction of 0.3 under a constant shearing force. |
| 15.23.7 | Waterstops | Waterstops, including intersections, reducers and junctions, shall be of a proprietary type approved by the Engineer. Waterstops shall be natural or synthetic rubber or extruded polyvinyl chloride and shall have the properties stated in Table 15.12. |

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| Table 15.12: Properties of waterstops |

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| Property | Rubber waterstops | PVC waterstops |
| Density | 1100 kg/m3 (± 5%) | 1300 kg/m3 (± 5%) |
| Hardness | 60 - 70 IRHD | 70 – 90 IRHD |
| Tensile strength | ≥20 N/mm2 | ≥13 N/mm2 |
| Elongation at break point | ≥450% | ≥285% |
| Water absorption | ≤5% by mass after 48 hours immersion | ≤0.15% by mass after 24 hours immersion |
| Softness number | - | 42 - 52 |

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| **15.24** | **SUBMISSIONS** |  |
| 15.24.1 | Particulars of materials for joints | (1) The following particulars of the proposed materials for joints shall be submitted to the Engineer:  Manufacturer’s literature and a certificate for joint filler showing the manufacturer's name, the date and place of manufacture and showing that the joint filler complies with the requirements stated in the Contract and including results of tests for:  Disintegration and shrinkage  Recovery value and reduction in mass  Extrusion,  Manufacturer’s literature and a certificate for bitumen emulsion showing the manufacturer's name, the date and place of manufacture and showing that the bitumen emulsion complies with the requirements stated in the Contract,  Manufacturer’s literature for joint sealant, including details of the method and time required for mixing the different components, and a certificate showing the manufacturer's name, the date and place of manufacture and showing that the sealant complies with the requirements stated in the Contract and including results of tests as appropriate for:  Rheological properties  Plastic deformation  Adhesion and tensile modulus  Application life  Adhesion in peel  Loss of mass after heat ageing  Staining  Transverse butt joint movement range  Extension  Flow  Penetration  Degradation,  Manufacturer’s literature and a certificate for bearing strip for sliding joints showing the manufacturer's name, the date and place of manufacture and showing that the strips comply with the requirements stated in the Contract and including results of tests for:  Vertical load  Coefficient of friction,  Manufacturer’s literature for waterstops, including details of intersections, reducers and junctions, and a certificate showing the manufacturer's name, the date and place of manufacture and showing that the waterstops comply with the requirements stated in the Contract and including results of tests for:  Density  Hardness  Tensile strength  Elongation at break point  Water absorption  Softness number of PVC waterstops, and  Particulars of primers and caulking material for joint sealant and of bond breaker tape.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 15.24.2 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:  Joint filler,  Bond breaker tape,  Bearing strip for sliding joints, and  Waterstops, including intersections, reducers and junctions. |
| **15.25** | **STORAGE OF MATERIALS** |  |
| 15.25.1 | Storage of materials for joints | (1) Bitumen emulsion, joint sealant and primer for joint sealant shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions which may affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.  (2) Joint filler, bond breaker tape and waterstops shall be stored in accordance with the manufacturers’ recommendations in a dry weatherproof store with a raised floor. Absorbent joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air.  (3) Bearing strip for sliding joints supplied in rolls of 5 m length or less shall be unrolled immediately after delivery and shall be stored flat at full length on an even surface. Bearing strip supplied in rolls of more than 5 m length may be left in the original packing. Bearing strip shall be stored in accordance with the manufacturer’s recommendations and shall be protected from mechanical damage and creasing. The two layers of strip shall be kept free from deleterious material. |
| **15.26** | **FORMING JOINTS** |  |
| 15.26.1 | Forming joints | (1) Materials for joints shall be used in accordance with the manufacturers’ recommendations or as otherwise stated in the Contract.  (2) Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and formation.  (3) Waterstops shall be securely fixed in position to formwork in such a manner that compaction of the concrete will not be affected. In-situ joints in waterstops shall be made using methods and equipment recommended by the manufacturer. Exposed waterstops shall be protected from exposure to conditions that may affect the waterstop and shall be kept free from rust, hydrocarbons and other deleterious material.  (4) Joints shall be formed in straight lines perpendicular to the surface of the concrete unless otherwise stated in Contract. |
| 15.26.2 | Forming grooves | (1) Grooves for joint sealant shall be straight and shall be perpendicular to the surface of the concrete. The bottom of the groove shall be flat and shall be parallel to the surface of the concrete.  (2) Grooves shall be formed by using timber or other approved formers and shall not be formed by cutting back or raking out the joint filler. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove. |
| 15.26.3 | Protection of grooves | Before permanent sealing, grooves for joint sealant shall be protected from contamination by a temporary sealing strip or cover or by other methods agreed by the Engineer. |
| 15.26.4 | Sealing joints | (1) The permanent sealing of joints shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.  (2) Immediately before permanent sealing, timber formers, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.  (3) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.  (4) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.  (5) Concrete surfaces within 75 mm of the edges of the joint shall be masked with tape before the primer is applied and until the sealing of the joint is complete.  (6) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer’s recommendations.  (7) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air. The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.  (8) The groove shall be clean and dry at the time of applying the primer and joint sealant.  (9) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the face of the concrete. |
| **15.27** | **TOLERANCES** |  |
| 15.27.1 | Tolerances: joints | (1) The best-fit straight line of straight joints shall be within 25 mm of the specified line. The line of straight joints shall be within 10 mm of the best-fit straight line.  (2) The best-fit curved line of curved joints shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints shall be within 10 mm of the best-fit curved line.  (3) Joints shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint.  (4) The depth of grooves for joint sealant shall be within 3 mm of the specified depth. |
| **15.28** | **TESTING: MATERIALS FOR JOINTS** |  |
| 15.28.1 | Batch: joint filler, joint sealant, waterstops | A batch of joint filler, joint sealant or waterstop is any quantity of joint filler, joint sealant or waterstop of the same type, manufactured by the same manufacturer, covered by the same certificates and delivered to the Site at any one time. |
| 15.28.2 | Samples: joint filler, joint sealant, waterstops | (1) One sample of each type of joint filler, joint sealant or waterstop shall be provided at the same time as particulars of the material are submitted to the Engineer. Unless otherwise permitted by the Engineer, one sample of each type of material shall be provided from each batch of the material delivered to the Site. Unless otherwise permitted by the Engineer, one sample of mixed joint sealant shall be provided on each day that joints are sealed.  (2) The size of each sample of joint filler shall be sufficient to permit all tests stated in existing national standards or similar to be carried out.  (3) Samples of unmixed joint sealant and primers for joint sealant shall be taken from sealed containers delivered to the Site. Samples of mixed joint sealant shall be taken immediately before the sealant is applied to the joint. The method of sampling shall be as stated in BS 2499, Appendix A. The size of each sample shall be as follows:  Unmixed joint sealant : 1 kg  Mixed joint sealant : 1.5 kg  Primer for joint sealant : 1 L.  (4) The size of each sample of waterstop shall be 1 m. |
| 15.28.3 | Testing: joint filler, joint sealant, waterstops | (1) If required by the Engineer, samples of joint filler shall be tested to determine the disintegration and shrinkage, the recovery value and reduction in mass and the extrusion. The method of testing shall be in accordance with existing national standards or similar  (2) If required by the Engineer, samples of joint sealant shall be tested to determine the properties stated in Table 15.13. The method of testing shall be as stated in Table 15.13.  (3) If required by the Engineer, samples of waterstop shall be tested to determine the properties stated in Table 15.14. The method of testing shall be as stated in Table 15.14. |

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| Table 15.13: Testing joint sealant |

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| Type of joint sealant | Properties to be tested | Method of testing |
| Polysulphide-based sealant Polyurethane-based sealant | Rheological properties Plastic deformation  Adhesion and tensile modulus Application life  Adhesion in peel  Loss of mass after heat ageing Staining | BS 4254 |
| Hot-applied bitumen rubber sealant | Extension Flow Penetration Degradation | BS 2499 |

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| Table 15.14: Testing waterstops |

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| Property | Method of testing | |
| Rubber waterstops | PVC waterstops |
| Density | BS 903: Part A1 | ISO 1183 |
| Hardness | BS 903: Part A26 | BS 2782: Part 3,  Method 365D |
| Tensile strength | BS 903: Part A2 and BS 903: Part A5 | BS 2782: Part 3,  Methods 320A to 320F |
| Elongation at break point | BS 903: Part A2 and BS 903: Part A5 | BS 2782: Part 3,  Methods 320A to 320F |
| Water absorption | BS 903: Part A18 | BS 2782: Part 4,  Methods 430A to 430D |
| Softness number | - | BS 2782: Part 3,  Method 365A |

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| 15.28.4 | Compliance criteria: joint filler | The results of tests on joint filler shall comply with the following requirements:  None of the three specimens in the weathering test shall show any sign of disintegration or shrinkage.  Each of the four specimens in the compression and recovery test shall have a recovery value of at least 70%, and the reduction in mass of each of the two new specimens shall not exceed 1%.  The extrusion of the free edge of the specimen shall not exceed 6 mm as determined by the extrusion test |
| **16.** | **SECTION 16 STEELWORK** |  |
| **16.1** | **GENERAL** |  |
| 16.1.1 | Steelwork | (1) Steelwork shall comply with BS 5950: Part 2 unless it is stated in the Contract that the steelwork shall comply with BS 5400: Part 6.  (2) Allowances shall be made for the deformation due to permanent loads and the process and sequence of fabrication, erection and construction such that steelwork is completed to within the specified tolerances.  (3) The compatibility of the dimensions and setting-out data of steelwork shall be verified by the Contractor before the materials for steelwork are ordered. |
| 16.1.2 | Protection of steelwork | Protection of steelwork against corrosion shall comply with BS 5493. Amendments to BS 5400: Part 6 |
| 16.1.3 | Amendments to BS 5400: Part 6 | The following amendments shall apply to BS 5400: Part 6:  Contents page:  Delete ‘6.3.1 General’.  Page 2, Clause 3.1.4.1, lines 5, 8 and 14:  Delete ‘C of DD21’ and insert ‘L1 of BS 5996’.  Page 2, Clause 3.1.4.1, line 10 and Clause 3.1.4.2, line 3: Delete DD21’ and insert ‘BS 5996’.  Page 3, Clause 4.2.1, line 2:  Delete ‘4.4.2’ and insert ‘4.2.2’.  Page 3, Clause 4.3.3(e), line 1:  Delete line 1 of text and insert ‘the hardness of the edge is reduced to less than 350 HV 30 of BS 427 by a suitable heat treatment’.  Page 4, Clause 4.7.1, paragraph 2, line 4:  Delete ‘23 of BS 5135’ and insert ‘20 of BS 5135’.  Page 5, Clause 4.14:  Delete and insert:  ‘The Contractor shall determine the dead load camber of beams required to comply with Clause 16.1.1of the GS. The camber of plate girders shall be formed by either of the two following alternatives, whichever is stated in the Contract :  Type A cambering camber introduced by welding the flanges pressed against a web plate cut to a smooth cambered profile,  or  Type B cambering camber introduced by connecting straight sections of girder with a change of slope at their junctions.  Type A camber shall be used if the alternative to be used is not stated in the Contract.  With Type B cambering the junctions positioned at bolted connections shall not be  Page 6, Clause 5.2.2, line 2:  Delete ‘DD21’ and insert ‘BS 5996’.  Page 7, Clause 5.5.2, paragraph 3, line 3:  Delete ‘grider’ and insert ‘girder’.  Page 9, Clause 6.3.1:  Delete Clause 6.3.1.  Page 15, Table 5, column 3, Member component 4:  Delete ‘G=0’ and insert ‘G=D’. |
| **16.2** | **MATERIALS** |  |
| 16.2.1 | Structural steel | (1) Structural steel shall comply with BS 4360, including Clause B7 at Appendix B, and with BS 5950: Part 2, Section 2.1 or BS 5400: Part 6, Section 3.1 as appropriate.  (2) Hot rolled sections complying with BS 4: Part 1, BS 4848: Part 2, BS 4848: Part 4 or BS 4848: Part 5 shall not be replaced with sections complying with other standards unless approved by the Engineer. If approved, the sections shall have equivalent properties to, and the dimensional tolerances shall comply with, the relevant British Standard. |
| 16.2.2 | Rivet steel | Steel rivet bars for the manufacture of steel rivets shall comply with BS 5400: Part 6, Appendix A. |
| 16.2.3 | Steel for shear connectors | Steel for headed-stud-type shear connectors shall have a yield stress of at least 385 N/mm2 and a tensile strength of at least 495 N/mm2. Steel for other types of shear connectors shall comply with BS 4360. |
| 16.2.4 | Bolts, screws, nuts and  washers | (1) Bolts, screws and nuts shall comply with the British Standards strength grades stated in Table 16.1 unless other strength grades or British Standards are stated in the Contract.  (2) Washers for high strength friction grip bolts and nuts shall comply with the following:  High strength friction grip bolts and associated nuts and washers for structural engineering:  - General grade : BS 4395: Part 1  - Higher-grade bolts  and nuts and general-grade washers : BS 4395: Part 2  - Higher-grade bolts  (waisted shank), nuts and  general-grade washers : BS 4395: Part 3  Plain washers for other bolts, screws and nuts shall comply with BS 4320. Tapered washers for other bolts, screws and nuts shall comply with BS 3410. |
| 16.2.5 | Welding consumables | (1) Welding consumables used in metal-arc welding of grades of steel complying with BS 4360 shall comply with BS 5135. Welding consumables used in the fusion welding of steel castings shall comply with BS 4570. Welding consumables used in metal-arc welding of austenitic stainless steels shall comply with BS 4677.  (2) Welding consumables and the procedures used shall be such that the mechanical properties of the deposited weld metal shall not be less than the respective minimum values of the parent metal being welded.  (3) Welding consumables used with grades of steel other than those complying with BS 4360 shall be such that the performance requirements stated in BS 5400: Part 6, Table 1 or BS 5950: Part 2, Table 1 as appropriate are achieved. |
| 16.2.6 | Rolled steel pins | Rolled steel pins, including those made from slabs, shall comply with BS 970: Part 1 or BS 4360, Grades 43, 50 or 55. |

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| Table 16.1: British Standards and strength grades for bolts, screws and nuts |

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| Type of bolts, screws and nuts | British Standard | Strength grade of bolt | Strength grade of nut |
| High strength friction grip (HSFG) bolts and nuts | BS 4395: Part 1 | General grade | as specified in BS 4395: Part 1 |
| Precision bolts, screws and nuts | BS 3692 | 4.6 | 4.0 |
| Cup head and countersunk head bolts, screws and nuts | BS 4933 | 4.6 | 4.0 |
| Black bolts, screws and nuts | BS 4190 | 4.6 | 4.0 |
| Other types of bolts, screws and nuts | BS 4190 | 4.6 | 4.0 |
| Hexagon socket screws | BS 4168:  Part 1 | 12.9 | 12.0 |

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| 16.2.7 | Steel castings and cast steel pins | Carbon manganese steel castings shall comply with BS 3100. |
| 16.2.8 | Steel forgings and forged steel pins | Steel forgings and forged steel pins shall comply with BS 29. |
| 16.2.9 | Stainless steel | (1) Wrought stainless steel shall comply with BS 970: Part 1, Grade  316 S 16.  (2) Flat rolled stainless steel shall comply with BS 1449: Part 2, Grade 316 S 16 in the softened condition.  (3) Stainless steel tubes shall comply with BS 6323: Part 1 and BS 6323: Part 8, designation LW 23 GZF(S).  (4) Stainless steel bolts and nuts shall comply with BS 6105, steel Grade A4 and property class 80. Stainless steel washers shall comply with BS 1449: Part 2, Grade 316 S 31 in the softened condition. The dimensions and tolerances of bolts and nuts shall comply with BS 3692. The dimensions and tolerances of tapered washers shall comply with BS 3410 and the dimensions and tolerances of flat washers shall comply with BS 4320, Form C. |
| 16.2.10 | Cast iron | (1) Grey cast iron shall comply with BS 1452, Grade 10.  (2) Malleable cast iron shall comply with BS 6681.  (3) Spheroidal or nodular cast iron shall comply with BS 2789. |
| 16.2.11 | Grout for column bases | (1) Grout for bedding steel bases and for filling bolt pockets and pocket bases shall be based on OPC and shall have the same grade strength as the surrounding foundation concrete. The grout shall contain a non-metallic expanding admixture and shall have a total chloride content of not more than 0.1% by mass of cement.  (2) Grout for bedding steel bases and for filling bolt pockets shall be of a proprietary type approved by the Engineer and shall be suitable for filling the space by pouring under a suitable head. The proportions of the grout shall be in accordance with the manufacturer’s recommendations.  (3) A dry packed mortar may be used for bedding steel bases that exceed 75 mm thick. The mortar shall consist of 1 part by weight of cement to 2 parts by weight of fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for thorough ramming against supports such that the space is completely filled.  (4) Grout for filling pocket bases shall be a mix approved by the Engineer with a nominal maximum aggregate size of 10 mm. |
| 16.2.12 | Lubricant for nut threads of HSFG bolts | Lubricant for lubricating nut threads of high strengthen friction grip (HSFG) bolts shall be of a wax-based type approved by the Engineer. Machine oil and other free-flowing lubricants shall not be used. |
| 16.2.13 | Paint for steelwork | (1) Paint for steelwork shall comply with BS 5493, Section 2, Table 4. Organic zinc-rich paint shall comply with BS 4652. Lead-based paint shall not be used for finishing coats.  (2) Paint shall be supplied in sealed containers of not more than 5 litres capacity. Each container shall be marked on the side to show the following:  The name of the manufacturer,  The paint manufacturer’s reference number,  Intended purposes, type of pigment and binder,  Batch number, date of manufacture, expiry date and pot life, and  Colour, gloss, drying times and flash point.  (3) The Volatile Organic Compound (VOC) content, in grams per litre, of all paint applied on surfaces of steelwork shall not exceed:  Water-based Paint: 100 g/litre  Solvent-based Paint: 450 g/litre  The VOC content of paint shall be determined either by recognized method of calculation or laboratory testing. |
| **16.3** | **SUBMISSIONS** |  |
| 16.3.1 | Particulars of steel | (1) The manufacturer’s certificates for steel shall be submitted to the Engineer in accordance with BS 4360, Clause 12 and Appendix B 6.  (2) The certificates shall be submitted to the Engineer not more than 2 days after the steel has been delivered to the place of fabrication. |
| 16.3.2 | Particulars of workshop drawings | (1) Two sets of drawings of the steelwork shall be submitted to the Engineer. The drawings shall show details of the following:  Steelwork and welds, including any stud welds, marked with the relevant welding procedures,  Joints or non-standard welds proposed by the Contractor,  Locations and method of removal of any temporary welded attachments proposed by the Contractor,  Edges of steelwork complying with BS 5400: Part 6 to be formed by flame cutting or shearing procedures complying with BS 5400: Part 6, Clause 4.3.3(a), (d) or (e) with the edges marked with the procedures to be used, and  Parts of steelwork complying with BS 5400: Part 6 to be worked by hot processes complying with BS 5400: Part 6, Clause 4.8, 4.9 or 4.10 with the parts marked with the processes to be used.  (2) The drawings shall be submitted to the Engineer for approval at least 6 weeks before fabrication of the steelwork starts. Drawings shall not be approved until all procedures and details shown on the drawing have been approved by the Engineer.  (3) A print and a diazo film of the approved drawings shall be submitted to the Engineer at least 7 days before fabrication of the steelwork starts. |
| 16.3.3 | Particulars of delivery of steelwork | (1) The following particulars of steelwork fabricated off the Site shall be submitted to the Engineer:  Expected and actual arrival dates,  Name of carrier,  Duplicate copies of bill of lading and packing list for steelwork transported by sea, and  Duplicate copies of delivery note and a list showing the marking and weight of each component for steelwork transported by land.  (2) The particulars of expected arrival date and name of carrier shall be submitted to the Engineer at least 14 days before the due date. Other particulars shall be submitted to the Engineer within 3 days after delivery of the steelwork to the Site. |
| 16.3.4 | Particulars of method of erecting steelwork | (1) The following particulars of the proposed method of erecting steelwork shall be submitted to the Engineer:  Sequence and method of erection of steelwork,  Method of lifting and handling the components,  Method of preventing damage to protective coatings on steelwork during handling,  Procedure for aligning, levelling and plumbing steelwork, including temporary supports and method of making beddings for column bases, and  Sequence of casting concrete bonded to the steelwork.  (2) The particulars shall be submitted to the Engineer at least 6 weeks before erection of the steelwork starts. |
| 16.3.5 | Welder certificates | (1) Certificates endorsed by an inspecting authority approved by the Engineer shall be submitted to the Engineer to show that each welder has been approved in accordance with BS 4570, BS EN 287: Part 1 or BS 4872: Part 1 as appropriate. The extent of approval of the welder shall be appropriate to the categories of welds that he will carry out.  (2) The welder certificates shall be submitted at least 4 weeks before fabrication of the steelwork starts. |
| 16.3.6 | Particulars of welding procedures | (1) The following particulars of the proposed welding procedures shall be submitted to the Engineer:  Welding procedures in accordance with BS 5135, Clause 20 for each type and size of weld other than welds stated in Table 16.2,  Documentation endorsed by an inspecting authority approved by the Engineer to show that the welding procedure has complied with the procedure trial requirements stated in the Contract in previous tests, or that the welding procedure for steel castings complies with the exemption criteria stated in BS 4570, Clause 20.1.1, and  Records of approval tests as stated in Clause 16.4.7 if procedure trials are required under Clause 16.4.1  (2) The welding procedures for permanent welds shall be submitted to the Engineer at the same time as welder certificates are submitted. The welding procedures for temporary welds shall be submitted to the Engineer at the same time as welder certificates are submitted. |

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| Table 16.2: Welds for which submission of welding procedures is not required |

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| Weld Type | Weld Size |
| Fillet weld | Leg length not exceeding 4 mm |
| Butt weld | Thickness of the parts or, if the parts are  of different thicknesses, the thickness of the thinner part to be joined not exceeding 4 mm |

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| 16.3.7 | Particulars of stud welding, flame cutting and shearing procedures | (1) The following particulars of the proposed stud welding, flame cutting and shearing procedures for steelwork complying with BS 5400: Part 6 shall be submitted to the Engineer:  Procedures for stud welding, flame cutting and shearing processes complying with BS 5400: Part 6, Clause 4.3.3(a),(d) or (c),  Documentation endorsed by an inspecting authority approved by the Engineer to show that the stud welding, flame cutting or shearing procedure has complied with the procedure trial requirements stated in the Contract in previous tests, and  Report of procedure trials as stated in Clause 16.4.7 if procedure trials are required under Clause 16.4.1  (2) The particulars shall be submitted to the Engineer at least 6 weeks before fabrication of the steelwork starts. |
| 16.3.8 | Particulars of vent holes for galvanizing | Particulars of the method of plugging vent holes required for hot-dip galvanizing hollow or box sections shall be submitted to the Engineer at least 3 weeks before fabrication of the steelwork starts. |
| 16.3.9 | Particulars of method of non-destructive testing | Particulars of the proposed method for carrying out non-destructive testing on welds shall be submitted to the Engineer at least 4 weeks before the tests start. |
| 16.3.10 | Particulars of inspection authority and testing consultant | (1) The name of the proposed inspecting authority endorsing welder certificates and records of approval tests for welding procedures shall be submitted to the Engineer. The name shall be submitted at least 3 weeks before approval tests start or, if approval tests are not required, at the same time as the welder certificates are submitted.  (2) The name of the proposed testing consultant stated in Clause 16.13.1 shall be submitted to the Engineer at least 3 weeks before the testing consultant commences work. |
| 16.3.11 | Particulars of paint | (1) The following particulars of the proposed paints and associated products shall be submitted to the Engineer:  Name of manufacturer,  Duplicate copies of the manufacturer’s data sheets including temperature, humidity and other conditions at the workshop or on the Site under which the paint is to be applied, and  Manufacturer’s product specifications, product range and technical information,  (2) The particulars shall be submitted to the Engineer at least 6 weeks before the painting starts. |
| 16.3.12 | Samples of materials | (1) A sample of blast cleaned steel plate shall be submitted to the Engineer for approval at least 14 days before blast cleaning starts. The sample shall be 150 mm x 150 mm x 6 mm and shall be enclosed in a sealed, colourless, transparent wrapping. The grade of steel and the method of blasting shall be representative of those that will be used in the permanent work.  (2) Two samples of painted tin plates for each painting system shall be submitted to the Engineer at least 14 days before painting starts. Each plate shall be 150 mm x 75 mm x 1 mm and shall have smooth edges and 10 mm corner radii. The plates shall be brush cleaned and painted on one face with the painting system in such a manner that each coat is stepped back from the underlying coat in equal strips. The degree of gloss of the finishing coat shall be as agreed by the Engineer.  (3) Samples of each type of nut, bolt, washer, stud and rivet shall be provided within 3 days after the material is delivered to the Site. |
| **16.4** | **TRIALS** |  |
| 16.4.1 | Procedure trials for welding, flame cutting and shearing | (1) If in the opinion of the Engineer the proposed welding procedure submitted as stated in Clause 16.3.6 or the proposed stud welding, flame cutting or shearing procedure for steelwork complying with BS 5400: Part 6 submitted as stated in Clause 16.3.7 has not complied with the procedure trial requirements for the procedure stated in the Contract in previous tests, a procedure trial shall be carried out as stated in Clause 16.4.1  (2) Procedure trials for welding for structural steel shall comply with BS 5400: Part 6, Clauses 4.7.3, 5.4.1.1 and 5.4.1.2.  (3) Procedure trials for welding for steel castings shall comply with BS 5400: Part 6, Clauses 4.7.3 and 5.4.2.  (4) Procedure trials for welding of studs shall comply with BS 5400: Part 6, Clauses 4.7.4 and 5.4.4.  (5) Procedure trials for flame cutting and shearing shall comply with BS 5400: Part 6, Clauses 4.7.3 and 5.4.3.  (6) Welds for grade A steels complying with BS 4360 are not required to comply with the requirements for Charpy V-notch impact tests. The temperature of -20°C stated in BS 5400: Part 6, Clause 5.4.1.2(a)(3) shall be amended to 0°C.  (7) If in a welding procedure one or more of the parts to be welded is coated with a prefabrication primer or metal coating before welding, the same primer or coating shall be applied to the sample before the procedure trial for the welding procedure is carried out.  (8) The thickness of the sample of material to be used in procedure trials for flame cutting shall be:  20 mm for material not exceeding 20 mm thick,  40 mm for material exceeding 20 mm and not exceeding 40 mm thick, and  T mm for material exceeding (T-10) mm and not exceeding T mm thick, where T is any multiple of 10 from 50 up. |
| 16.4.2 | Inspection of procedure trials for welding, flame cutting and shearing | Procedure trials for welding, flame cutting and shearing shall be carried out in the presence of an inspecting authority approved by the Engineer. |
| 16.4.3 | Results of procedure trials for welding, flame cutting and shearing | If a procedure trial for welding, flame cutting or shearing does not comply with the specified requirements for the procedure trial, the cause of failure shall be established by the Contractor and particulars of proposed changes shall be submitted to the Engineer. Further procedure trials shall be carried out to establish the amended procedure unless otherwise permitted by the Engineer. |
| 16.4.4 | Approved procedures for welding, flame cutting and shearing | (1) A welding, flame cutting or shearing procedure that complies with the specified requirements for the procedure trial shall become an approved procedure.  (2) If a procedure trial is not required, the procedure for welding, flame cutting or shearing submitted as stated in Clauses 16.3.6 and 16.3.7 shall become an approved procedure. |
| 16.4.5 | Commencement of welding, flame cutting and shearing | Welding, flame cutting or shearing shall not commence until the procedure has been approved by the Engineer. |
| 16.4.6 | Changes in procedures for welding, flame cutting and shearing | Unless permitted by the Engineer, approved procedures for welding, flame cutting or shearing shall not be changed. Further procedure trials shall be carried out to demonstrate proposed changes to the procedure unless otherwise permitted by the Engineer. |
| 16.4.7 | Records of procedure trials for welding, flame cutting and shearing | (1) A record of the approval test for welding procedures shall be submitted to the Engineer for approval at least 3 weeks before fabrication of the steelwork starts. The record shall be in the form stated in BS 4870: Part 1, Appendix B or BS 4570, Appendix A as appropriate and shall be endorsed by the inspecting authority approved by the Engineer.  (2) Reports of procedure trials for stud welding, flame cutting and shearing shall be submitted to the Engineer at least 3 weeks before fabrication of the steelwork starts. |
| 16.4.8 | Painting trials | (1) A painting trial shall be carried out for each painting system that will be applied to areas exceeding 100 m2 to demonstrate that the proposed materials and methods of application will produce a painted surface that complies with the specified requirements.  (2) Painting trials shall be carried out at the place where painting to the permanent work will be carried out and using the employees and equipment which will be used to carry out painting to the permanent work.  (3) Painting trials shall be carried out on blast cleaned steel. |
| 16.4.9 | Results of painting trials | If the painted surface produced in a painting trial does not comply with the specified requirements for the paintwork, the cause of failure shall be established by the Contractor and particulars of proposed changes shall be submitted to the Engineer. Proposed changes to the paint formulation, other than an adjustment in the amount of thinners, shall be carried out at the paint manufacturer’s works before the final painting trial and before the first batch of paint is delivered. |
| 16.4.10 | Commencement of painting | Painting shall not commence until the painted surface produced in painting trials complies with the specified requirements for paintwork. |
| 16.4.11 | Changes in materials and methods of application for painting | Unless permitted by the Engineer, the materials and methods of application used in a painting trial that complies with the specified requirements shall not be changed. |
| **16.5** | **HANDLING, STORAGE AND TRANSPORT OF MATERIALS** |  |
| 16.5.1 | Handling and transport of steelwork | (1) Steelwork shall not be subject to rough handling, shock loading or dropping from a height.  (2) During handling and transport of coated steelwork, the steelwork shall be separated from wires and lashings by rubber padding in such a manner that the coatings are not damaged or discoloured. Free ends shall be stiffened, measures shall be taken to prevent permanent distortion and machined surfaces and faying surfaces shall be protected.  (3) Steelwork shall not be lifted from the painting bed until the last applied coating is sufficiently dry or cured for handling.  (4) Rivets, bolts, nuts, washers, screws and small plates and articles shall be packed in containers marked to identify the contents. |
| 16.5.2 | Storage of steelwork | (1) Steelwork shall be stored off the ground on level supports in well drained areas in a manner which will not result in damage or deformation to the steelwork or coatings or in contamination of the steelwork or coatings. Packings shall be placed between steelwork that is stacked.  (2) Covered places in which steelwork is stacked shall be ventilated.  (3) Different types and sizes of steelwork shall be stored separately.  (4) Steelwork shall not be stored on or adjacent to concrete surfaces that form part of the permanent work.  (5) Steelwork shall be protected from exposure to conditions that may affect the steelwork or coatings.  (6) Wet paint films, steelwork surfaces that are to be primed or overcoated and joint surfaces that are to be assembled shall be protected from exposure to conditions which may affect the film or surface. Undercoats which contain anatase titanium dioxide shall be protected from exposure to direct sunlight.  (7) Except as stated in Clause 16.5.2 steelwork shall be stored in an enclosed workshop and protected from conditions which may affect the steelwork after the steelwork has been cleaned as stated in Clause 16.7.1 until the following times:  When the second undercoat to painted steelwork has hard dried,  When the coating process to hot dip galvanized, electroplated or metal sprayed steelwork has been completed,  When the sealer to metal sprayed and sealed steelwork has been completely absorbed, and  When the first undercoat to metal sprayed and painted steelwork has hard dried.  (8) Primed steelwork surfaces may be exposed outside the enclosed workshop for a period not exceeding two weeks.  (9) Micaceous iron oxide undercoats to steelwork may be exposed outside the enclosed workshop for the minimum period necessary to move the steelwork from one part of the workshop to the other. The undercoat surfaces shall be covered when the steelwork is being moved. |
| 16.5.3 | Storage of paint | Paint and associated materials shall be stored in sealed containers marked as stated in Clause 16.2.13 and protected from exposure to conditions that may affect the material. The materials shall be stored in accordance with the manufacturers’ recommendations and shall not be used after the recommended expiry date has been exceeded. The materials shall be stored in a locked store. |
| **16.6** | **FABRICATION OF STEELWORK** |  |
| 16.6.1 | Fabrication of steelwork | Fabrication of steelwork shall comply with BS 5400: Part 6, Clauses 4.1 to 4.16 or BS 5950: Part 2, Sections 3 and 4 as appropriate except as stated in Clauses 16.6.3 to 16.6.11. |
| 16.6.2 | Reinstatement on zinc coating with post-galvanising welding | (1) Where post-galvanising welding is necessary, the zinc coating shall be ground off the mating surfaces directly before welding. Immediately after welding, the surface of the weld area shall be prepared by removal of slag with the chipping hammer followed by vigorous wire brushing. The zinc coating shall then be restored by either:  Application of the two coats of an organic zinc rich paint (zinc content at least 95%) to an overall dry film thickness greater than 100 µm. (ref. BS EN ISO 12944), or  Pre-heating to 315oC and application of proprietary metallic repair stick or powder to a thickness greater than 100 µm.  (2) If re-coating does not take place within 4 hours of welding, the weld areas shall be vacuum-grit blasted to BS EN ISO 8501 “first quality” and hot-zinc spray coated. Work shall be in accordance with BS EN 22063(1994) and to a minimum coating thickness of 100 µm.”  (3) After reinstatement of the zinc coating, a complete paint system as specified in Clause 16.7.10 shall be applied to the repaired area in such a manner that the new paint overlaps the existing coats by at least 50 mm all around the affected part. |
| 16.6.3 | Welding, heating and cutting | (1) Welding shall be carried out by welders who possess a valid welding certificate for the appropriate category of welding. A welder shall cease to carry out welding if any of the circumstances stated in BS 4570, Clause 21.1 or BS 4872: Part 1, Clause 6 as appropriate occurs, or the requirements stated in BS EN 287: Part 1, Clause 10.1 are not satisfied.  (2) Pre-setting, pre-bending, skip welding, back-step techniques and other measures shall be taken as necessary to counteract shrinkage or distortion due to welding, gouging, thermal cutting or heat treatment.  (3) Butt welds shall be complete penetration butt welds made between fusion faces.  (4) Butt welds in each component part shall be completed before the final assembly of built-up assemblies.  (5) Welding of austenitic stainless steel shall be carried out in accordance with BS 4677.  (6) Temporary welded attachments shall not be used unless permitted by the Engineer. Temporary welded attachments, when permitted, shall be removed by cutting with a flame torch 3 mm above the surface of the steel member when not required any longer. The excess metal protruding above the parent plate surface shall be removed by grinding and finished flush.  (7) Welding, heating or thermal cutting processes which give off toxic or irritant gases shall not be used unless permitted by the Engineer. If permitted, precautions, including the provision of exhaust ventilation, breathing apparatus and display of warning signs, shall be taken to enable the work to be carried out in safe conditions. Welding, heating or thermal cutting shall not be carried out within 2 m of lead-based, cadmium or carbonaceous coatings. |
| 16.6.4 | Length of bolts | The length of HSFG bolts shall comply with BS 4604: Part 1 or BS 4604: Part 2 as appropriate. The length of bolts complying with BS 3692, BS 4190 and BS 4933 shall be such that the end of the bolt will project above the nut by at least one thread, but by not more than one nominal bolt diameter, after tightening. |
| 16.6.5 | Length of threads | The length of threads on bolts shall be determined in accordance with BS 3692, BS 4190, BS 4395: Part 1, BS 4395: Part 2, BS 4395: Part 3 or BS 4933 as appropriate. If additional locknuts or other nuts are specified, the thread length shall be increased by one nominal bolt diameter for each additional nut. |
| 16.6.6 | Use of nuts | Nuts shall not be used with bolts or screws that comply with a different standard. |
| 16.6.7 | Use of washer | Washers for HSFG bolts shall be provided in accordance with BS 4604: Part 1 or BS 4604: Part 2 as appropriate. Washers shall be provided for bolts complying with BS 3692, BS 4190 and BS 4933 under the nut or bolt head, whichever is rotated during tightening, if the parts to be connected are to be coated with protective coatings before assembly. Washers shall be provided under the nuts and heads of bolts in oversized and slotted holes. |
| 16.6.8 | Tightening of bolts | Bolts shall be tightened in such a manner that the contact surfaces of permanent bolted joints are drawn into close contact. |
| 16.6.9 | Tightening of HSFG bolts | (1) The degree of preliminary tightening of bolts and nuts complying with BS 4395: Part 1, which is tightened by the part turn method, shall be torque controlled. The tightening equipment for preliminary tightening shall be calibrated with a bolt load meter. The value of bedding torque for the preliminary tightening shall be within 10% of the values stated in Table 16.3.  (2) Bolts and nuts at each joint with bolts or washers with load indicating devices shall be initially tightened to bring the faying surfaces into close contact over the full area. The range of the average gap after initial tightening shall be as agreed by the Engineer. The bolts and nuts shall be re-tightened if necessary to close the average gap back to the agreed range. After all bolts and nuts at the joint have been initially tightened, the bolts and nuts shall be finally tightened to attain the shank tension stated in BS 4604: Part 1 or BS 4604: Part 2 as appropriate. The range of average gap corresponding to the required shank tension shall be established for each batch as defined in BS 4395: Part 1, BS 4395: Part 2 or BS 4395: Part 3 as appropriate by testing at least three bolt, nut and washer assemblies in a bolt load meter and shall be as agreed by the Engineer. The average gap after final tightening shall be within the established range.  (3) The threads of nuts for HSFG bolts that are to be tightened by the part turn method or the load indicating method shall not be lubricated unless approved by the Engineer. If the use of lubricant is approved in the part turn method, the bedding torque shall be established by a bolt load meter and shall be as agreed by the Engineer. The lubricant shall be applied at the place of manufacture and shall only be applied to the nut threads. The bearing surfaces of the nuts and the faying surfaces shall not be contaminated with the lubricant.  (4) The bolt load meter for measuring bolt shank tension in the part turn, torque control or load indicating methods of tightening shall be calibrated by a laboratory approved by the Engineer before tightening of bolts and nuts starts and at regular intervals agreed by the Engineer. During re-calibration, a replacement calibrated bolt load meter shall be provided on the Site. Calibration results shall be submitted to the Engineer at least one week before the bolt load meter is used. |

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| Table 16.3: Bedding torque for HSFG bolts |

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| Nominal diameter of bolt  (mm) | Bedding torque (Nm) |
| 16 | 80 |
| 20 | 160 |
| 22 | 210 |
| 24 | 270 |
| 27 | 340 |
| 30 | 460 |

|  |  |  |
| --- | --- | --- |
| 16.6.10 | Defects in steelwork | Defective components for steelwork shall not be used in the permanent work unless repair of the defects is permitted by the Engineer If permitted, defective components shall be repaired by methods agreed by the Engineer. |
| 16.6.11 | Approval of fabricated steelwork | Fabricated steelwork shall not be:  Covered with protective coatings, concrete or other materials,  Erected, or  Despatched from the place of fabrication if fabricated off the Site  until the steelwork, including any repaired areas, complies with the specified test and inspection requirements and has been approved by the Engineer. |
| **16.7** | **PREPARATION OF STEELWORK SURFACES** |  |
| 16.7.1 | Cleaning of steelwork and coated surfaces | (1) Soil, concrete and other adherent matter shall be removed immediately from steelwork or coated surfaces and the surfaces shall be made good by methods agreed by the Engineer.  (2) Dust, soot, grit, detritus, metallic or other loose particles shall be removed by vacuuming after steelwork surfaces have been blast cleaned or before coated surfaces are washed or steam cleaned.  (3) Oil and grease shall be removed by emulsion cleaners, by steam cleaning or by high pressure water jets before removing rust and mill scale or overcoating. Oil and grease shall not be removed with turpentine or other solvents. If steam cleaning is used, steam cleaning shall be carried out after the greasy deposits have been removed by scraping and a detergent shall be added to the feed water of the steam generator.  (4) Salts, chemicals, corrosion or paint degradation products, including rust-spotting on blast cleaned surfaces and zinc salts on zinc coatings or zinc-rich paints, shall be removed by washing with detergent solution before coating steelwork surfaces or overcoating.  (5) The final shop coats on external surfaces shall be thoroughly washed with a detergent solution at the Site before being overcoated.  (6) Unless otherwise permitted by the Engineer finished coated surfaces shall be cleaned as stated in Clause 16.7.1 not more than 14 days before handover of the steelwork.  (7) Cleaning agents to be used shall be as agreed by the Engineer. Surfaces that have been cleaned using cleaning agents shall be rinsed with fresh water to remove all traces of the cleaning agent.  (8) Cleaning tools shall be of a type that will not result in damage to the surfaces being cleaned. Wire brushes and brooms shall not be used for cleaning coated surfaces. |
| 16.7.2 | Preparation of steelwork surfaces |  |
| 16.7.3 | Blast cleaning of steelwork | (1) Bare metal surfaces of steelwork which are to be painted or metal coated shall be treated before rust and mill scale are removed in accordance with the following requirements:  Burrs, arrises and serrations shall be smoothed by grinding or filing.  Weld spatter, weld slag and raised metal laminations shall be removed by grinding or chipping and the surface shall be made good.  (2) Rust and mill scale shall be removed from steelwork which is to be metal coated in factories by a pickling process which is compatible with the metal coating process.  (3) Rust and mill scale shall be removed from steelwork which is to be metal sprayed by blast cleaning carried out in accordance with BS 2569: Part 1, Clause 3.  (4) Rust and mill scale shall be removed from steelwork which is to be painted by blast cleaning as stated in Clause 16.7.3 unless the use of acid-pickling, mechanical cleaning or flame cleaning as stated in Clauses 16.7.5 to 16.7.7 has been approved by the Engineer.  (5) Excess acid or other chemicals used in the pickling process shall be removed from steelwork that has been prepared by pickling before the application of the metal coating. Pickling shall not be carried out for longer than is necessary to remove the rust and mill scale. |
| 16.7.4 | Blst cleaning of steelwork | (1) Blast cleaning of steelwork shall be carried out to second quality of surface finish in accordance with Sa 2½ in Swedish Standard SIS 05 59 00 using chilled iron abrasive.  (2) Chilled iron grit shall be graded in accordance with BS 2451. The maximum size of grit shall be G17 for use in automatic-impeller-type equipment and shall be G12 for manual or compressed air equipment. The difference in level between a peak and the adjacent trough of the blasted surface profile shall not exceed 0.1 mm.  (3) Non-metallic abrasives with a maximum particle size not exceeding 1 mm shall not be used other than with portable equipment.  (4) Abrasives shall not contain materials that may contaminate the steel surfaces. Sand containing salt or excessive amounts of silt shall not be used. Contaminants shall be removed from recovered abrasives before re-use.  (5) Blast cleaning shall be carried out in a fully enclosed space separated from the place of painting. The enclosed space shall be fitted with dust extractors and filters to prevent the dispersal of dust outside the enclosed space. |
| 16.7.5 | Acid-pickling of steelwork | Acid-picking of steelwork shall be carried out by the Footner process in accordance with BS 5493, Clause 14.3.2. The first priming coat of paint shall be applied as soon as the steel has dried and is still warm. |
| 16.7.6 | Mechanical cleaning of steelwork | Mechanical cleaning of steelwork shall be carried out using carborundum grinding discs or other power-driven tools followed by steel wire brushing and dusting to remove all loosened material which is not firmly bonded to the metal surface. Excessive burnishing of the metal through prolonged application of rotary wire brushes shall not be carried out. Visible peaks and ridges shall be removed. Pneumatic chipping hammers shall not be used. |
| 16.7.7 | Flame cleaning of steelwork | (1) Flame cleaning of steelwork shall not be carried out at the following locations:  Within 2 m of HSFG bolts, cold worked high tensile steel and surfaces already coated with paint or cadmium, lead-based or carbonaceous materials, and  On sections thinner than 0.5 mm.  (2) Flame cleaning shall be carried out without distorting the steelwork and without adversely affecting the properties of the steel. The temperature of the steel surface being flame cleaned shall not exceed 200°C.  (3) Loose materials shall be removed from the flame-cleaned surface by wire brushing followed by blowing dry air or vacuuming. The priming coat shall be applied when the surface temperature of the steel is between 35°C and 40°C. Surfaces with temperatures of less than 35°C shall be reheated. |
| 16.7.8 | Cleaning of bolts, nuts and washers | Bolts, nuts and washers for steelwork shall be kept free of dirt and deleterious material. Oil and grease on bolts, nuts and washers, other than approved lubricants for nuts of HSFG bolts, shall be removed before assembling and coating the exposed parts of assembled bolts, nuts and washers. |
| 16.7.9 | Approval of surface preparation | Surfaces shall not be coated until the cleaning and preparation of the surfaces have been approved by the Engineer. |
| 16.7.10 | Metal coatings to steelwork | (1) Metal coatings to steelwork shall be as stated in Clause 16.7.10  (2) Galvanized coatings shall be applied by hot-dip galvanizing in accordance with BS EN ISO 1461:1999. The coating thickness shall comply with BS EN ISO 1461:1999.  (3) Sherardized zinc coatings shall comply with BS 4921, Table 1, Class 1.  (4) Sprayed zinc and aluminium coatings shall comply with BS 2569: Part 1. The nominal coating thickness shall be 100 m. The sprayed metal shall be pre-treated with product CP1 and sealed with product CP3C in accordance with BS 5493.  (5) Electroplated zinc and cadmium coatings on threaded components with a diameter not exceeding 36 mm shall comply with BS 3382: Parts 1 and 2. The coating thickness shall be at least 5 µm.  (6) Metal coatings that will be overcoated with paint shall not be passivated.  (7) Allowance for the thickness of the metal coating shall be made in the sizes of the threads of metal coated threaded components. Nuts shall not be tapped oversize by more than 0.4 mm. Metal-coated HSFG bolts and nuts shall not be tapped oversize unless approved by the Engineer.  (8) Damaged areas of metal coatings shall be rubbed down to remove excessive roughness, cleaned and made good with a compatible coating of a type approved by the Engineer.  (9) Metal coatings required on part of a component shall be completed before the rest of the component is painted. |
| **16.8** | **PAINTING STEELWORK** |  |
| 16.8.1 | Painting systems for steelwork | (1) The painting system to be used for steelwork shall be one or more of the following systems as stated in the Contract, where DFT is the dry film thickness:  System A: - primer: 1 coat of high build zinc phosphate paint,  - undercoat: 2 coats of oil based with micaceous iron oxide phenolic paint,  - finish : 1 coat of alkyd resin paint,  - minimum total DFT : 250 µm  System B: - primer : 1 coat of epoxy resin with aluminium mastic  paint,  - undercoat : 1 coat of epoxy resin paint,  - finish : 1 coat of epoxy resin paint,  - minimum total DFT : 280 µm  System C: - primer : 1 coat of inorganic zinc silicate paint,  DFT 75 µm,  - undercoat : 2 coats of high build micaceous iron oxide  epoxy paint,  - finish : 1 coat of high build amine adduct cure epoxy  paint,  - minimum total DFT : 320 µm  System D: - primer : 1 coat of two pack wash primer, DFT 5 µm,  - undercoat : 1 coat of epoxy resin paint,  - finish : 1 coat of epoxy resin paint or 2 coats of  polyurethane paint,  - minimum total DFT : 180 µm  System E: - Inhibitor : Rustoleum or other rust inhibitor paint  approved by the Engineer,  - primer : zinc phosphate or, for hot-dip galvanized or  GI surface, ‘T’ wash as specified in BS 5493, Section  2, Clause 11.3.2,  - undercoat : 2 coats of micaceous iron oxide paint,  - finish : 1 coat of oil based paint or 1 coat of micaceous  iron oxide paint,  - DFT of each coat : as recommended by the  manufacturer  (2) The different types of paints within each painting system shall be compatible with each other and shall be manufactured by the same manufacturer. Successive coats in a painting system, including stripe coats, shall be in contrasting colours to aid identification. |
| 16.8.2 | Application of paint to steelwork | (1) Surfaces that are to be painted shall be dry immediately before paint is applied.  (2) Paint shall be taken from the paint store ready for application. Thinning, if necessary, shall be carried out in the paint store in the presence of the Engineer and using the type of thinner in the ratio stated in the manufacturer’s data sheets.  (3) Paint shall be applied by brush, by air pressure spray or by airless spray. Sealer and primers shall be applied by continuous spraying.  (4) Each coat in the paintwork system shall be sufficiently dry or cured before the next coat is applied. The time between the applications of successive coats shall be within the limits recommended by the manufacturer and the limits stated in Clause 16.8.4  (5) Paints having a pot life specified by the manufacturer, including two pack paints and moisture cured paints, shall be discarded on expiry of the pot life or at the end of each working day, whichever comes first. Other paints in opened containers shall be kept in sealed containers with not more than 10% ullage in store after each day’s work and shall not be thinned or mixed with fresh paint when re-issued for another day’s work. |
| 16.8.3 | Working conditions for painting | (1) Paint shall not be applied to steelwork under the following conditions:  When the ambient temperature falls below 4°C or the relative humidity rises above 90%,  For outdoor work, during periods of inclement weather including fog, frost, mist and rain or when condensation has occurred or is likely to occur on the metal,  When the surface temperature of the metal to be painted is less than 3°C above the dew point of the ambient air, and  When the amount of dust in the air or on the surface to be painted is in the opinion of the Engineer excessive.  (2) Two pack paints of the epoxide-resin type shall not be applied and cured when the temperature is below that recommended by the paint manufacturer. |
| 16.8.4 | Priming and overcoating time limits | (1) Blast cleaned steel shall be primed or metal coated within 4 hours after blast cleaning.  (2) Primed steel surfaces shall be overcoated within 8 weeks after priming.  (3) Second undercoats shall be applied within 72 hours after application of the first undercoat.  (4) Sealer or etch primer to sprayed metal shall be applied within 4 hours after spraying. The etch primed surfaces shall be overcoated within 72 hours after priming.  (5) Etch primer to galvanized steelwork shall be applied within 14 days after delivery of the steelwork to the Site. The etch primed surfaces shall be overcoated within 48 hours after priming.  (6) Overcoats to two pack paints of the epoxide- or polyurethane-type shall be applied within 48 hours after application of the two-pack paint. If it is not possible to overcoat within 48 hours, the two pack paint shall be abraded to produce a roughened surface and shall be given a flash coat of primer of a type approved by the Engineer. The primer shall be allowed to dry for at least 4 hours before application of the next coat of the system. |
| 16.8.5 | Stripe coats to steelwork | Immediately after the first undercoat of the painting system to steelwork has dried, a stripe coat of undercoat paint shall be applied by brush to edges, corners, crevices, exposed parts of bolts, nuts, rivets and welds. Another stripe coat of finishing paint shall be applied in the same manner after the last undercoat has dried. |
| 16.8.6 | Paint coats to steelwork | (1) The dry film thickness of the paint coats to steelwork shall be measured using a magnetic dry film thickness gauge or other apparatus approved by the Engineer. The total dry film thickness shall be measured at spacing of approximately 1.0 m. If the measured dry film thickness is less than 75% of the specified nominal dry film thicknesses or if more than 10% of the measured dry film thickness are less than 95% of the specified nominal dry film thickness, repair work shall be carried out as stated in Clause 16.8.8  (2) Wet film thickness gauges shall not be used as a means of determining whether the dry film thickness of the painting system complies with the specification.  (3) Each coat of paint shall be free of embedded foreign matter, mechanical damage and surface defects, including bittiness, blistering, brush marks, bubbling, cissing, cracking, cratering, dry spray, floating, pinholing, rivelling, runs, sagging, spotting and spray mottle as stated in BS 2015. The finished paintwork system shall have an even and uniform appearance.  (4) Each coat of paint shall adhere firmly to the substrate without blistering, chipping, flaking or peeling. |
| 16.8.7 | Etch primers and blast primers | Etch primers and blast primers shall not be applied on phosphated steel and shall not be overcoated with zinc-rich primers. |
| 16.8.8 | Repairs to damaged areas of paint | (1) Areas of paint to steelwork that have been damaged shall be cleaned to bare metal or to the metal coating. The edges of the undamaged paint shall be bevelled.  (2) The full specified painting system shall be restored in such a manner that each new paint coat overlaps the existing paint by at least 50 mm all round the affected part. |
| **16.9** | **PROTECTION OF JOINTS IN STEELWORK** |  |
| 16.9.1 | Protection of HSFG bolted joints | (1) The faying surfaces of HSFG bolted joints in steelwork that is metal sprayed overall and sealed or metal sprayed and painted overall shall be coated with the sprayed metal. The sealer on the parent material shall extend for a distance of between 10 mm and 20 mm inside the perimeter of the faying surfaces. Free surfaces and edges of the joint material shall be coated with the same sealer.  (2) The joint material and the faying surfaces on the parent material of steelwork which is metal sprayed only at joints and painted overall shall be metal sprayed. The sprayed metal on the parent material shall extend for a distance of between 10 mm and 20 mm outside the perimeter of the faying surfaces. The primer on the parent material shall extend for a distance of between 10 mm and 20 mm inside the perimeter of the faying surfaces. Sprayed metal on the free surfaces and edges of the joint material shall be coated with a sealer which is compatible with the painting system.  (3) The primer on the parent material of steelwork which is painted overall and uncoated at faying surfaces of HSFG bolted joints shall extend for a distance of between 10 mm and 20 mm inside the perimeter of the faying surfaces. |
| 16.9.2 | Protection of other shop-bolted joints | Blast primer for painted steelwork or sprayed metal plus sealer for metal sprayed steelwork shall be applied to the joint and parent material of shop-bolted joints other than HSFG bolted joints. Joints for painted steelwork shall be assembled after the first undercoat of the painting system has been applied to the contact surfaces and while the undercoat is still wet. |
| 16.9.3 | Protection of other site-bolted joints | Surfaces of the parent and joint material of site-bolted joints other than HSFG bolted joints shall be coated with the same protective system as the parent material. |
| 16.9.4 | Protection of welded joints | Welds and steelwork surfaces that have been affected by welding shall be coated with the same protective system as the parent material. |
| 16.9.5 | Joints made after coating the parent material | (1) Hot-dip galvanizing and electroplating to steelwork shall not be carried out until all welds for the steelwork that is to be galvanized or electroplated have been completed.  (2) Except as stated in Clause 16.9.5, sprayed metal on the parent material shall be kept at least 15 mm, but not more than 300 mm, clear of areas that are to be welded. The restricted area shall be masked during metal spraying.  (3) Except as stated in Clause 16.9.5, successive coats of paint on the parent material shall be stepped back at 30 mm intervals commencing at 100 mm from welded joints and at 10 mm from the perimeter of HSFG bolted joints.  (4) If the parent metal in the approved welding procedure is coated with the pre-fabrication primer or sprayed metal such coatings are permitted to cover the area to be welded. After welding the pre-fabrication primer or sprayed metal adjacent to the weld shall be made good.  (5) The parent material, joint material, exposed parts of bolts, nuts and washers, welds and weld affected areas shall be cleaned, prepared and brought up to the same protective system as the adjoining surfaces not more than 14 days after the joints have been made. |
| 16.9.6 | Sealing of joints in steelwork | (1) The different parts of joints in steelwork shall be dry immediately before the joints are assembled.  (2) Gaps around the perimeter of bolted joints and load indicator gaps of HSFG bolts in steelwork painted overall shall be sealed by brush application of the same painting system as the parent material. Gaps shall be plugged if necessary with soft solder wire without flux core as a backing before sealing with paint. |
| **16.10** | **PROTECTION OF SPECIAL SURFACES OFSTEELWORK** |  |
| 16.10.1 | Protection of hollow steel sections | The ends of hollow steel sections shall be sealed by welding mild-steel plates over the open ends. The plates shall be at least 5 mm thick. Immediately before hollow steel sections are sealed, bags of anhydrous silica gel shall be inserted in each void at the rate of 0.25 kg/m3 of void. |
| 16.10.2 | Protection of bearing surfaces for bridge bearings | Dirt, oil, grease, rust and mill scale shall be removed from the metal bearing surfaces for bridge bearings. The surfaces shall be masked with tape or other methods agreed by the Engineer and shall not be primed or painted until the bonding agent has been applied. |
| 16.10.3 | Protection of uncoated steelwork surfaces | The coated surfaces of steelwork coated over part of the surface shall be protected from rust that may form on the uncoated surfaces. Temporary coatings that may affect the bond between concrete and uncoated surfaces against which the concrete is to be placed shall be removed and the uncoated surfaces shall be cleaned before the concrete is placed. The full coating system shall extend 25 mm, or 75 mm for steel piles, into areas against which concrete is to be placed. |
| **16.11** | **ERECTION OF STEELWORK** |  |
| 16.11.1 | Temporary supports and fastenings to steelwork | (1) Steelwork shall be secured in position by temporary supports and fastenings until sufficient permanent connections are complete to withstand the loadings liable to be encountered during erection. The temporary supports and fastenings shall be capable of withstanding loadings that may be encountered during erection and shall not damage the steelwork or the protective coatings.  (2) Riveted and bolted connections shall be aligned using drifts complying with BS 5400: Part 6, Clause 4.12 and shall be temporarily fastened using service bolts. |
| 16.11.2 | Alignment of steelwork | (1) Steelwork shall be erected in such a manner that the alignment and levels of the steelwork comply with the tolerances stated in Clause 16.12.3. Allowance shall be made for the effects of temperature on the steelwork.  (2) Measures shall be taken to ensure that the steelwork will remain stable before temporary supports and fastenings are slackened or removed for lining, levelling, plumbing or other purposes. The temporary supports and fastenings shall be re-tightened or replaced as soon as the adjustments are complete and at the end of each continuous period of working.  (3) Permanent connections shall be made as soon as a sufficient portion of the steelwork has been lined, levelled and plumbed. Temporary supports and fastenings shall be replaced by permanent connections progressively and in such a manner that the parts connected are securely restrained in the aligned position at all times.  (4) Permanent connections for each portion of steelwork shall be completed not more than 14 days after the portion has been erected. |
| 16.11.3 | Foundation bolts for steelwork | 1) Foundation bolts for steelwork shall be held firmly in the set position during fixing. Measures shall be taken to ensure that the full movement tolerances are achieved and the bolts are not displaced during concreting. Bolts and nuts, including the threads, shall be protected against damage, corrosion and contamination.  (2) Bolt pockets shall be kept dry and clean. Tubes that are cast in concrete for grouting bolt pockets shall be securely fixed and sealed to prevent ingress of grout during concreting.  (3) Bolts in bolt pockets shall be installed in such a manner that the bolt can be moved inside the pocket as designed without hindrance. |
| 16.11.4 | Supporting devices for steelwork | The material, size, position and cover of packs, shims and other supporting devices for steelwork which are to be embedded shall be as approved by the Engineer. |
| 16.11.5 | Bedding and grouting of column bases | (1) Column bases for each portion of steelwork shall not be bedded or grouted until the portion has been lined, levelled, plumbed and permanently connected. Spaces below the steel shall be dry, clean and free of rust immediately before bedding or grouting.  (2) Proprietary types of grout shall be used in accordance with the manufacturer’s recommendations.  (3) Temporary timber wedges holding steel columns in position shall not project into pocket bases by more than one-third of the embedded length of the steel column. The pocket shall be initially concreted up to the underside of the wedges and the steel column shall be left undisturbed until 48 hours after concreting. The wedges shall then be removed and the remainder of the pocket shall be concreted. |
| **16.12** | **TOLERANCES** |  |
| 16.12.1 | Tolerances fabrication of steelwork | Fabrication tolerances for steelwork shall comply with BS 5400: Part 6, Clause 4.2 or BS 5950: Part 2, sub-section 7.2 as appropriate. |
| 16.12.2 | Tolerances: foundation bolts | The position of cast-in foundation bolts at the top of base plates shall be within 3 mm of the specified position. The position of foundation bolts in bolt pockets at the top of base plates shall be within 5 mm of the specified position. The line of bolts shall not be tilted from the specified line by more than 1 in 40. |
| 16.12.3 | Tolerances: erection of steelwork | (1) Steelwork shall be erected to within the tolerances stated in Clause 16.12.3 after lining, levelling, plumbing and making the permanent connections.  (2) The position in plan of vertical components at the base shall be within 10 mm of the specified position.  (3) The level of the top of base plates and the level of the lower end of vertical or raking components in a pocket base shall be within 10 mm of the specified level.  (4) The thickness of bedding shall be within one-third of the nominal thickness or 10 mm, whichever is less, of the specified nominal thickness.  (5) The line of vertical or raking components other than in portal frames shall be within 1 in 600 and within 10 mm of the specified line in every direction.  (6) The line of vertical or raking components in portal frames shall be within 1 in 600 and within 10 mm of the specified line normal to the plane of the frame.  (7) The position and level of components connected with other components shall be within 5 mm of the specified position and level relative to the other components at the point of connection.  (8) The position of components supported on a bearing shall be within 5 mm of the specified position relative to the bearing along both principal axes of the bearing.  (9) The difference in level between adjacent sloping or horizontal components connected by a deck slab shall be within 10 mm of the specified difference in level. |
| **16.13** | **TESTING CONSULTANT** |  |
| 16.13.1 | Testing consultant | Tests that are stated in the Contract to be carried out by an approved testing consultant shall be carried out by a testing consultant employed by the Contractor and approved by the Engineer. |
| **16.14** | **TESTING: TESTS ON STEELWORK AT MANUFACTURER’S WORKS** |  |
| 16.14.1 | Testing: tests on steelwork at manufacturer’s works | (1) Tests shall be carried out on structural steel in accordance with BS 5400: Part 6, Clauses 5.2.1, 5.2.2 and 5.3.  (2) Tests shall be carried out on bolts, nuts and washers in accordance with BS 3692, BS 4190, BS 4395: Part 1, BS 4395: Part 2, BS 4395: Part 3 or BS 4933 as appropriate. The tests shall be carried out on full size bolts. The rates of sampling and testing shall be in accordance with BS 4395: Part 1.  (3) The tests shall be carried out by the manufacturer at the manufacturer’s works on samples selected by the manufacturer. |
| **16.15** | **TESTING: STEELWORK** |  |
| 16.15.1 | Batch: steelwork | (1) A batch of steelwork is the amount of steelwork stated in the Contract and which is completed or delivered to the Site at any one time.  (2) The Contractor shall submit to the Engineer a list of the parts included in each batch at least 7 days before testing starts. |
| 16.15.2 | Samples: steelwork | (1) Samples to be tested shall be selected by the Engineer if testing is to be carried out in the Maldives and shall be selected by the approved testing consultant if testing is not to be carried out in the Maldives.  (2) Samples shall be selected from positions that in the opinion of the Engineer or approved testing consultant are representative of the batch as a whole.  (3) The Engineer shall inform the Contractor of the samples selected for testing at least 3 days before testing starts. |
| 16.15.3 | Testing: steelwork | (1) The relevant tests stated in Clauses 16.15.7 to 16.15.11 shall be carried out on each batch of steelwork.  (2) The Contractor shall inform the Engineer at least 7 days before tests are carried out. |
| 16.15.4 | Reports of tests on steelwork | (1) Records of tests on steelwork carried out by the Contractor or the approved testing consultant shall be kept by the Contractor and a report shall be submitted to the Engineer at least 7 days before approval of the batch of steelwork tested is required. The report shall contain the following details:  Procedure tested and exact test location in the steelwork,  Results of tests compared to the required values, with any non-complying results highlighted,  Any tearing, cracking or other defects, and  Conclusion as to the overall acceptability of the parts of steelwork examined by the approved testing consultant.  (2) Reports shall be certified by the Contractor’s authorised representative or by the approved testing consultant who carried out the tests. |
| 16.15.5 | Non-compliance: steelwork | (1) If the result of any test on steelwork stated in Clauses 16.15.7 to 16.15.11 does not comply with the specified requirements for the test, the test shall be carried out on additional samples from the batch. The number of additional tests shall be twice the number of original tests.  (2) The batch shall be considered as not complying with the specified requirements for the test if the result of any additional test does not comply with the s  (3) If the result of every additional test complies with the specified requirements for the test, only those parts the samples from which have failed in the original tests shall be considered as not complying with the specified requirements of the test. |
| 16.15.6 | Samples: steel | Samples of steel shall be provided from each batch of steel within 3 days after delivery of the batch to the fabricator’s works or to the Site. The rate of sampling and the position and direction of the samples shall be in accordance with BS 4360. |
| 16.15.7 | Testing: steel | (1) The tensile test and the impact test shall be carried out on each sample of steel. The method of testing shall be in accordance with BS 4360.  (2) Quality grading of structural steel shall be carried out on steel that has not been tested for quality grades by the manufacturer. Quality grading shall be carried out in accordance with BS 5400: Part 6, Clause 3.1.4 or BS 5950: Part 2, Clause 2.1.6 as appropriate.  (3) Testing and quality grading shall be carried out by the approved testing consultant. |
| 16.15.8 | Testing: welds | (1) Examination and testing of welds shall be carried out after post-weld heat treatment and before the application of corrosion protective coatings. De-burring, dressing, grinding, machining and peening shall be carried out after the visual inspection for cracks, surface pores and joint fit-up and before other inspections and tests are carried out.  (2) Destructive testing of welds for steelwork complying with BS 5400: Part 6 shall be carried out in accordance with BS 5400: Part 6, Clauses 5.5.1.1, 5.5.1.2 and 5.5.1.3.  (3) Welds for structural steel and steel castings shall be visually inspected in accordance with BS 5289. No-destructive testing shall be carried out on a proportion of welds after visual inspection. The compliance criteria and the proportion of welds to be tested are denoted by quality categories as stated in BS 5135, Table 18 for butt welds and in BS 5135, Table 19 for fillet welds. The quality categories of welds shall be as stated in Table 16.4.  (4) No-destructive testing of butt welds shall be carried out by ultrasonic examination in accordance with BS 3923: Part 1 or BS 3923: Part 2 or by radiographic examination in accordance with BS 2600: Part 1, BS 2600: Part 2 or BS 2910. No-destructive testing of fillet welds shall be carried out by either the liquid penetrant method in accordance with BS 6443 or the magnetic particle flaw detection method in accordance with BS 6072. The particular standard or part of standard to be used shall be appropriate for the joint geometry, material and production requirements and shall be as agreed by the Engineer. Welds shall be dressed to facilitate ultrasonic examinations.  (5) If the parent metal adjacent to a length of weld subject to non-destructive testing has been tested for laminations in accordance with BS 5996, the same areas on the parent metal shall be tested by ultrasonic examination in accordance with BS 3923: Part 1 or BS 3923: Part 2 as appropriate when no-destructive testing is carried out on that length of weld.  (6) Welds for steelwork that has been fabricated and tested by no-destructive testing at the fabricator’s works shall be visually inspected for cracks when the steelwork is delivered to the Site. 5% of the welds other than welds stated in Table 16.2 shall be examined for cracks by the magnetic particle flaw detection method in accordance with BS 6072.  (7) Testing shall be carried out by the approved testing consultant except as stated in Clause 16.15.8  (8) Inspection of welds will be carried out by the Engineer for welds stated in Table 16.2. |

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| Table 16.4: Quality categories of welds |

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| Type of welds | Steelwork Complying with BS 5400: Part 6 | | Steelwork Complying with BS 5950: Part 2 | |
| Butt Welds | Fillet Welds | Butt welds | Fillet welds |
| Welds stated in the Contract  for 100% non-destructive testing | A | A | A | A |
| Welds stated in Table 16.2 | D | D | D | D |
| Other welds | B | B | C | C |

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| 16.15.9 | | Testing: stud shear connectors and rivets | (1) Tests shall be carried out on 5% of welded stud shear connectors in accordance with BS 5400: Part 6, Clause 5.5.4.  (2) Tests shall be carried out on 5% of driven rivets in accordance with BS 5400: Part 6, Clause 5.8.  (3) Testing shall be carried out by the Contractor in the presence of the Engineer. | |
| 16.15.10 | | Testing: fabrication tolerance | (1) Rolled and built-up sections of steelwork complying with BS 5400: Part 6 shall be tested to determine compliance with fabrication tolerances in accordance with BS 5400: Part 6, Clauses 5.6.1 to 5.6.6.  (2) Testing shall be carried out by the Contractor in the presence of the Engineer. | |
| 16.15.11 | | Testing: repairs | Defects that have been repaired and adjoining areas that in the opinion of the Engineer may have been affected by the repair shall be retested as instructed by the Engineer. | |
| **17.** | | **SECTION 17 HANDRAILING, LADDERS, STAIRS AND FLOORING** |  | |
| **17.1** | | **GENERAL** |  | |
| 17.1.1 | | General requirements | The works and materials specified in Clauses 17.1.2 to 17.1.6 shall comply with the sections stated, unless otherwise stated in this Section. Hot dip galvanization shall comply with BS EN ISO 1461:1999. | |
| 17.1.2 | | Fencing | Fencing shall comply with Section 4. | |
| 17.1.3 | | Pedestrian guardrailing | Pedestrian guardrailing shall comply with Section 10. | |
| 17.1.4 | | Materials for grout | Materials for grout shall comply with Section 15. | |
| 17.1.5 | | Steelwork | Steelwork, including protective treatment, shall comply with Section 16. | |
| 17.1.6 | | Vehicular parapets | Vehicular parapets shall comply with Section 18. | |
| **17.2** | | **MATERIALS** |  | |
| 17.2.1 | | Steel | Steel for handrailing, ladders, stairs and flooring shall comply with the following:  Steel tubes and tubulars suitable  for screwing to BS 21 pipe threads : BS 1387  Hot rolled sections : BS 4: Part 1  Hot rolled structural steel sections  Equal and unequal angles : BS 4848: Part 4  Hollow sections : BS 4848: Part 2  Weldable structural steels : BS 4360. | |
| 17.2.2 | | Stainless steel | Stainless steel for handrailing, ladders, stairs and flooring shall be Grade 304 S 15 complying with BS 970: Part 1. Stainless steel tubes shall be longitudinally welded tubes complying with BS 6323: Part 8, designation LW 21 GZF(S). Tubes for handrails shall be polished. | |
| 17.2.3 | | Aluminium | (1) Aluminium for handrailing, ladders, stairs and flooring shall be of type H 30 TF and shall comply with the following:  Wrought aluminium and aluminium alloys for general engineering purposes  Plate, sheet and strip BS 1470  Drawn tube BS 1471  Bars, extruded round BS 1474 tubes and sections  (2) Aluminium shall be anodised to Grade AA 25 in accordance with BS 1615. | |
| 17.2.4 | | Bolts, nuts, screws, washers and rivets | (1) Bolts, nuts, screws, washers and rivets shall comply with the following:  ISO metric black hexagon  bolts, screws and nuts : BS 4190  ISO metric black cup and  countersunk headbolts and  screws with hexagon nuts : BS 4933  Metal washers for general  engineering purposes : BS 4320  Rivets for general engineering  purposes : BS 4620  Wrought aluminium and aluminium  alloys for general engineering purposes : BS 1473 - rivet, bolt and screw stock  Stainless steel fasteners : BS 6105  (2) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.  (3) Rag, indented bolts, expansion bolts and resin bonded bolts shall be of a proprietary type approved by the Engineer and shall be capable of withstanding the design working load.  (4) Hot dip galvanized bolts, nuts, screws, washers and rivets shall be used with hot dip galvanized handrailing, ladders, stairs and flooring. Aluminium bolts, nuts, screws, washers and rivets shall be used with aluminium handrailing, ladders, stairs and flooring. Stainless steel bolts, nuts, screws, washers and rivets shall be used with other types of handrailing, ladders, stairs and flooring. Bolts, nuts, screws and washers shall be insulated from aluminium by non-metallic washers and sleeves. | |
| 17.2.5 | | Cement mortar | (1) Mortar for grouting fixing bolts shall consist of 1 part of Portland cement to 3 parts of sand together with the minimum amount of water necessary to achieve a consistency suitable for completely filling the bolt holes. The mix shall contain a non-shrink admixture.  (2) Resin grout shall be of a proprietary type approved by the Engineer and shall contain a non-shrink admixture.  (3) Mortar for building in curbs for metal flooring shall consist of 1 part of cement to 3 parts of sand together with the minimum amount of water necessary to achieve a consistency suitable for the work. The mix shall contain a non-shrink admixture. | |
| **17.3** | | **DESIGNED BY CONTRACTOR** |  | |
| 17.3.1 | | Designed by Contractor | Handrailing, ladders, stairs and flooring which are to be designed by the Contractor shall comply with the following requirements:  Handrailing shall be capable of withstanding a horizontal loading of 740 N/m. The deflection of handrailing shall not exceed 1 in 200 at mid-span.  Stairs shall be designed for a live loading of 5 kPa.  Flooring shall be designed for a live loading of 5 kPa. deflection of flooring shall not exceed 1/200 of the span. | |
| **17.4** | | **FABRICATION OF HANDRAILING, LADDERS, STAIRS AND FLOORING** |  | |
| 17.4.1 | | Fabrication of steelwork | Steelwork for handrailing, ladders, stairs and flooring shall be fabricated in accordance with BS 5950: Part 2. | |
| 17.4.2 | | Galvanizing to steel | (1) All steel that is to be galvanized shall be hot dip galvanized in accordance with BS EN ISO 1461:1999.  (2) Galvanizing to steel shall be applied after welding, drilling and cutting are complete. | |
| 17.4.3 | | Welding steel | (1) Welds to steel for handrailing, ladders, stairs and flooring shall be full depth fillet welds. The welded surface shall be clean and flush before application of the protective coating.  (2) Steel shall not be welded after hot dip galvanizing unless permitted by the Engineer and if permitted, the welded areas shall be free from scale and slag and shall be treated with appropriate coating system approved by the Engineer, which is compatible with the protective system of the parent material. | |
| 17.4.4 | | Fabrication of handrailing | Handrailing shall be discontinued at movement joints in structures. The spacing between standards shall be regular and shall not exceed 1.6 m. Curved handrailing shall not be made up of a series of straights. | |
| 17.4.5 | | Fabrication of ladders | (1) Ladders shall comply with BS 4211  (2) Steel ladders shall be hot-dip galvanized.  (3) Aluminium ladders shall be Grade 6082 aluminium.  (4) Rungs, extended stringers, safety cages and brackets shall be welded to the stringers of ladders.  (5) Rungs on aluminium ladders shall have longitudinal grooves and pressed aluminium alloy caps shall be fixed to open ends. | |
| 17.4.6 | | Fabrication of stairs | Stairs shall comply with BS 5395: Part 1. | |
| 17.4.7 | | Fabrication of flooring | (1) The shape of each panel of flooring shall be such that the panel can be easily removed. The mass of each panel shall not exceed 40 kg. Where intermediate supports are provided to support flooring they shall be capable of being removed to provide the specified clear opening.  (2) Curbs shall be provided in concrete surfaces for flooring.  (3) Cut-outs in flooring shall be neatly shaped and shall be provided with toe plates. Cut-outs in open mesh flooring shall be trimmed with edge bars welded to the bearing bars. The clearance between the edge of cut-outs and the component passing through the cut-out shall not exceed 30 mm.  (4) The bearing bars in open mesh flooring shall be welded to the nosing bars. The transverse bars shall be rivetted or welded to the bearing bars. Panels of open mesh flooring shall be secured with adjustable fixing clips.  (5) Chequer plate flooring shall have a non-slip pattern of a type approved by the Engineer and shall be provided with lifting holes. The flooring shall be secured to curbs by countersunk screws. | |
| 17.4.8 | | Fabrication of toe plates | Toe plates shall be fixed to handrail standards by brackets and shall be bolted or welded to stairs and flooring. | |
| 17.4.9 | | Fabrication of safety chains | (1) Safety chains shall comply with BS 4942 and shall be capable of withstanding a breaking force of 30 kN and a proof force of 15 kN.  (2) Steel safety chains shall be 8 mm nominal size, Grade M4 non-calibrated chain Type 1 and shall be hot-dip galvanized.  (3) The links of stainless steel safety chains shall be welded and shall have an internal length exceeding 45 mm and an internal width of between 12 mm and 18 mm. Fins caused by welding shall be removed.  (4) Hot dip galvanized hooks on chains shall be fitted with a sprung securing device. | |
| **17.5** | | **SUBMISSIONS** |  | |
| 17.5.1 | | Particulars of handrailing, stairs, ladders and flooring | (1) The following particulars of the proposed handrailing, ladders, stairs and flooring shall be submitted to the Engineer:  Details of manufacturer's name and place of manufacture,  An original certificate bearing the chop of the manufacturer showing that the materials comply with the requirements stated in the Contract,  Drawings showing layout and details of handrailing, including positions of the different types of standards,  Drawings showing details of ladders, stairs, toe plates and safety chains,  Drawing showing layout and details of flooring, including positions and sizes of panels and supports,  Details of methods of fixing and of rag, indented, expansion and resin bonded bolts, including manufacturer's literature, and  Design details in accordance with Clause 17.3.1  (2) The particulars shall be submitted to the Engineer at least 14 days before fabrication starts. | |
| 17.5.2 | | Samples of materials | (1) The following samples of the proposed handrailing, ladders, stairs and flooring shall be submitted to the Engineer at least 14 days before the relevant work starts:  Handrails,  Standards,  Ladders, including rungs,  Toe plates,  Flooring and curbs,  Safety chains, and  Rag, indented, expansion and resin bonded bolts.  (2) The details of samples shall be as instructed by the Engineer. | |
| **17.6** | | **STORAGE OF MATERIALS** |  | |
| 17.6.1 | | Storage of handrailing, ladders, stairs and flooring | Handrailing and flooring shall be stored on level supports in a dry weatherproof store and in a manner that will not result in damage or deformation to the materials or in contamination of the materials. Handrailing, ladders, stairs and flooring shall be protected from damage and damaged handrailing, ladders, stairs and flooring shall not be used in the permanent work unless permitted by the Engineer. | |
| **17.7** | | **INSTALLATION OF HANDRAILING, LADDERS, STAIRS, AND FLOORING** |  | |
| 17.7.1 | | Installation of handrailing, ladders and stairs | (1) Handrailing shall be installed to a smooth alignment to the Engineer’s satisfaction.  (2) Handrail standards, flanges, ladders and stairs shall be bolted to metalwork and shall be fixed to concrete using rag, indented, expansion or resin bonded bolts. The bolts shall be fitted into pockets left in the concrete and the pockets shall be filled with cement mortar or resin grout. | |
| 17.7.2 | | Installation of flooring | (1) Flooring and curbs shall be flush with the adjoining surfaces.  (2) Curbs shall be fitted into rebates left in the concrete and the rebates shall be filled with cement mortar.  (3) Flooring shall be closely butted and the gap between panels and curbs, adjacent panels and other surfaces shall not exceed 10 mm. | |
| **17.8** | | **TOLERANCES** |  | |
| 17.8.1 | | Tolerances: handrailing, ladders, stairs and flooring | Handrailing, ladders, stairs and flooring shall comply with the following requirements:  The position and height of handrailing shall be within 10 mm of the specified position and height.  The level of the top rung of ladders and the top tread of stairs shall be within 75 mm of the specified level.  The level of flooring and curbs shall be within 3 mm of the specified level. | |
| **18.** | | **SECTION 18 BRIDGEWORKS** | **N/A** | |
| **19.** | | **SECTION 19 MARINE WORKS** | **N/A** | |
| **20.** | **SECTION 20 WATER SUPPLY PIPEWORKS** | | |  | |
| **20.1** | **GENERAL** | | |  | |
| 20.1.1 | General requirements | | | The works and materials specified in Clauses 20.1.2 to 20.1.5 shall comply with the sections stated, unless otherwise stated in this Section. | |
| 20.1.2 | Drainage works | | | Drainage works shall comply with Section 5. | |
| 20.1.3 | Earthworks | | | Earthworks shall comply with Section 6. | |
| 20.1.4 | Formwork | | | Formwork and finishes to concrete shall comply with Section 13. | |
| 20.1.5 | Concrete | | | Concrete shall comply with Section 15. | |
| **20.2** | **GLOSSARY OF TERMS** | | |  | |
| 20.2.1 | Fitting | | | Fitting is a component fitted to a pipe for jointing or connecting or for changing the direction or bore of a pipe. | |
| 20.2.2 | Flexible joint | | | Flexible joint is a connection between pipes and fittings that provides angular deflection or axial movement or a combination of both in service without impairing the efficiency of the connection. | |
| 20.2.3 | Mechanical joint | | | Mechanical joint is a flexible joint in which an elastomeric joint ring is located in the socket and the joint sealed by applying pressure to the joint ring by means of a gland bolted to the socket. | |
| 20.2.4 | Nominal size | | | Nominal size (DN) is a numerical designation of size, which is common to all components in a pipework system. The nominal size is stated as a convenient round number in millimetres and is related to, but not normally the same as, the actual internal diameter of the pipe works. “dn” designates the nominal size of tees and tapers that are less than DN. | |
| 20.2.5 | Push-in joint | | | Push-in joint is a flexible joint in which an elastomeric joint ring is located in the socket and the joint is effected by entering the spigot through the joint ring into the socket. | |
| 20.2.6 | Special fitting | | | Special fitting is a fitting that is made from a manipulated or fabricated pipe. | |
| 20.2.7 | Thi- walled pipe | | | Thin-walled pipe is a pipe, including pipes of DN 1200 or greater, which has a ratio of nominal size to wall thickness, excluding linings and coatings, exceeding 125. | |
| **20.3** | **MATERIALS** | | |  | |
| 20.3.1 | Materials for water supply pipe works | | | Materials for water supply pipe works for potable water shall be non-toxic, shall not promote microbial growth and shall not impart a taste, odour, cloudiness or discolouration to the water after disinfection and washing out of the pipelines as stated in Clause 20.21.1 | |
| 20.3.2 | Steel pipes and fittings | | | (1) Steel pipes and fittings shall comply with the following:  Steel pipes, joints and  specials for water and sewage : BS 534  Dimensions and masses per  unit length of welded and  seamless steel pipes and tubes  for pressure purposes : BS 3600  Steel pipes and tubes for pressure  purposes: carbon steel with specified  room temperature properties : BS 3601.  (2) Steel pipes and fittings shall be manufactured by the electric- resistance welded and induction-welded process or by the submerged- arc welded process. The tensile strength of the steel used shall be at least 410 N/mm2.  (3) Steel pipes, fittings and specials (including all flanges and blank flanges) shall be coated or lined internally and externally as stated in Table 20.1. Other requirements of using epoxy system shall be in accordance with existing national standards or similar  Gusseted steel bends and tees shall be fabricated in accordance with BS 534, BS 2633 and BS 4515 | |
| 20.3.3 | DI pipes and fittings | | | (1) DI pipes and fittings shall comply with BS 4772. Pipes and fittings other than collars, caps and blank flanges shall be lined internally with cement mortar in accordance with BS 4772, Clause 3.2. Linings shall be made with sulphate-resisting Portland cement complying with BS 4027.  (2) Pipes shall be externally coated with metallic zinc in accordance with BS 4772, Clause 3.1. Fittings shall be externally coated with zinc rich paint in accordance with BS 4772, Clause 3.1.5(b). After zinc coating pipes and fittings shall be externally coated with a finishing coat of one of the following materials as stated in BS 4772, Clause 3.3:  Bitumen based hot applied coating material complying with Clause 20.3.10 and BS 4147: Type I, Grade C, or  Bitumen based cold applied coating material complying with Clause 20.3.10 and BS 3416: Type II. | |

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| Table 20.1: Protection to steel pipes and fittings |

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| Protection | Description |
| Pipe External | A Fusion Bonded Epoxy system, complying with latest revision of ANSI/AWWA C213, manufactured under a quality system certified to ISO 9001, and factory applied by an applicator approved by the manufacturer, to a minimum dry film thickness of 400 microns.  OR  A chemically-cured Liquid Epoxy system, complying with the latest revision of ANSI/AWWA C210 manufactured under a quality system certified to ISO 9001, and factory applied by an applicator approved by the manufacturer, to a minimum dry film thickness of 400 microns. |
| AND  For pipes to be installed outdoor under direct sunlight, a topcoat of aliphatic polyurethane at 50 microns shall be applied for extra protection. |
| Pipe Internal | A Fusion Bonded Epoxy system, complying with latest revision of ANSI/AWWA C213, manufactured under a quality system certified to ISO 9001, and factory applied by an applicator approved by the manufacturer, to a minimum dry film thickness of 400 microns.  OR  A chemically-cured Liquid Epoxy system, complying with the latest revision of ANSI/AWWA C210 manufactured under a quality system certified to ISO 9001, and factory applied by an applicator approved by the manufacturer, to a minimum dry film thickness of 750 microns. |

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| 20.3.4 | uPVC pipes and fittings | uPVC pipes and fittings shall be Class D and shall comply with following:  uPVC pipe for cold water  services : BS 3505  Joints and fittings for use  with uPVC pressure pipes  injection moulded uPVC fittings  for solvent welding for use with  pressure pipes, including potable  water supply : BS 4346: Part 1  mechanical joints and fittings  principally of uPVC : BS 4346: Part 2  solvent cement : BS 4346: Part 3 |
| 20.3.5 | GI pipes and fittings | GI pipes and fittings shall comply with the following:  Steel tubes and tubulars  suitable for screwing to BS 21  Pipe threads : BS 1387, medium grade  Pipe threads for tubes  and fittings where pressure-tight joints are made on the threads : BS 21  Wrought steel pipe Fittings  (screwed BSP thread) : BS 1740: Part 1 |
| 20.3.6 | Flanges | (1) Steel flanges shall comply with BS 4504: Section 3.1, and shall be either steel plate for welding type or steel plate blank flange type. The dimensions and drilling of flanges shall comply with BS 4504: Section 3.1, Table 11, as appropriate regardless of the nominal pressure rating.  (2) Steel ring flanges shall be machined in the bore to a diameter of 4 mm ± 1 mm larger than the outside diameter of the pipe to which the flange is to be welded.  (3) Steel puddle flanges shall be separated into 180°segments.  (4) DI flanges shall be cast-on or welded-on standard flanges complying with BS 4772. |
| 20.3.7 | Bolts and nuts | (1) Bolts and nuts for flanged joints shall comply with BS 4504: Section 3.1, Section 6.  (2) Bolts and nuts shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint.  (3) Bolts shall be sufficiently long and shall be suitably threaded for jointing the relevant flanges. |
| 20.3.8 | Elastomeric joint rings | Elastomeric joint rings shall comply with BS 2494, type W (water). Elastomeric joint rings for DI pipes and fittings shall comply with BS 4772, Clause 2.3.4. The dimensions of rings for use with flanged joints shall comply with BS 4865: Part 1. The rings shall be compatible with the type of joint and, unless otherwise approved by the Engineer, shall be obtained from the same manufacturer as the joint. |
| 20.3.9 | Anticorrosion tape | (1) Anticorrosion tape shall be of a proprietary type approved by the Engineer. The tape shall either be a petrolatum tape with fabric reinforcement or a bituminous tape with PVC backing. Petrolatum tape shall be used for valves, flanged joints, slip-on type couplings and flange adaptors of all sizes. Bituminous tape shall be used in buried or non-exposed condition for welded joints of steel pipe, repair of steel pipe sheathing and other applications as specified on the Drawings.  (2) Anticorrosion tapes shall have a high resistance to cathodic disbondment, acids and alkalis. Colour of bituminous tape shall be black. Anticorrosion tapes shall have the minimum properties stated in Table 20.2.  (3) Primer and mastic filler for use with anticorrosion tape shall be compatible with the tape and shall be of a type recommended by the manufacturer of the tape and approved by the Engineer. Notwithstanding Clause 20.4.1, primer and mastic filler for use with anticorrosion tape shall be supplied by the Contractor.  (4) Bituminous tapes shall be stored in a cool dry place away from the sun's rays. No dirt or grits shall be allowed to stick on the edge of the tape before applying the tape for pipe protection.  (5) The following particulars of the proposed anticorrosion tape for water supply pipe works shall be submitted to the Engineer:  Manufacturer’s literature for anticorrosion tape, and  Certificate for anticorrosion tape showing the manufacturer's name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests in accordance with the Contract.  (6) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |

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| Table 20.2: Properties of anticorrosion tape |

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| Properties | | | Petrolatum tape | Bituminous tape |
| Thickness of PVC backing (mm) | | | - | 0.75 |
| Total thickness (mm) | | | 1.1 | 1.65 |
| Mass (kg/m2) | | | 1.4 | 2.0 |
| Tensile strength (N/mm) | | | 4 | 10 |
| Adhesion strength (180 0  peel) (N/mm) | Self | | N/A | 2.5 |
| Steel | | N/A | 2.5 |
| Tacky adhesion strength (N/mm) | Self | | 0.5 | N/A |
| Steel | | 0.5 | N/A |
| Dielectric strength (2 layers) (kV) | | | 15 | 30 |
| Elongation (at break) (%) | | | - | 260 |
| Temperature range(0C) | | Wrapping | -5 to +45 | +5 to +50 |
| In service | -5 to +45 | -20 to +75 |

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| 20.3.10 | Bituminous coatings | (1) Bituminous coatings shall comply with the following:  Bitumen-based hot applied  coating material for protecting  iron and steel including suitable primers  where required : BS 4147, Type I, Grade C  Black bitumen coating solutions  for cold application : BS 3416, Type II.  (2) Bituminous coatings used for repairing joints and coatings shall be compatible with the adjacent coating.  (3) Bituminous coatings shall be made from petroleum or asphaltic bitumen. |
| 20.3.11 | Whitewash | Whitewash shall comply with AWWA C 203. |
| 20.3.12 | Zinc-based paint | (1) Zinc-based paint shall be a proprietary type approved by the Engineer.  (2) Primers for zinc-based paint shall comply with BS 4652.  (3) Rust inhibitor shall be a chemical agent that is capable of converting rust into iron phosphate. |
| 20.3.13 | Joint filler and  compressible padding | (1) Joint filler for joints in concrete bed, haunch and surround shall be of a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler.  The thickness of the filler shall be as stated in Table 20.3.  (2) Compressible padding between pipes and supports shall be bitumen damp-proof sheeting complying with BS 743. |

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| Table 20.3: Joint filler for concrete bed, haunch and surround |

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| --- | --- |
| Nominal diameter of pipe | Thickness of joint filler (mm) |
| less than 450 mm | 18 |
| 450 mm - 1200 mm | 36 |
| exceeding 1200 mm | 54 |

|  |  |  |
| --- | --- | --- |
| 20.3.14 | Polyethylene sheeting | Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm. |
| 20.3.15 | Extension keys | Extension keys, clamps and its associated bolts, nuts and washers for valves shall be Grade 316 stainless steel complying with BS 970: Part 1. |
| **20.4** | **MATERIALS PROVIDED AND EQUIPMENT LOANED BY THE EMPLOYER** |  |
| 20.4.1 | Materials provided by the Employer | (1) The following materials for water supply pipe works included in Contracts entered into with Water Supplies Department will be provided by the Employer and shall be used in the permanent works:  Full, half and quarter length pipes with plain, flanged and spigot and socket ends,  Ring flanges, puddle flanges, slip-on type couplings, flange adapters, collars, expansion joints, detachable joints, elastomeric joint rings, nuts and bolts,  Blank flanges and caps other than those required for pressure tests,  Bends, tees and tapers,  Steel pipes for the fabrication of gusseted steel bends and tees,  Primer, bitumen based composition and woven glass cloth for repairs to joints in steel pipes with bitumen coating provided by the Employer other than materials for protection of steel flanged joints, slip-on type couplings and flange adapters, and  Gate valves, air relief valves, butterfly valves and non-return valves, including all winding gear, operating motors and control equipment.  (2) The materials shall be obtained from the locations and at the times stated in the Contract.  (3) Water and sterilising chemicals for cleaning, sterilising and testing pipelines as stated in Clauses 20.21.1 and 20.27.1 will be provided by the Employer for one set of tests. The water and sterilising chemicals shall be obtained from the locations stated in the Contract or from other locations agreed by the Engineer and shall be mixed by the Contractor. |
| 20.4.2 | Equipment loaned by the Employer | The continuous pressure recorder and purpose made charts for pressure tests on pipelines for water supply pipe works as stated in existing national standards or similar will be loaned by the Employer. |
| **20.5** | **INSPECTION OF MANUFACTURE** |  |
| 20.5.1 | Inspection of manufacture and testing | (1) The manufacture and testing of pipes, joints, fitting and valves for water supply pipe works other than materials provided by the Employer shall be inspected by an independent inspection authority approved by the Engineer.  (2) The inspections shall be carried out at the manufacturer’s works or at other locations stated in the Contract or instructed by the Engineer. The facilities and equipment required for inspections shall be provided by the Contractor. |
| **20.6** | **SUBMISSIONS** |  |
| 20.6.1 | Particulars of independent inspection authority | Particulars of the proposed independent inspection authority for pipes, joints, fittings and valves for water supply pipe works, including name and address, previous experience, and names of inspectors, shall be submitted to the Engineer at least 28 days before manufacture of the materials starts. |
| 20.6.2 | Particulars of pipes, joints and fittings | (1) The following particulars of the proposed pipes, joints and fittings for water supply pipe works shall be submitted to the Engineer:  Manufacturer’s literature, including details of:  Manufacturing process  Pressure and temperature ratings  Permissible values of straight draws and angular deflection of flexible joints  Recommendations for handling, storage, laying, jointing and repair  Drilling and tapping equipment for connections to pipes,  A certificate for each material showing the manufacturer’s name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract and including results of tests required in accordance with the relevant British Standard,  Three copies of drawings showing details of the pipes, joints and fittings, including the materials used and the mass of each item, and  A certificate of inspection of the manufacture and testing signed by the approved independent inspection authority.  (2) The particulars, including certificates other than certificates of inspection, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 20.6.3 | Particulars of welding | (1) The following particulars of the proposed materials and methods of construction for welding joints in steel pipes for water supply pipe works shall be submitted to the Engineer:  Details of welders, including names, copies of Identity Cards and details of previous experience,  Details of format of records,  Details of welding procedures, including welding plant, method of welding, materials, manufacturer and size of electrodes, number of runs and current strength,  Procedures for nitrogen gas tests on joints, and  Valid certificate of competency in accordance with BS 2633, Clause 11 for each welder, issued by an authority approved by the Engineer.  (2) The particulars shall be submitted to the Engineer at least 14 days before welding starts. |
| 20.6.4 | Particulars of pressure tests | (1) The following particulars of the proposed procedures for pressure tests on pipelines for water supply pipe works shall be submitted to the Engineer:  Test equipment and method of setting up the equipment,  Calibration certificates for pressure gauges,  Procedure for carrying out the test, and  Programme for testing.  (2) The particulars shall be submitted to the Engineer at least 14 days before the test starts. |
| **20.7** | **TRIALS** |  |
| 20.7.1 | Welding trials | (1) Unless otherwise permitted by the Engineer, trials shall be carried out to demonstrate the competency of each proposed welder who will be employed to weld joints in steel pipes for water supply pipe works.  (2) Trials shall be carried out at least 7 days before welding starts.  (3) The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out welding trials.  (4) The trials shall be carried out using the welding procedures submitted to the Engineer.  (5) Trials shall be carried out under similar conditions as those that will be encountered on the Site. Each trial shall consist of fillet welding two steel plates using at least two electrodes to complete one run of weld. The thickness of the steel plates shall be the same as the thickness of the steel pipe that will be welded.  (6) A 150 mm length of the plate that contains what in the opinion of the Engineer is the worst welding shall be cut from the steel plates and broken in a vice.  (7) The Engineer shall determine the competency or otherwise of each welder on the basis of the results of the welding trials. |
| 20.7.2 | Pipe jointing trials | (1) Trials shall be carried out to demonstrate that the pipes, joints and fittings for water supply pipe works fit correctly.  (2) The trials shall be carried out at least 6 weeks, or such shorter period agreed by the Engineer, before the materials are to be incorporated in the permanent work.  (3) The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by Engineer, before carrying out trials.  (4) The Contractor shall immediately inform the Engineer of any pipes, joints or fittings which do not fit correctly. Modifications shall be made to pipes, joints and fittings that do not fit correctly or replacements shall be provided as instructed by the Engineer. |
| 20.7.3 | Trials for drilling and tapping | (1) Trials shall be carried out to demonstrate that the proposed equipment and methods of drilling and tapping pipes for water supply pipe works will produce connections that comply with the specified requirements.  (2) The trials shall be carried out at least 14 days before drilling and tapping starts.  (3) The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before carrying out trials. |
| **20.8** | **TRANSPORT, HANDLING, AND STORAGE OF MATERIALS** |  |
| 20.8.1 | Transport, handling and storage of pipes, joints and fittings | (1) Pipes, joints and fittings for water supply pipe works shall be transported, handled and stored in accordance with the manufacturers’ recommendations and in a manner, which will not result in damage or deformation to the pipes, joints and fittings, or in contamination of the pipes, joints and fittings.  (2) Pipes, joints and fittings shall be protected from damage and damaged pipes, joints and fittings shall not be used in the permanent work unless permitted by the Engineer. Pipes, joints and fittings shall be securely packed and supported to prevent movement when being transported.  (3) uPVC pipes, joints and fittings shall be protected from exposure to conditions which may affect the material.  (4) Bolts and nuts shall be packed in sealed metal containers.  (5) Elastomeric joint rings shall be packed in bags and lubricant for joints shall be stored in sealed containers marked to identify the contents. The rings and lubricant shall be protected from exposure to conditions that may affect the material.  (6) Boxed or crated materials or those in sealed containers shall remain in their original boxes, crates or containers. |
| 20.8.2 | Handling of pipes and fittings | (1) Pipes and fittings other than thin walled pipes shall be handled by manual methods or by using lifting appliances or chains, wire rope or canvas slings of a type recommended by the pipe manufacturer and agreed by the Engineer. Hooks shall not be used.  (2) Slings shall be placed around the pipes and fittings and padding shall be provided at points of contact between pipes and fittings and metal lifting appliances or slings. Pipes and fittings shall not be handled by means of metal slings passed through the pipes.  (3) Pipes and fittings shall not be subjected to rough handling, shock loading or dropping and shall not be rolled down ramps unless permitted by the Engineer. If permitted, the ramps shall be padded. |
| 20.8.3 | Storage of pipes | (1) Pipes other than thin walled pipes shall be stored horizontally at least 75 mm above the ground on wedged timber bearers. The bottom layers and the outer pipes in each layer shall be securely wedged to prevent sideways movement.  (2) Socket and spigot pipes shall be stored with the sockets alternating and in such a manner that loads are not applied to the sockets.  (3) The height of stacks of pipes other than thin walled pipes shall not exceed 2 m unless recommended by the manufacturer and permitted by the Engineer.  (4) Pipes shall not be strung out along the route of the pipeline unless permitted by the Engineer. |
| 20.8.4 | Transport of thin walled pipes | When being transported, thin-walled pipes shall be supported on three rubber-covered saddles shaped such that the pipes are supported over at least one-quarter of the circumference. The pipes shall be securely fixed in position at each saddle by straps tightened by turnbuckles. One saddle shall be placed at the mid-point of the length of the pipe and the other two saddles shall be placed at distances of one-fifth of the length of the pipe from each end of the pipe. |
| 20.8.5 | Handling and storage of thin walled pipes | (1) When being handled and stored, thin walled pipes shall be protected from deformation by means of at least two screw jack cruciform struts with rubber-padded ends shaped to fit the circumference of the pipes. The struts shall be fitted inside the pipes. Any temporary struts fixed by the manufacturer shall be left in position until the cruciform struts have been fixed.  (2) Thin-walled pipes shall be handled by using two reinforced canvas slings at least 300 mm wide. The slings shall be suspended from a lifting beam and shall be placed at a distance of one-fifth of the length of the pipe from each end of the pipe.  (3) Thin-walled pipes shall not be rolled.  (4) Thin-walled pipes shall be stored on timber bearers padded with hessian or straw to provide continuous support over at least one-third of the circumference of the pipe. The pipes shall be securely fixed in position with wedges placed at a distance of one-fifth of the length of the pipe from each end of the pipe.  (5) Thin-walled pipes shall not be stacked on top of each other. |
| 20.8.6 | Storage of valves | Valves, including power operated valves and associated electrical and control equipment, shall be stored in accordance with the manufacturer’s recommendations in a weatherproof store. |
| **20.9** | **ACCESS TO PIPELINES** |  |
| 20.9.1 | Access to pipelines | (1) Rubber wheeled trolleys shall be provided to obtain access inside pipelines exceeding DN 500 for water supply pipework in order to joint pipes, repair joints, coatings and linings and inspect the pipeline. Persons entering pipelines shall wear clean soft-soled footwear.  (2) Mechanical fans shall be provided to ensure that an adequate air supply is available to those entering pipelines for inspection. Engine driven fans shall be fitted with a flexible exhaust or other methods of keeping exhaust fumes clear of the fresh air intake. |
| **20.10** | **SETTING OUT OF PIPELINES** |  |
| 20.10.1 | Setting out of pipelines | (1) Both horizontal and vertical alignment shown on the Drawings are indicative only. The exact alignment shall be determined by the Engineer on site in accordance with the procedure set out in this Clause.  (2) Three weeks before commencing trench excavation of a section of pipeline, the Contractor shall set out on site such section of pipeline based on the indicative information given on the Drawings and shall proceed to conduct the underground utilities survey. When this has been carried out, the Contractor shall prepare his proposal of inspection pits excavation and submit the same to the Engineer for agreement two weeks before commencing trench excavation all in accordance with Clause 1.7.2. The agreed inspection pits excavation shall be completed within one week to provide the remaining one week as float time for the Engineer to inspect and, if found necessary, adjust the indicative alignment to suit topography and obstruction in accordance with sub-clause (3) of this Clause.  (3) The Engineer may order excavation of inspection pits after initial setting out or after the completion of the excavation of inspection pits proposed by the Contractor at locations that may deviate from the proposed indicative alignment to ascertain the final alignment. The inspection pits so ordered shall be payable under the Bills of Quantities. The Contractor shall exercise his best endeavour to complete such inspection pits excavation before the scheduled commencement date for trench excavation.  (4) The method of setting out shall be a centre line peg with suitable offset at every change in horizontal alignment and a slight rail mounted on two posts at 30m maximum or at every change in vertical alignment or any other appropriate methods agreed by the Engineer.  (5) Following the setting out and adjustments, if any, the existing ground levels shall be recorded and agreed.  (6) The chainages shown on the Drawings for main laying works are nominal only and should only be used as a means of reference. The measured distance between the chainages assigned to any two points will not necessarily be that given by the difference in those chainages. |
| **20.11** | **LAYING AND BEDDING PIPES** |  |
| 20.11.1 | Laying pipes | (1) The Engineer shall be allowed to inspect trenches, bedding, pipes, joints, fittings and valves before pipe laying for water supply pipe works starts. The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before pipe laying starts in any part of the permanent work.  (2) The permission of the Engineer shall be obtained before pipe laying starts in any part of the permanent work.  (3) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after pipe laying. Valves shall be inspected to ensure that they are in working order and are capable of being fully opened and closed. Deleterious material shall be removed and damage shall be repaired immediately before and after pipe laying. Potable water shall be used for washing.  (4) The inside of pipelines shall be kept clean and free from water, dirt, stones, debris and deleterious material. Except when pipes are being jointed, the open ends of pipelines shall be sealed with a wooden plug or stopper or by other methods agreed by the Engineer.  (5) Measures shall be taken to prevent flotation of pipes.  (6) Pipe laying shall follow closely on excavation of the trench. Lengths of trench, which in the opinion of the Engineer are excessive, shall not be left open.  (7) Unless otherwise permitted by the Engineer, pipelines with a gradient steeper than 1 in 20 shall be laid in an uphill direction with sockets facing uphill.  (8) Pipes shall be laid in such a manner that water will not pond in locations with zero and shallow gradients and such that the line and level of pipes will comply with the specified tolerances. |
| 20.11.2 | Laying steel pipes | Steel pipes with welded joints for water supply pipe works shall be spot welded to the adjacent pipe to which they will be jointed immediately after laying. Steel pipes manufactured with longitudinal or spiral welds shall be aligned in such a manner that the welds are staggered from pipe to pipe by at least 15° of arc. |
| 20.11.3 | Laying pipes with flexible joints | The degree of the curve of pipes for water supply pipe works with flexible joints, which are to be laid to a curve, shall be equally distributed over all joints within the curved section. The deflection at a completed joint shall not exceed 3° or three-quarters of the maximum deflection recommended by the manufacturer whichever is less. |
| 20.11.4 | Installation of valves | (1) Operating gear and associated fittings shall be installed and fixed at the same time as valves for water supply pipe works are installed. After installation, valves shall be cleaned inside and outside and left in a closed position.  (2) Extension keys and clamps shall be fixed to valves in valve chambers if the vertical distance between the top of the valve spindle and the finished ground level exceeds 600 mm. The length of extension keys shall be such that the top of the extension key is not more than 300 mm below the finished ground level. |
| 20.11.5 | Bedding pipes | (1) Surfaces on which pipes for water supply pipe works will be laid shall be cleaned and objects that may damage the pipes shall be removed before pipes are laid.  (2) The bottom of trenches on which pipes will be laid directly shall be shaped to support the pipes uniformly along the length of the barrel. Holes shall be dug to prevent pipes resting on the sockets and to allow the pipes to be jointed. |
| **20.12** | **CUTTING AND DRILLING PIPES** |  |
| 20.12.1 | Cutting pipes | (1) Pipes for water supply pipe works shall be cut and the ends shall be prepared in accordance with the manufacturer’s recommendations. Purpose-made equipment recommended by the manufacturer and agreed by the Engineer shall be used for cutting the pipes.  (2) Cut ends of pipes shall be square and even, without damage to the pipe or coating. Cut ends, including cut ends of the piece not immediately required, shall be trimmed and chamfered to suit the type of joint and in such a manner that elastomeric joint rings will not be damaged by the cut end.  (3) Pipes requiring to be cut to form closing lengths shall not be cut until adjacent pipes have been laid and jointed and the length to be cut can be accurately measured.  (4) The permission of the Engineer shall be obtained before pipes provided by the Employer are cut. Only those pipes, which in the opinion of the Engineer are suitable for cutting on Site, shall be cut. All off-cuts shall be used for the permanent work unless in the opinion of the Engineer this is not practicable. |
| 20.12.2 | Drilling pipes | (1) Pipes for water supply pipe works shall be drilled for small diameter connections using purpose made drilling and tapping equipment.  (2) The threads of screw joints shall be painted before assembly with two coats of bituminous paint and shall be wrapped with three turns of spun yarn or other material approved by the Engineer. |
| **20.13** | **JOINTING PIPES** |  |
| 20.13.1 | Jointing pipes | (1) Pipes for water supply pipe works shall be jointed in accordance with the manufacturer’s recommendations and using jointing equipment and jointing materials recommended by the manufacturer and agreed by the Engineer.  (2) The Contractor shall inspect pipes, joints, fittings and valves, including internal and external coatings, immediately before and after jointing. Deleterious material shall be removed and damage shall be repaired immediately before and after jointing. Potable water shall be used for washing. Surfaces that are to be jointed and jointing materials shall be cleaned immediately before jointing.  (3) All joints in pipelines shall be watertight.  (4) The widths of gaps at joints shall be in accordance with the manufacturer’s recommendations and shall be achieved by marking the outside of the pipe, by using metal feelers or by other methods agreed by the Engineer. The position of elastomeric joint rings shall be checked by using metal feelers after jointing.  (5) Gaps at joints in pipes shall be protected after jointing by methods agreed by the Engineer to prevent dirt, stones or other material entering the joint.  (6) Bolts holes in flanged joints and joints incorporating bolted components shall be correctly orientated before the bolts are tightened. The correct size of bolts and nuts shall be used. Bolt threads shall be lubricated and bolts shall be tightened using the correct size of spanner. Bolts shall be tightened in diametrically opposite pairs working around the bolt circle until all bolts are tightened to the torque recommended by the manufacturer.  (7) Bolt holes in flanged joints shall be orientated symmetrically about the vertical diameter with no bolt-holes on the vertical diameter. Elastomeric joint rings shall be the correct size and shall not protrude into the bore of the pipe. The rings may be temporarily fixed to the face of the flange using a minimum amount of adhesive of a type recommended by the manufacturer. Jointing compound or paste shall not be used. |
| 20.13.2 | DI pipes with push-in joints | DI pipes with push-in joints for water supply pipe works shall be jointed by smearing the spigot end of the pipe with lubricant and placing the elastomeric joint ring in position inside the groove of the socket end of the laid pipe. The spigot end of the pipe shall be placed in the socket end of the laid pipe and pushed home. |
| 20.13.3 | DI pipes with mechanical joints | (1) DI pipes with mechanical joints for water supply pipe works shall be jointed as stated in Clauses 20.13.3  (2) The elastomeric joint ring and the ends of the pipe shall be smeared with lubricant over a distance recommended by the manufacturer.  (3) The gland and the elastomeric joint ring shall be placed in position on the spigot end of the pipe.  (4) The spigot end of the pipe shall be placed in the socket end of the laid pipe before the bolts are tightened. |
| 20.13.4 | Welding joints in steel pipes | (1) Welding of joints in steel pipes for water supply pipe works shall be carried out by the metal-arc process in accordance with BS 2633 and BS 4515.  (2) Butt welding shall not be used for jointing plain-ended pipes other than for gusseted bends unless approved by the Engineer. If approved, the ends of the pipes shall be prepared in accordance with BS 534 and BS 2633 and welding shall be carried out in accordance with BS 4515.  (3) Records of welding operations shall be kept by the Contractor on the Site and shall be available for inspection by the Engineer at all times. Records shall contain the following details:  Date,  Names of welders,  Location of welding operation, and  Electrodes used in making each weld. |
| 20.13.5 | Steel pipes with spigot and socket joints | (1) Steel pipes with spigot and socket joints for water supply pipe works shall be jointed as stated in Clause 20.13.5.  (2) Pipes not exceeding DN 700 shall be welded externally. Pipes exceeding DN 700 shall be welded internally and shall then be welded externally with a sealing weld.  (3) Loose scale, slag, rust, paint and other deleterious material shall be removed from parts of pipes to be welded by wire brushing or by other methods agreed by the Engineer. The parts shall be kept clean and dry before welding.  (4) A double-run convex fillet weld shall be used for pipes not exceeding DN 900 and a triple-run convex fillet weld shall be used for pipes exceeding DN 900. The leg length of the fillet as deposited shall be at least the same as the full thickness of the pipe wall. The actual throat depth shall not be less than seven-tenths, and shall not exceed nine-tenths, of the minimum leg length as deposited.  (5) Deposition of the weld metal shall be carried out in such a manner that all welds have adequate root fusion and are of good, clean metal, free from cracks, gas holes, slag intrusion and other impurities. The surface of the weld shall have an even contour with a regular finish and shall indicate proper fusion with the parent metal. Slag shall be removed from each weld by light hammering with a chipping hammer and by wire brushing.  (6) Welds that contain cracks or other cavities or defects or in which the weld metal overlaps on to the parent metal without proper fusion shall be cut out and the joints shall be rewelded. |
| 20.13.6 | Steel pipes with welded steel collar joints | Steel pipes with welded steel collar joints for water supply pipe works shall be jointed by leaving a gap not exceeding 75 mm between the ends of the pipes to be jointed. A split steel collar shall be placed centrally around the ends of the pipes. The collar shall be at least the same thickness as the pipe wall and shall be approximately 300 mm long. The end of each pipe shall be fillet welded to the collar as stated in Clause 20.13.5 |
| 20.13.7 | Steel pipes with couplings and flange adapters | (1) Steel pipes with slip-on type couplings and flange adapters for water supply pipe works shall be jointed as stated in Clause 20.13.7  (2) Protective wrappings shall be removed from the ends of plain ended pipes to be jointed and shall be replaced by:  Epoxy or plastics based coating of a proprietary type approved by the Engineer.  (3) The pipe shall be finished to an even, smooth surface free from distortion to allow the components of the coupling or flange adapter to be correctly positioned and jointed.  (4) The coupling or flange adapter shall be placed in position on the plain end before the bolts are tightened. |
| 20.13.8 | uPVC pipes with push-in joints | uPVC pipes with push-in joints for water supply pipe works shall be jointed as stated in Clause 20.13.2 |
| 20.13.9 | uPVC pipes with solvent welded joints | uPVC pipes with solvent welded joints for water supply pipe works shall be jointed by applying solvent cement to the pipes to be jointed and pushing the pipes home. Excess solvent shall not be applied and surplus solvent shall be removed after jointing. Solvent welded pipes jointed outside the trench shall not be placed in the trench until the solvent setting period recommended by the manufacturer has elapsed. |
| 20.13.10 | GI pipe joints | GI pipes for water supply pipe works shall be screw jointed using a threaded coupler. The surface of the pipe and coupler shall be cleaned and the threads shall be painted with two coats of bituminous paint. The pipe thread shall be wrapped with three turns of spun yarn or other material approved by the Engineer and the joint tightened using purpose made tools. Coal tar compounds or lead-based paint shall not be used. Locking nuts to branch connections shall be tightened. Branch connections shall not protrude inside the pipe. |
| **20.14** | **MAKING FLANGED JOINTS** |  |
| 20.14.1 | Making flanged joints | (1) Further to Clause 20.13.1, both pipes and/or fittings to be joined together shall be independently supported and properly aligned. After placing the gasket in position, the bolts shall be tightened in the sequence as shown in Sketch No. 22.1 to avoid severe overstressing of the flange. If it is necessary to dismantle the flanged joint, the bolts shall be slackened in the reverse sequence to that used for tightening.  (2) When flanges other than polyethylene flanges are tightened, the bolts shall be tightened with a torque not exceeding the corresponding value specified in Table 20.4(a), (b) or (c) as appropriate. If the joint is not sealed after applying the specified torque, then the bolts shall be tightened with the torque increased by 10%. This procedure will be repeated until the joint is sealed. A final tightening shall then be applied with a further 10% increase in torque.  (3) When polyethylene flanges are tightened, the bolt torque shall be in accordance with manufacturer's recommendations or in the absence of such recommendations to the limits as shown in Table 20.4 (d). Bolts shall be tightened by means of a torque wrench. |
| **20.15** | **PROTECTION TO STEEL FLANGED JOINTS, SLIP-ON TYPE COUPLINGS AND FLANGE ADAPTERS** |  |
| 20.15.1 | Protection to steel flanged joints, slip-on type couplings and flange adapters | (1) Steel flanged joints, slip-on type couplings and flange adapters in steel pipes for water supply pipe works shall be protected as stated in Clauses 20.15.1. Protection shall be carried out after jointing is complete.  (2) The joint, including bolts and nuts, shall be cleaned to remove all moisture, dirt, oil, grease and deleterious material. Bolts and nuts shall be painted with two coats of bituminous paint and the joint shall be coated with primer. Mastic filler shall be applied in such a manner that all depressions, corners and voids between the bolts and nuts are filled and a smooth surface is available on which to apply the anticorrosion tape.  (3) At least two layers of anticorrosion tape shall be applied to all parts of the joint and to the adjacent pipe for at least 200 mm beyond each end of the joint. The tape shall be applied in accordance with the manufacturer’s recommendations and shall be wrapped spirally around the joint and pipe with at least 55% overlap per spiral.  (4) The tape shall be moulded manually after application to take up the contours of the parts being protected. |

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| Table 20.4(a): Approximate bolt torques (PN 10 Flanged Joints) Using rubber, cork, or paper millboard gaskets (3 mm thick only) |

|  |  |  |  |
| --- | --- | --- | --- |
| Nominal Size DN (mm) | Approximate Bolt Torque (Nm) | | |
| To seal at 5 bar | To seal at 10 bar | To seal at 16 bar |
| 80 | 55 | 55 | 55 |
| 100 | 55 | 60 | 65 |
| 150 | 90 | 90 | 95 |
| 200 | 95 | 105 | 110 |
| 250 | 90 | 95 | 105 |
| 300 | 95 | 105 | 115 |
| 350 | 90 | 100 | 110 |
| 400 | 125 | 135 | 150 |
| 450 | 120 | 130 | 145 |
| 500 | 125 | 135 | 155 |
| 600 | 160 | 180 | 220 |
| 700 | 160 | 185 | 235 |
| 800 | 200 | 240 | 325 |
| 900 | 200 | 240 | 330 |
| 1000 | 240 | 310 | 430 |
| 1100 | 240 | 315 | 440 |
| 1200 | 290 | 395 | 555 |
| 1400 | 335 | 470 | 670 |
| 1600 | 425 | 610 | 875 |

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| Table 20.4(b): Approximate bolt torques (PN 16 Flanged Joints (DN 80 - 600)) Using rubber, cork, or paper millboard gaskets (3 mm thick only) |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nominal size DN (mm) | Approximate Bolt Torque (Nm) | | | | |
| To seal at 5 bar | To seal at 10 bar | To seal at 16 bar | To seal at 20 bar | To seal at 25 bar |
| 80 | 55 | 55 | 55 | 60 | 60 |
| 100 | 55 | 60 | 65 | 65 | 65 |
| 150 | 90 | 90 | 95 | 100 | 110 |
| 200 | 85 | 90 | 90 | 95 | 105 |
| 250 | 115 | 125 | 130 | 140 | 145 |
| 300 | 120 | 130 | 145 | 150 | 170 |
| 350 | 115 | 130 | 140 | 150 | 160 |
| 400 | 145 | 160 | 175 | 190 | 215 |
| 450 | 140 | 155 | 170 | 185 | 210 |
| 500 | 170 | 190 | 215 | 235 | 275 |
| 600 | 215 | 245 | 290 | 340 | 405 |

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| Table 20.4 (c): Approximate bolt torques (PN 16 Flanged Joints (DN 700 - 1600)) Using rubber, cork, or paper millboard gaskets (thickness up to and including 3 mm) |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nominal size DN  (mm) | Approximate Bolt Torque (Nm) | | | | |
| To seal at 5 bar | To seal at 10 bar | To seal at 16 bar | To seal at 20 bar | To seal at 25 bar |
| 700 | 235 | 280 | 370 | 430 | 510 |
| 800 | 290 | 375 | 505 | 590 | 695 |
| 900 | 290 | 380 | 515 | 610 | 720 |
| 1000 | 350 | 485 | 670 | 790 | 940 |
| 1100 | 350 | 490 | 680 | 805 | 965 |
| 1200 | 450 | 650 | 910 | 1090 | 1305 |
| 1400 | 475 | 730 | 1040 | 1245 | 1500 |
| 1600 | 600 | 945 | 1350 | 1630 | 1970 |

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| --- |
| Table 20.4 (d): Typical bolt torques for polyethylene flanges |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nominal PE Size (mm) | | Equivalent Size of Metal Flange (mm) | | No. of Bolts | Torque Required (Nm) |
| 63 | | 50 | | 4 | 35 |
| 90 | | 80 | | 8 | 35 |
| 125 | | 100 | | 8 | 35 |
| 180 | | 150 | | 8 | 60 |
| 250 | | 250 | | 12 | 100 |
|  | |  | | Bolt tightening sequence Sketch No. 22.1 | | | |
|  | |  | |  | | | |
|  | |  | | For sizes having 12 bolts or more, it is recommended two jointers work simultaneously on diametrically opposite bolts. Each jointer tightens the first nut in the first quadrant then the first nut in the second quadrant, returns to the second nut in the first quadrant and so on. | | | |
| **20.16** | | **REPAIRS TO JOINTS, COATINGS AND LININGS** | |  | | | |
| 20.16.1 | | Repairs to joints, coatings and linings | | (1) Joints and damage to coatings and linings of pipes, joints and fittings for water supply pipe works shall be repaired as stated in Clauses 20.16.1 to 20.16.4  (2) Unless otherwise approved by the Engineer, repairs to joints, coatings and linings shall be carried out using materials of the same type and grade as in the pipe, joint or fitting.  (3) External repairs shall be completed before internal repairs are carried out.  (4) Internal repairs and adjacent areas shall be washed with potable water after the repair is complete. | | | |
| 20.16.2 | | Repairs to DI pipes with bitumen coatings | | Internal and external repairs to joints and coatings of DI pipes with bitumen coatings shall be carried out using bituminous paint. The area to be repaired shall be cleaned to bare metal and dried. The area to be repaired shall be painted with bituminous paint to the same thickness as the adjacent coating. The paint shall be finished to a smooth uniform surface. | | | |
| 20.16.3 | | Internal repairs to DI pipes with cement mortar lining | | (1) Internal repairs to joints and linings of DI pipes with cement mortar linings shall be carried out as stated in Clause 20.16.3  (2) The area to be repaired shall be cut back to leave clean, bright metal. The area surrounding the area to be repaired shall be wetted.  (3) The cement mortar shall be worked into the area to be repaired and compacted to the same thickness as the adjacent lining. The cement mortar shall be finished to a smooth uniform surface. The repaired area shall be cured with curing compound as stated in Clause 15.3.6  (4) The inside of pipe sockets and the faces of flanges shall be kept free from cement mortar. | | | |
| 20.16.4 | | Repairs to GI pipes | | Internal and external repairs to joints and coatings of GI pipes shall be carried out using zinc-based paint. The area to be repaired shall be cleaned to bare metal and dried. The area to be repaired shall be painted with a rust inhibitor, primer and two coats of zinc-based paint. | | | |
| **20.17** | | **THRUST AND ANCHOR BLOCKS** | |  | | | |
| 20.17.1 | | Thrust and anchor blocks | | (1) The bearing face, and other faces stated in the Contract, of concrete thrust and anchor blocks for water supply pipe works shall be cast directly against undisturbed ground. The faces of excavations shall be trimmed to remove loose material before concreting. Excess excavation and working space shall be filled with concrete of the same Grade as the block.  (2) Internal pressure shall not be applied to the pipeline until thrust and anchor blocks have developed the specified grade strength. | | | |
| **20.18** | | **BED, HAUNCH AND SURROUND** | |  | | | |
| 20.18.1 | | Concrete bed, haunch and surround | | (1) Concrete bed, haunch and surround to pipelines for water supply pipe works shall be constructed as stated in (2) to (5) of this Clause.  (2) Pipes shall be supported at the required level by Grade 20 precast concrete wedges, blocks or cradles or by other methods agreed by the Engineer. One support shall be placed adjacent to each end of each pipe and the spacing between supports shall not exceed 3 m. Compressible sheeting shall be placed between the pipes and supports.  (3) Flexible joints shall be formed in concrete bed, haunch and surround at flexible joints in pipelines. Joint filler shall be placed next to the flexible joint in the pipeline and shall extend for the complete thickness of the bed, haunch and surround.  (4) Polyethylene sheeting shall be placed on the trench bottom before concreting.  (5) Concrete shall be placed evenly over the complete width of the bed and over the complete length of the pipe being concreted up to a level of 25 mm below the underside of the pipe. Concrete shall then be placed on one side of the pipe only and worked under the pipe until the concrete spreads under the pipe. Concrete shall then be placed equally on both sides of the pipe to the specified level. | | | |
| **20.19** | | **TOLERANCES** | |  | | | |
| 20.19.1 | | Tolerances : pipelines | | The line and level of pipelines for water supply pipe works shall be within 25 mm of the specified line and level. | | | |
| **20.20** | | **SWABBING** | |  | | | |
| 20.20.1 | | Swabbing of pipelines | | (1) The decision as to whether swabbing should be carried out is subject to the availability of water, which should be agreed with the Distribution Engineer of Water Supplies Department. Swabbing shall not normally be required for new pipes exceeding DN 600 that can be inspected internally to ensure cleanliness.  (2) Swabs shall be of a proprietary brand obtained from an approved manufacturer and used in accordance with the manufacturer's instructions. They shall be of a compressible hard grade polyurethane foam in cylindrical shape and shall have the following diameters:  DN of Pipe Diameter of Swab  Up to 300 mm Pipe DN + 25%  Above 300 mm Pipe DN + 75 mm  Swabs shall be suitable for clearing out new pipelines and removing dirt and materials inadvertently left in the pipeline during construction. It is recommended that swabs be fitted with a signalling device to enable the swab to be located within the pipeline.  (3) Water for swabbing shall be supplied free of charge by the Employer. The Contractor shall be responsible for the conveyance of water to the place where swabbing work is required and if necessary, pressurize the water to a level sufficient for the swabbing work.  (4) Unless otherwise approved by the Engineer, the swab shall be inserted into a short plain-ended pipe at ground level adjacent to the trench and the pipe shall then be fitted, by means of flange adaptors, into position in the pipeline between two gate valves which shall then be opened to allow the swab to pass through the pipeline.  (5) The swab must be fully immersed in water during the entire operation using water as the driving medium. Foam swabs must not be air driven and the water must not drain away from the swab on downhill sections. The velocity of the swab, which shall be controlled by the rate of flow of water downstream of the swab, shall be kept within a range of 300 mm/sec to 1200 mm/sec.  (6) All air valves and valves on tees/branches from the pipeline shall be closed before swabbing work commences.  (7) At least 14 days before the swabbing operation is to be carried out, the Contractor shall submit the following information for the approval of the Engineer:  Name and address of supplier of swab,  Place and name of manufacturer,  Type and grade of swab,  Manufacturer's recommended instructions for use,  Details of previous applications of the proposed type of swab,  Programme and details of swabbing operation, and  Means of recovering swab from pipeline at the end of the swabbing run. | | | |
| **20.21** | | **CLEANING AND STERILISATION OF PIPELINES** | |  | | | |
| 20.21.1 | | Cleaning and sterilisation of pipelines | | (1) Fresh water and potable water pipelines for water supply pipe works shall be cleaned and flushed through with potable water. Cleaning and flushing shall be carried out after:  The complete pipeline, or parts of the pipelines permitted by the Engineer, has been tested,  Temporary Works required for testing have been removed, and  Parts of the pipeline removed for testing have been reconnected.  (2) The pipeline shall be completely filled with water that has been dosed with a homogeneous solution of sterilising chemicals such that the final concentration of free chlorine in the water is at least 30 ppm. The water shall be left in the pipeline for at least 24 hours.  (3) After the 24-hour period, the pipeline shall be drained down and the sterilising water shall be flushed out using potable water until the concentration of the remaining chlorine is less than 1 ppm.  (4) Unless otherwise permitted by the Engineer, pipelines shall be cleaned and sterilised not more than 7 days before the pipeline is handed over. | | | |
| **20.22** | | **CONNECTION TO EXISTING WATERMAINS** | |  | | | |
| 20.22.1 | | Connection to existing water mains | | (1) Where connections to existing water mains are specified in the Contract, whether to be done by others or by the Contractor, the Contractor shall excavate inspection pits to determine the locations and levels of the existing water mains as directed by the Engineer. The Engineer may adjust the lines and levels of the proposed water mains to suit the lines and levels of the existing water mains.  (2) Where connections to existing water mains are specified in the Contract to be done by others, the Contractor shall lay and terminate the proposed water mains approximately 2 m from the existing water mains or as directed on Site by the Engineer. | | | |
| **20.23** | | **IDENTIFICATION TAPES FOR WATERMAINS** | |  | | | |
| 20.23.1 | | Identification tapes for water mains | | (1) Identification tapes for water mains shall be as existing standards and regulations  (2) A sample of the proposed identification tape of a minimum length of 1 metre shall be submitted to the Engineer for approval at least 14 days before the relevant work starts.  (3) During the backfilling of pipe trenches, the fill material shall be properly levelled and compacted to prepare for the laying of the identification tapes on a flat surface.  (4) Identification tapes shall be laid continuously along all water mains with the printed pattern facing upward. Wherever lapping is required, a minimum overlapping length of 300 mm shall be provided at each lap position. Identification tapes shall be temporarily secured in position before further backfilling.  (5) Identification tapes shall terminate at the external faces of chambers and pits. | | | |
| **20.24** | | **DETECTABLE WARNING TAPE FOR NON-METALLIC WATERMAINS** | |  | | | |
| 20.24.1 | | Detectable warning tape for non-metallic water mains | | (1) Detectable warning tape for buried non-metallic water mains shall be a polyethylene tape with a continuous aluminium foil inside as existing standards and regulations  (2) At the commencement of the Contract, the Contractor shall submit a 1 m (minimum) long sample of proposed detectable warning tape to the Engineer for approval.  (3) Detectable warning tapes shall be laid continuously along all new buried non-metallic water mains and be used in conjunction with the identification tapes. Detectable warning tapes shall be placed directly on top of the non-metallic water mains with the printed pattern facing upward and fixed onto the pipe bodies using adhesive tapes at regular intervals of 5 m (approx.). Identification tapes shall then be placed at 300 mm above the crown of the water mains during backfilling.  (4) Wherever lapping is required, a minimum overlapping length of 300 mm shall be provided. At the lap, detectable warning tapes shall be jointed together by either 2 no. stainless steel crimps or a stainless steel clamp as shown on Drawing No. WSD 1.37. The stainless steel crimps/clamp shall pierce through the plastic covering of the tapes to make direct contact with the aluminium foils.  (5) Any change in direction of the detectable warning tape to suit the alignment of the water main shall be achieved by folding the tape and stapling the laps with stainless steel crimp(s) as shown on Drawing No. WSD 1.37. For tee connection of the water main, the tee joint of the detectable warning tape shall be formed by joining two tapes together perpendicularly using a stainless steel clamp as shown on Drawing No. WSD 1.37.  (6) Terminal connection points shall be provided at the internal face of valve pits at regular spacing not exceeding 200 m or at locations as indicated on the drawing. The detectable warning tape shall be brought to the surface within such valve pit and mounted to the pit wall to form a terminal connection point as shown on Drawing No. WSD 1.37 by means of a stainless steel clamp and rawl bolts. Further, the tape shall be folded to by-pass the valve in order to avoid interfering the normal open-close operation of the valve.  (7) The deposition and compaction of fill material to pipe trenches shall be carried out in such a manner as to enable the detectable warning tapes and identification tapes to be laid properly. During the backfilling of pipe trenches, the fill material shall be properly deposited, levelled and compacted to prepare for the laying of these tapes. | | | |
| **20.25** | | **WORK ON ASBESTOS CEMENT PIPES AND DISPOSAL OF ASBESTOS WASTES** | |  | | | |
| 20.25.1 | | Work on asbestos cement pipes and disposal of asbestos wastes | | (1) Not less than 7 days before disposing of any unwanted Asbestos Cement pipes or fittings, the Contractor shall confirm to the Engineer that the Permit required by Waste Disposal Authority has been obtained. | | | |
| **20.26** | | **TESTING: JOINTS IN STEEL PIPES** | |  | | | |
| 20.26.1 | | Testing: joints in steel pipes | | (1) Spigot and socket joints in steel pipes exceeding DN 700 for water supply pipe works shall be tested after welding by the nitrogen gas test.  (2) A tapped hole of approximately 6 mm diameter shall be made in the socket end of each pipe to be tested and a non-return valve shall be fixed in the hole. The nitrogen gas test shall be carried out by pumping nitrogen to a pressure of 400 kPa into the annular space between the spigot and socket. The pump shall be disconnected and the pressure shall be recorded for 30 minutes. | | | |
| 20.26.2 | | Compliance criteria: joints in steel pipes | | There shall be no drop in pressure in the joint during the 30 minute period of the nitrogen gas test. | | | |
| 20.26.3 | | Non-compliance: joints in steel pipes | | If the result of any nitrogen gas test does not comply with the specified requirement for the test, the weld at the joint shall be cut out and the joint shall be rewelded and tested. | | | |
| **20.27** | | **TESTING: PRESSURE PIPELINES FOR WATER SUPPLY PIPEWORKS** | |  | | | |
| 20.27.1 | | Testing: pressure pipelines for water supply pipe works | | (1) Pressure pipelines for water supply pipe works shall be tested as stated in Clause 20.27.1  (2) The pipeline shall be tested in sections as stated in the Contract unless otherwise permitted by the Engineer. If testing in sections other than those stated in the Contract is permitted, the section to be tested shall be as long as practicable provided that the specified test pressure will not be exceeded. Final tests on complete pipelines that have been tested in sections shall not be carried out unless stated in the Contract.  (3) The test pressure shall be as stated in the Contract. If the test pressure is not stated in the Contract, the test pressure shall be:  1.5 times the maximum working pressure if the maximum working pressure does not exceed 1.5 MPa, or  1.3 times the maximum working pressure if the maximum working pressure exceeds 1.5 MPa.  (4) Unless otherwise permitted by the Engineer, pressure tests shall not be carried out until the fill material has been deposited and compacted over the complete length of the pipeline to be tested. If permitted, sufficient fill material shall be deposited to restrain the pipeline in position during the test.  (5) Tests shall not be carried out simultaneously on pipelines in the same trench.  (6) The method of testing shall be in accordance with existing national standards or similar  (7) Unless otherwise permitted by the Engineer, the pipeline shall be left charged with water at a head of at least 15 m after testing and until the pipeline has been sterilised or handed over to the Employer. | | | |
| 20.27.2 | | Compliance criteria: pressure pipelines for water supply pipe works | | The results of tests on pressure pipelines for water supply pipe works shall comply with the following requirements:  The leakage of water from the pipeline determined by the pressure test shall not exceed the permitted leakage calculated in accordance with Clause 20.1.4 in existing national standards or similar  There shall be no discernable leakage of water from the pipeline or from any joint during the pressure test. | | | |
| 20.27.3 | | Non-compliance: pressure pipelines for water supply pipe works | | If the result of any test on pressure pipelines for water supply pipe works does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the pipeline shall be retested. | | | |
| **20.28** | | **TESTING: WATER STERILISATION** | |  | | | |
| 20.28.1 | | Testing: water sterilisation | | (1) After the pressure test on fresh water and potable water pipelines for water supply pipelines has been completed, samples of the water in the pipeline will be taken by the Engineer. The number of samples and locations of sampling shall be as instructed by the Engineer. Testing shall be carried out as stated in Clauses 21.15.2 and 21.15.3 for water sterilisation of water retaining structures.  (2) The colour, odour, appearance, turbidity, conductivity and pH value of the water samples shall be of a quality comparable with that drawn from the supply point and acceptable for potable water. | | | |
| **21.** | | **SECTION 21 WATER RETAINING STRUCTURES** | |  | | | |
| **21.1** | | **GENERAL** | |  | | | |
| 21.1.1 | | General requirements | | The works and materials specified in Clauses 21.1.2 to 21.1.7 shall comply with the sections stated, unless otherwise stated in this Section. | | | |
| 21.1.2 | | Earthworks | | Earthworks shall comply with Section 6. | | | |
| 21.1.3 | | Formwork | | Formwork and finishes to concrete shall comply with Section 13. | | | |
| 21.1.4 | | Reinforcement | | Steel reinforcement shall comply with Section 14. | | | |
| 21.1.5 | | Concrete | | Concrete shall comply with Section 15. | | | |
| 21.1.6 | | Joints in concrete | | Joints in concrete shall comply with Section 15. | | | |
| 21.1.7 | | Drainage systems | | Drainage systems shall comply with Section 5 | | | |
| **21.2** | | **GLOSSARY OF TERMS** | |  | | | |
| 21.2.1 | | Water retaining structure | | Water retaining structure is a structure, or part of a structure, including walls, floors, roofs, columns and footings, which is stated in the Contract to be constructed for storing, conveying or excluding water, sewage or other aqueous liquids. | | | |
| **21.3** | | **MATERIALS** | |  | | | |
| 21.3.1 | | Sliding layers | | Sliding layers below floor slabs of water retaining structures shall be of a proprietary type of polyethylene sheeting approved by the Engineer. Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 1.1 mm. | | | |
| **21.4** | | **MATERIALS PROVIDED AND EQUIPMENT LOANED BY THE EMPLOYER** | |  | | | |
| 21.4.1 | | Materials provided by the Employer | | (1) Water and sterilising chemicals for cleaning, sterilising and testing water retaining structures as stated in Clauses 21.11.1 and 21.14.1 will be provided by the Employer for one set of tests. The water and sterilising chemicals shall be obtained from the locations stated in the Contract or from other locations agreed by the Engineer and shall be mixed by the Contractor.  (2) Further to sub-clause (1) of this Clause, the Contractor shall be responsible for providing the water and sterilizing chemicals for re-testing when the water retaining structures tests do not comply with the test requirements and compliance criteria specified in the Contract. | | | |
| 21.4.2 | | Equipment loaned by the Employer | | The equipment for recording water levels in tests on water retaining structures as stated in Clause 21.14.1 that is to be included in Contracts entered into with the Water Supplies Department will be loaned by the Employer. | | | |
| **21.5** | | **SUBMISSIONS** | |  | | | |
| 21.5.1 | | Particulars of sliding layers | | Particulars of the source and type of proposed sliding layers for water retaining structures shall be submitted to the Engineer for approval at least 14 days before the first delivery of the sliding layer to the Site. | | | |
| 21.5.2 | | Particulars of materials and methods of construction for water retaining structures | | (1) The following particulars of the proposed materials and methods of construction for water retaining structures shall be submitted to the Engineer:  Sequence and method of concreting bays in floor slabs, walls and roof slabs and in columns and footings,  Details of alternative locations of construction joints if required,  Details of type and size of waterstops at construction joints and box-outs,  Sequence and method of testing roofs for watertightness, and  Details of method of testing water retaining structures for watertightness including:  Arrangement of pumps and equipment  Source of water  Equipment for measuring fall in water level  Device for dampening the oscillatory motion of the water surface  Filling rate  - Method of correction for evaporation and rainfall.  (2) The particulars shall be submitted to the Engineer at least 28 days before the relevant work starts. | | | |
| 21.5.3 | | Samples of sliding layers | | Samples of the proposed sliding layers for water retaining structures shall be submitted to the Engineer at the same time as particulars of the sliding layer are submitted. | | | |
| **21.6** | | **STORAGE OF MATERIALS** | |  | | | |
| 21.6.1 | | Storage of sliding layers | | Sliding layers for water retaining structures shall be stored in accordance with the manufacturer’s recommendations in a dry weatherproof store. | | | |
| **21.7** | | **DRAINAGE SYSTEMS** | |  | | | |
| 21.7.1 | | Drainage systems | | Measures shall be taken to prevent concrete and deleterious material from being deposited in drainage systems under floors and on roofs of water retaining structures. After construction and before testing, the drainage system shall be thoroughly cleaned by rodding and flushing to remove any deleterious material that may impede the flow of water into or through the drainage system. The lines and levels of drainage systems shall be within 20 mm of the specified horizontal alignment and within 10 mm of the specified vertical alignment. | | | |
| **21.8** | | **CONSTRUCTION OF WATER RETAINING STRUCTURES** | |  | | | |
| 21.8.1 | | Laying sliding layers | | Polyethylene sheeting in sliding layers below floor slabs of water retaining structures shall be laid flat without creases. Laps shall be at least 225 mm and there shall be no gaps at the edges of bays. | | | |
| 21.8.2 | | Floor slabs of water retaining structures | | If reinforcement is continuous across the joint between bays in the floor slab of water retaining structures, the bays shall be concreted contiguously, in sequence, with a minimum period of 48 hours between completion of concreting one bay and commencement of concreting the adjacent bay. | | | |
| 21.8.3 | | Walls of water retaining structures | | (1) If reinforcement is continuous across the joint between bays in the wall of water retaining structures, the bays shall be concreted contiguously, in sequence, with a minimum period of 72 hours between the completion of concreting the lift in one bay and commencement of concreting the adjacent lift in the adjacent bay.  (2) Unless otherwise permitted by the Engineer the first lift in each bay in the walls of water retaining structures shall be concreted not more than 7 days after completion of concreting the adjacent base of the wall. Individual lifts shall be concreted in one continuous operation without cold joints, whether or not the full height of the wall is concreted in one lift. If the full height of the wall is not placed in one lift, succeeding lifts shall be concreted within 7 days of concreting of the adjacent lift unless otherwise permitted by the Engineer. | | | |
| 21.8.4 | | Roof slabs of water retaining structures | | If reinforcement is continuous across the joint between bays in the roof slab of water retaining structures, the bays shall be concreted contiguously, in sequence, with a minimum period of 48 hours between completion of concreting one bay and commencement of concreting the adjacent bay. | | | |
| 21.8.5 | | Built-in pipes in water retaining structures | | Puddle flanges on built-in pipes in water retaining structures shall be located centrally within the formwork. Waterstops shall be fixed around the perimeter of box-outs to the built-in pipes. | | | |
| **21.9** | | **PROTECTION OF WATER RETAINING STRUCTURES** | |  | | | |
| 21.9.1 | | Protection of water retaining structures | | (1) Immediately after the roof slab of water retaining structures has been tested, the slab shall be protected with damp sacks or by other methods agreed by the Engineer from exposure to conditions that may affect the slab. The protection shall be continued until the roof drainage system has been constructed or the fill material has been deposited and compacted.  (2) Materials shall not be stockpiled on roof slabs of water retaining structures. Constructional Plant or other vehicles shall not stand or run on floor slabs or roof slabs of water retaining structures unless permitted by the Engineer. | | | |
| **21.10** | | **DEPOSITION OF FILL MATERIAL** | |  | | | |
| 21.10.1 | | Deposition of fill material | | (1) Fill material shall not be deposited behind sections of walls of water retaining structures until at least 7 days after completion of concreting to the section of wall.  (2) Fill material shall be spread out evenly and shall not be stockpiled on roofs to water retaining structures. Weed killer or other chemicals shall not be applied to fill material on the roofs of water retaining structures for potable or fresh water.  (3) Deposition of fill material on or adjacent to water retaining structures shall be carried out after the watertightness test on the structure has been completed, unless otherwise permitted by the Engineer. | | | |
| **21.11** | | **CLEANING AND STERILISATION OF WATER RETAINING STRUCTURES** | |  | | | |
| 21.11.1 | | Cleaning and sterilisation of water retaining structures | | (1) Immediately before water retaining structures are tested for watertightness, all dust, debris, unused materials and equipment shall be removed from the structure and the interior of the structure shall be washed and brushed down with water.  (2) Water for washing water retaining structures for potable or fresh water shall be fresh, potable water incorporating a mixture of sterilising chemicals added before the structure is washed at a concentration instructed by the Engineer. The structure shall be maintained in a clean condition after cleaning. | | | |
| 21.11.2 | | Treatment and disposal of effluent | | (1) Whereas the cleansing effluent is not fit for discharging into the natural stream course or the storm water drainage system, it should be discharged to the washout chamber or into the sewerage system subject to the approval of the Engineer and the agreement of the Drainage Services Department.  (2) If the cleansing effluent requires de-chlorination, the outlet pipe of the washout chamber should be blocked and the cleansing effluent shall be pumped from the washout chamber to the de-chlorination plant for de-chlorination before discharging to waste. The discharge of cleansing effluent from the washout shall be stopped under the following situation whichever first occurs as directed by the Engineer:  The bottom deposits are visually discovered in the cleansing effluent discharged into the washout chamber; or  Any part of the compartment floor is not submerged; or  At level as instructed by the Engineer.  (3) The outlet pipe of the washout chamber shall then be kept blocked. The remaining sludge inside the compartment shall then be discharged to the washout. The sludge shall be pumped from the washout chamber to a mobile “centrifuge and microfiltration plant” or equivalent mobile treatment plant approved by the Engineer for treatment.  (4) Sludge cake samples shall be taken in hourly intervals and the samples shall be sent to the an accredited laboratory or institute for testing their dry solid content. The results shall be recorded. The sampling record shall be submitted to the Engineer within two weeks after cleaning works.  (5) Subject to the approval of the Environmental Protection Agency, the sludge cake produced shall be disposed of at landfill site.  (6) Samples of filtrate from the microfiltration plant or in case if equivalent mobile treatment plant approved by the Engineer is used, samples of the final effluent from the mobile treatment plant, shall be taken at hourly intervals and the samples shall be tested for turbidity on site and sent to the an accredited laboratory and institute for testing their suspended solids content. If the turbidity of the filtrate or in case of equivalent mobile treatment plant approved by the Engineer is used, the final effluent from the mobile treatment plant, is higher than the limit specified by the Engineer, the Contractor is required to stop the discharge and rectify the situation before restart of operation. The testing results shall be recorded in a log record. The sampling record shall be submitted to the Engineer within two weeks after cleaning works. | | | |
| **21.12** | | **TESTING:DRAINAGE SYSTEMS RETAINING STRUCTURES FOR WATER** | |  | | | |
| 21.12.1 | | Testing: drainage systems for water retaining structures | | Drainage systems under floors and on roofs of water retaining structures shall be tested in accordance with the following requirements:  Water shall be poured at different locations agreed by the Engineer along the drainage system and the flow of water observed at junction pits, outfalls and other discharge points.  A mandrel shall be pulled through each completed section of pipeline of 300 mm diameter or less. The mandrel shall be 750 mm long and 12 mm less in diameter than the nominal diameter of the pipe. | | | |
| 21.12.2 | | Compliance criteria: drainage systems for water retaining structures | | The results of tests on drainage systems for water retaining structures shall comply with the following requirements:  The water shall in the opinion of the Engineer be freely discharged by the drainage system.  The bore, linearity and jointing of pipes shall comply with the specified requirements. | | | |
| 21.12.3 | | Non-compliance: drainage systems for water retaining structures | | If the result of any test on the drainage system for water retaining structures does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the drainage system shall be retested. | | | |
| **21.13** | | **TESTING: WATERTIGHTNESS OF ROOFS** | |  | | | |
| 21.13.1 | | Testing: watertightness of roofs | | (1) The roofs of water retaining structures shall be tested for watertightness over the complete area of the roof, including perimeter joints. Roofs shall not be tested in sections unless permitted by the Engineer.  (2) Water shall be allowed to be ponding on the roof for a period of 3 days and topped up to maintain a depth of at least 75 mm. The test shall be carried out before fill material is deposited or drainage systems are constructed on the roof. | | | |
| 21.13.2 | | Compliance criteria: watertightness of roofs | | There shall be no leaks or damp patches visible on the soffits of roofs of water retaining structures during or at the end of the test for watertightness. | | | |
| 21.13.3 | | Non-compliance: watertightness of roofs | | If the result of any test for watertightness of the roof of a water retaining structure does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the roof shall be retested. | | | |
| **21.14** | | **TESTING: WATERTIGHTNESS OF STRUCTURES** | |  | | | |
| 21.14.1 | | Testing: watertightness of structures | |  | | | |
| 21.14.2 | | Compliance criteria: watertightness of structures | | (1) Water retaining structures shall be tested for watertightness as stated in Clause 21.14.1. Each compartment of structures, which incorporate division walls, shall be tested separately with adjoining compartments empty. The complete structure shall also be tested.  (2) The structure shall be filled with water at an approximately uniform rate not exceeding 2 m depth in 24 hours to the levels stated in Table 21.1. The water used for testing water retaining structures for potable or fresh water shall be fresh potable water. The permission of the Engineer shall be obtained before filling starts. The structure or each compartment of the structure being tested shall be kept full for 7 days before testing allow for absorption.  (3) After the period for absorption, the water shall be topped up to the specified level and the test shall begin. During testing, the oscillatory motion of the water surface shall be dampened. The test period shall be 7 days.  (4) The equipment for recording water levels shall be installed in a temporary enclosure of minimum dimensions 2 m x 2 m x 2.5 m high with a lockable door. The enclosure shall be located over stilling wells, manhole openings or other points of recording water levels. The temporary enclosure shall be removed on completion of the test. The equipment shall be calibrated before testing starts and at regular intervals agreed by the Engineer and shall be readable and accurate to 0.5 mm.  (5) The fall in water level in water retaining structures shall be measured at hourly intervals between 8 a.m. and 5 p.m. each day. The total fall shall be measured at the end of the test period.  (6) Except as stated in Clause 21.14.1, structures shall be emptied after completion of testing and maintained in a clean and dry condition. The water shall be removed at an approximately uniform rate not exceeding 2 m depth in 24 hours. The permission of the Engineer shall be obtained before emptying starts.  (7) Unless otherwise instructed by the Engineer, the water used for the final tests on water retaining structures for potable or fresh water shall be retained in the structure and shall not be wasted or contaminated. | | | |
| 21.14.3 | | Compliance criteria: watertightness of structures | | The results of tests for watertightness of water retaining structures shall comply with the following requirements:  The total fall in water level at the end of the test period, after adjustment for evaporation and rainfall, shall not exceed 1/500 times the maximum specified depth of water in the test or 10 mm, whichever is less.  There shall be no leaks or damp patches visible on the surface of the structure, including any division walls, during or at the end of the test. | | | |
| 21.14.4 | | Non-compliance: watertightness of structures | | If the result of any test for watertightness of a water retaining structure does not comply with the specified requirements for the test, the Contractor shall investigate the reason. Remedial or replacement work approved by the Engineer shall be carried out and the structure shall be retested. | | | |

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| Table 21.1: Tests on water retaining structures |

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| Type of structure | Part of structure tested | Test water level |
| Water retaining structures other than for sewage | Structure with division wall  - each compartment of structure | 100 mm below top of division wall |
| Structure with division wall  - complete structure | Top water level of structure |
| Structure without division wall |
| Water retaining structures for sewage | Structure with division wall  - each compartment of structure | Top water level of structure |
| Structure with division wall  - complete structure |
| Structure without division wall |

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| **21.15** | **TESTING: WATER STERILITY** |  |
| 21.15.1 | Samples: water sterilisation | After the test for watertightness of a water retaining structure for potable or fresh water has been completed, samples of the water in the structure shall be taken by the Engineer. The number of samples and location of sampling shall be as instructed by the Engineer. |
| 21.15.2 | Testing: water sterilisation | Each sample of water shall be tested to determine the bacteriological content. The colour, odour, appearance, turbidity, conductivity and pH value of the water samples shall be of quality acceptable for potable water. |
| 21.15.3 | Compliance criteria: water sterilisation | The results of tests for bacteriological content of the water and the parameters stated in Clause 21.15.2 shall demonstrate that in the opinion of the Engineer the structure has been adequately sterilised for potable or fresh water. |
| **22.** | **SECTION 22 BUILDING WORKS** |  |
|  | ***PART 1: ASPHALT ROOFING*** |  |
| **22.1** | **MATERIALS** |  |
| 22.1.1 | Mastic asphalt | Mastic asphalt for asphalt roofing shall comply with BS 6925, Type R988 or BS 6577, Type R1162. |
| 22.1.2 | Isolating membrane | Isolating membrane for asphalt roofing shall be black sheathing felt complying with BS 747, Class 4A(i) and shall weigh at least 17 kg per 810 mm wide by 25 m long roll. |
| 22.1.3 | Bitumen dressing compound | Bitumen dressing compound for asphalt roofing shall be cut-back bitumen, Grade 25 sec or other grade approved by the Engineer and shall comply with the following:  Bitumens for road purposes : BS 3690: Part 1  Bitumens for industrial purposes : BS 3690: Part 2. |
| 22.1.4 | Bituminous paint | Bituminous paint for asphalt roofing shall comply with BS 6949. |
| 22.1.5 | Sand | Sand for finishing the surface of asphalt roofing shall be fine, clean sand and shall be graded such that 100% passes a 600 m BS test sieve and 100% is retained on a 300 µm BS test sieve. |
| 22.1.6 | Stone chippings | Stone chippings for asphalt roofing shall be white stone (Baak Shek) chippings and shall be graded such that 100% passes a 5 mm BS test sieve and 100% is retained on a 2.36 mm BS test sieve. |
| 22.1.7 | Reflective paint | Reflective paint for asphalt roofing shall be of a proprietary type approved by the Engineer and shall be a bituminous-based aluminium paint or a paint compatible with bituminous surfaces. |
| 22.1.8 | Metal lathing | Metal lathing for asphalt roofing shall be zinc coated or stainless steel expanded metal lathing complying with BS 1369: Part 1. The reinforcement shall be at least 10 mm short way of mesh and shall be at least 0.46 mm thick. |
| **22.2** | **SUBMISSIONS** |  |
| 22.2.1 | Particulars of asphalt roofing | (1) The following particulars of the proposed materials and methods of construction for asphalt roofing shall be submitted to the Engineer:  Name of specialist sub-contractor,  A certificate for each material for asphalt roofing showing the manufacturer’s name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests on mastic asphalt for  Hardness number, and  Binder content and grading of mineral aggregate.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before asphalt roofing work starts. Certificates for mastic asphalt shall be submitted for each batch of mastic asphalt delivered to the Site. |
| 22.2.2 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are provided:  Mastic asphalt,  Sand, and  Stone chippings. |
| **22.3** | **STORAGE OF MATERIALS** |  |
| 22.3.1 | Storage of isolating membrane, bitumen dressing compound, bituminous paint, sand, stone chippings, reflective paint and metal lathing | Isolating membrane, bitumen dressing compound, bituminous paint, sand, stone chippings, reflective paint and metal lathing shall be stored in a dry weatherproof store. |
| **22.4** | **ASPHALT ROOFING WORK** |  |
| 22.4.1 | Heating asphalt | (1) Mastic asphalt for asphalt roofing shall be gradually heated in a purpose made mixer to a temperature until it flows but not exceeding 230°C. The asphalt shall be continuously agitated such that local overheating is prevented during heating and until it has been discharged for use.  (2) The molten asphalt shall be transported in buckets that have been coated with cement. Ashes or oil shall not be used for coating buckets and other equipment. |
| 22.4.2 | Laying mastic asphalt | (1) Asphalt work for asphalt roofing shall be carried out in accordance with CP 144: Part 4.  (2) Mastic asphalt shall be laid on a clean dry surface using wood or metal gauges to ensure the correct thickness of each coat. Two coats of equal thickness to a total thickness of at least 20 mm shall be laid on horizontal roof surfaces and on slopes not exceeding 30°. Two coats of equal thickness to a total thickness of at least 13 mm shall be laid to skirtings, upstands and drips and on slopes exceeding 30°.  (3) Joints in successive coats shall be staggered by at least 150 mm.  (4) If blows due to entrapment of moisture or air are formed during laying, the affected parts shall be pierced and made good while the surrounding asphalt is warm. |
| 22.4.3 | Laying isolating membrane | Black sheathing felt for asphalt roofing shall be laid on a dry surface and shall not be sealed to the structure on slopes less than 30°to the horizontal. Laps of at least 75 mm shall be formed at joints. |
| 22.4.4 | Forming angles | (1) Internal angles between horizontal and vertical surfaces on asphalt roofing shall be formed with stout asphalt fillets. The fillets shall be at least 50 mm on face and shall be continuous with the surfaces.  (2) The specified total thickness of asphalt shall be maintained at external angles between horizontal and vertical surfaces or between sloping surfaces. |
| 22.4.5 | Forming skirtings | Skirtings shall be formed in asphalt roofing and shall be at least 150 mm high above roof finishes. The top edge shall be splayed and tucked into a groove at least 25 mm deep and 25 mm wide. |
| 22.4.6 | Dressing to rainwater outlets | Asphalt roofing shall be neatly dressed into rainwater outlets and sealed. Metal surfaces in contact with the asphalt roofing shall be cleaned and primed with one coat of bituminous paint before the asphalt is laid. Flashings to rainwater outlets shall be embedded in the first coat of the asphalt and then the second coat shall be applied. |
| 22.4.7 | Dressing to pipes through roofs | Asphalt roofing and isolating membrane shall be neatly dressed around sleeves to pipes passing through roofs. The dressing shall be at least 150 mm high and shall have a stout asphalt angle fillet at the bottom. Metal surfaces in contact with the asphalt roofing shall be cleaned and primed with one coat of bituminous paint before the asphalt is laid. |
| 22.4.8 | Finishing roof surfaces | Immediately after asphalt laying to asphalt roofing is complete, the roof surfaces shall be well rubbed with a clean wood float and fine clean sand. |
| 22.4.9 | Solar protection | (1) Roof surfaces to which stone chippings are to be applied shall be dressed with bitumen dressing compound applied at a rate of 3 kg/m . The surfaces shall be dressed immediately with stone chippings lightly rolled in at a rate of 15 kg/m . Loose chippings shall be removed.  (2) Reflective paint to asphalt roofing shall be applied in two coats at the rate recommended by the manufacturer. |
| **22.5** | **TESTING: ASPHALT ROOFING** |  |
| 22.5.1 | Batch: mastic asphalt | A batch of mastic asphalt is any quantity of mastic asphalt of the same type, manufactured at the same time in the same place and delivered to the Site at any one time and which, for the purpose of testing laid mastic asphalt, is laid on the same day. |
| 22.5.2 | Samples: mastic asphalt | (1) Samples of mastic asphalt shall be provided from each batch of mastic asphalt delivered to the Site. The samples shall be provided at least 14 days before asphalt roofing work starts.  (2) Samples of mastic asphalt shall be provided from each batch of laid mastic asphalt. Holes formed by taking samples of laid mastic asphalt shall be reinstated using mastic asphalt.  (3) The number and size of samples and the method of sampling shall be in accordance with BS 5284. |
| 22.5.3 | Testing: mastic asphalt | (1) Each sample of mastic asphalt shall be tested to determine the hardness number, binder content and grading of mineral aggregate.  (2) The method of testing shall be in accordance with BS 5284. |
| 22.5.4 | Compliance criteria: mastic asphalt | The results of tests on mastic asphalt shall comply with BS 6925. |
|  | ***PART 2: CARPENTRY AND JOINERY*** |  |
| **22.6** | **MATERIALS** |  |
| 22.6.1 | Timber for carpentry and joinery | (1) Timber for carpentry and joinery shall be of mature growth and shall be seasoned and free from large, loose or dead knots, wood wasp holes, infestation, splits and other defects which will reduce the strength or produce blemishes. The moisture content in timber at the time of fabrication shall not exceed the following:  Internal timber for use in air  conditioned premises : 12%  Other internal timber : 16%  Timber with one face to the exterior of the building and  one face to the interior : 18%  External timber : 20%.  (2) Hardwood shall be white seraya, red seraya, teak or other hardwood approved by the Engineer. The density of hardwood other than teak shall be at least 720 kg/m3 at 15% moisture content. The density of teak shall be at least 650 kg/m3 at 15% moisture content.  (3) Hardwood or teak shall only be used in special circumstances under the direction of the Engineer.  (4) Softwood shall be cedar, spruce or other available wood in the Maldives and approved by the engineer  (5) Plywood shall comply with BS 6566: Parts 1 to 8. Grade 1 veneer plywood shall be used for natural finishes and shall be hardwood faced as stated in the Contract. Grade 2 veneer plywood shall be used for painted finishes and shall be luan faced.  (6) Timber either softwood or hardwood shall be obtained from a sustainable forest or plantation. Hardwood of unknown species or from unidentified sources are expressly prohibited.  (7) Timber either softwood or hardwood shall be originating from a sustainable resource or managed plantation as certified by the Forest Stewardship Council (FSC) or other Approved Authority. |
| 22.6.2 | Nails, screws and plugs | (1) Nails for carpentry and joinery shall be steel nails with a ‘bright’ finish.  (2) Screws shall be brass, stainless steel, alloy or other non-corroding metal approved by the Engineer and shall have countersunk heads.  (3) Plugs for fixing to hard materials shall be of a proprietary type approved by the Engineer and shall be plastic, soft metal, fibre or similar material. |
| 22.6.3 | Wood preservative | (1) Wood preservative for carpentry and joinery shall be of a proprietary type approved by the Engineer. Wood preservative that will be completely concealed or not decorated shall be an exterior grade and colourless. Wood preservative that is likely to be exposed to or in contact with painted finishes shall be coloured and suitable for over-painting.  (2) Wood preservative shall be applied in a manner that is not hazardous to health and adhered strictly to the manufacturer’s instructions. |
| 22.6.4 | Adhesive | (1) Adhesive for timber for internal use shall be synthetic resin adhesive classified as moisture resistant and moderately weather-resistant in accordance with BS 1204: Part 1. Adhesive for timber for internal use under very damp conditions or for external use shall be synthetic resin adhesive classified as weather-proof and boil-proof in accordance with BS 1204: Part 1.  (2) Adhesive for plywood for external use or in areas of high humidity shall be phenol formaldehyde resin adhesive classified as weather-proof and boil-proof in accordance with BS 1203. Adhesive for plywood for other uses shall be resin adhesive classified as moisture resistant and weather resistant in accordance with BS 1203. |
| **22.7** | **SUBMISSIONS** |  |
| 22.7.1 | Particulars of timber | (1) The following particulars of the proposed timber for carpentry and joinery shall be submitted to the Engineer:  The species and country of origin;  The name of the concessions or plantations from which these timbers originate;  Copies of the forest policies implemented by these concessions or plantations which confirm that the management of the timber resource is sustainable;  Shipping documents that confirm that the suppliers has obtained the timber from the stated concessions or plantations.  A certificate from the Forest Stewardship Council (FSC) or other approved authority  A certificate for each type of timber showing the source of the timber and showing that the timber complies with the requirements stated in the Contract and including results of tests for  Density, and  Moisture content.  (2) The particulars shall be submitted to the Engineer at least 14 days before the first delivery of the timber to the Site. The particulars shall be submitted for each batch of the timber delivered to the Site. |
| 22.7.2 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the timber are submitted:  Hardwood, softwood and plywood, and  Nails, screws and plugs. |
| **22.8** | **STORAGE OF MATERIALS** |  |
| 22.8.1 | Storage of timber | Timber shall be stored in a dry, weatherproof and well ventilated store with a raised floor. |
| **22.9** | **CARPENTRY AND JOINERY WORK** |  |
| 22.9.1 | Treatment to timber | (1) Unexposed surfaces of timber doors and windows, including backing, fillets, backs of door and window frames, shall be treated with two coats of wood preservative before fixing or bedding in. Door and window frames shall be knotted and shall receive at least one coat of primer before being fixed in position.  (2) Hidden faces of built-in timber shall be treated with two coats of wood preservative before being assembled and fixed in position. |
| 22.9.2 | Finish to timber | Planed timber shall be used for all surfaces of carpentry and joinery. Exposed surfaces shall have a fine glasspapered finish and arrises shall be rounded to a radius of 1 mm. |
| 22.9.3 | Framed timber | (1) Faces of framed joints of timber shall be square and shall be driven together to give a close accurate fit.  (2) Timber shall be prepared and framed up with dry joints and stored until required for fixing in position. Before fixing, all joints shall be opened up, put back together with white lead and wedged up. Sections that have warped or developed shakes or other defects shall be replaced. |
| 22.9.4 | Running bonded joints | Running bonded joints in timber shall be cross-tongued using teak tongues. Double tongues shall be used for work exceeding 40 mm thick. |
| 22.9.5 | Building-in timber | Timber sections shall be screwed or nailed to the backing that shall be plugged. The location of concealed services shall be checked before fixing timber sections to walls and other surfaces. |
| 22.9.6 | Nailing Nail heads | Timber sections that are split when nailing shall be replaced. shall be punched below timber surfaces. |
| 22.9.7 | Fixing screws | (1) Timber sections shall be screwed in drilled pilot holes.  (2) Screws shall be inserted to their full depth with a screwdriver, and hammers shall not be used.  (3) Screw heads shall be countersunk at least 5 mm below timber surfaces. Colour and grain matched pellets cut from similar timber shall be fixed in with adhesive and finished off flush with the surrounding surface. |
| **22.10** | **TESTING: TIMBER** |  |
| 22.10.1 | Batch: timber | A batch of timber is any quantity of timber of the same type and grade, from the same source, covered by the same certificates and delivered to the Site at any one time. |
| 22.10.2 | Samples timber | (1) 1 sample of timber shall be provided from each batch of timber. The size of each sample shall be 1000 mm x 50 mm x 50 mm. |
| 22.10.3 | Testing: timber | (1) Each sample of timber shall be tested to determine the moisture content at the time of fabrication.  (2) The moisture content at the time of fabrication shall be calculated from the equation:  Moisture content = (mw - md)/md % where  mw is the wet or supplied mass, and  md is the dry mass.  (3) The dry mass shall be determined by drying the sample in an oven at a temperature of 103°C ± 2°C until the mass is constant and weighing the sample. |
|  | ***PART 3: GLAZING*** |  |
| **22.11** | **MATERIALS** |  |
| 22.11.1 | Glass | (1) Glass shall comply with BS 952 and be of a proprietary type approved by the Engineer. Glass shall be free from bubbles, smoke wanes, air holes, scratches and other defects and shall be cut to the required size with clean undamaged edges and surfaces which are not disfigured.  (2) Clear float glass shall be used for glazing unless otherwise stated in the Contract.  (3) Sheet glass shall be clear sheet glass and shall be at least 3 mm thick.  (4) Reinforced glass shall be Georgian wired cast or hexagonal wired cast glass of standard quality. The glass shall have a nominal thickness of 6 mm and shall have square wire mesh electrically welded at each intersection.  (5) Hollow pressed glass blocks shall have a pattern approved by the Engineer and shall have radius corner blocks to match.  (6) Glass blades for fixed and adjustable louvres shall have a nominal thickness of 6 mm. The edges shall be parallel and shall be ground to remove sharp arrises. |
| 22.11.2 | Putty | Putty for glazing to metal, hardwood and softwood shall be a proprietary type approved by the Engineer. |
| 22.11.3 | Bituminous paint | Bituminous paint for cut edges of wired glass shall comply with BS 6949. |
| **22.12** | **SUBMISSIONS** |  |
| 22.12.1 | Samples of materials | Samples of each proposed type of glass shall be submitted to the Engineer at least 14 days before glazing starts. |
| **22.13** | **STORAGE OF MATERIALS** |  |
| 22.13.1 | Storage of glass and putty | (1) Glass shall be stored vertically in a dry weatherproof store with a raised floor. Glass shall be kept clean and dry and shall be protected from exposure to condensation and moisture.  (2) Putty shall be stored in sealed containers which shall be marked to identify the contents and protected from exposure to conditions which may adversely affect the putty all in accordance with the manufacturer’s recommendations. The putty shall not be used after the recommended shelf life has been exceeded. |
| **22.14** | **GLAZING WORK** |  |
| 22.14.1 | Glazing work | (1) Glazing work shall be carried out in accordance with BS 6262. External glazing shall be weather-tight on completion.  (2) Frames and beading shall be cleaned and primed before glazing as stated in Part 6 of this section.  (3) Directionally patterned or wired glass shall be set with the pattern or wires parallel to the surround and aligned with adjacent panes. Cut edges of wired glass shall be painted with one coat of bituminous paint.  (4) Edge clearances shall be at least 3 mm and shall be equally spaced around each pane.  (5) Putty edge covers shall be as stated in Table 22.1.  (6) Setting and location blocks shall be used for panes of glass exceeding 0.2 m2. The blocks shall be located in accordance with BS 6262 and shall be at least 30 mm from the corners of the frame.  (7) Back putty shall be finished flush with the frame on top edges and sides, and at 45° on bottom edges. There shall be no metal-glass or wood-glass contact, and no voids or spaces in the putty.  (8) Glass shall be secured to wood surrounds by glazing sprigs at a maximum spacing of 450 mm and shall be secured to metal surrounds by spring clips. Glazing sprigs and spring clips shall be provided by the manufacturer of the surround.  (9) Back putty shall be of regular thickness and at least 2 mm thick. Front putty shall be formed to a triangular fillet stopping 2 mm short of sight lines. Opening lights shall be kept closed until the putty has hardened.  (10) Putty shall be primed and painted as soon as it has hardened.  (11) Timber beading shall be bedded in putty and secured with countersunk brass screws and cups. Screws and cups shall be at a maximum spacing of 200 mm and shall not be more than 75 mm from each corner.  (12) Metal beading shall be supplied with the frames and shall be fixed in accordance with the manufacturer’s recommendations.  (13) Gaps between glass and beading shall be sealed with putty. |

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| Table 22.1: Edge covers for glazing |

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| Area of glass (m ) | Edge cover (mm) |
| not exceeding 0.5 | 5 |
| Exceeding 0.5 and not exceeding 1.5 | 9 |
| Exceeding 1.5 and not exceeding 4.0 | 12 |

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|  | ***PART 4: PLUMBING GENERAL*** |  |
| 22.14.2 | Licensed plumber | Plumbing shall be carried out by a licensed plumber. |
| 22.14.3 | Taps, valves and fittings | Taps, valves and fittings shall be of a proprietary type approved by Water Supplies Department. Red lead jointing materials shall not be used. |
| **22.15** | **MATERIALS** |  |
| 22.15.1 | Pipework for plumbing | (1) Cast iron waste and ventilating pipes and fittings shall comply with BS 416 and shall have Type A or Type B sockets without ears. Holderbats shall be cast iron with 8 mm brass bolts and nuts or galvanized mild steel, which shall comply with BS EN ISO 1461: 1999 or otherwise approved by the Engineer, with cadmium plated bolts.  (2) Plastic rainwater pipes not exceeding 80 mm diameter, gutters and fittings shall comply with BS 4576: Part 1. Internal pipework, external pipes exceeding 80 mm diameter and fittings shall comply with BS 4514. Plastic roof outlets shall be of a proprietary type approved by the Engineer and shall be provided with a sealing flange and screw fixed flat or domed grating.  (3) Plastic soil and ventilating pipes and fittings shall comply with BS 4514. Plastic waste pipes shall comply with BS 5255.  (4) Plastic pipes for cold water shall be unplasticized PVC pipes complying with BS 3505 and shall have a pressure rating of Class D, or higher, as stated in the Contract. Fittings shall comply with BS 4346: Part 1, BS 4346 Part 2 and BS 4346: Part 3.  (5) Copper pipes shall comply with BS 2871: Part 1, Table X in half hard condition. Fittings for copper pipes shall comply with BS 864: Part 2, Table 6 symbol reference 864.1, 864.2 or 864.4.  (6) Adapters for pipework shall be of a proprietary type approved by the Engineer.  (7) Jointing compound for waste outlets shall be of a proprietary type approved by the Engineer. |
| 22.15.2 | Cisterns, tanks and cylinders | Cisterns and covers, tanks and cylinders shall be galvanized mild steel complying with BS 417: Part 2, Grade A thickness or other materials approved by the Engineer. Joints between sections of cistern covers shall have weatherproof standing welt type laps. |
| 22.15.3 | Draw-off taps and stop valve | (1) Screw-down-type draw-off taps and stop valves not exceeding 50 mm shall comply with BS 1010: Part 2. Stop valves in flushing water systems shall be diaphragm or ball-valves approved by the Engineer.  (2) Copper alloy gate valves and check valves shall comply with BS 5154.  (3) Gate valves exceeding 50 mm diameter shall be double flanged cast iron wedge gate valves complying with BS 5150. Gate valves for flushing water systems shall have zinc free bronze trim and a rising stem. Gate valves at incoming water mains shall comply with BS 5163. |
| 22.15.4 | Float operated valves | (1) Float operated valves not exceeding 50 mm diameter for tanks shall be bronze and shall comply with BS 1212: Part 1 or BS 1212: Part 2 and shall have the pressure rating stated in the Contract. The bronze shall be zinc free for flushing water systems. The float shall be plastic and comply with BS 2456.  (2) Float operated valves exceeding 50 mm diameter for tanks shall be cast iron with gunmetal trim and shall have the pressure rating stated in the Contract. For flushing water systems, the trim shall be zinc free bronze and the float shall be epoxy-coated copper or other material approved by the Engineer.  (3) Float operated valves for cisterns shall be diaphragm-type plastic bodied valves complying with BS 1212: Part 3. The valves shall have rubber or plastic diaphragms and shall have the pressure rating stated in the Contract. Metal parts of the valves shall be coated with two coats of bituminous paint. |
| 22.15.5 | Sanitary appliances | (1) Sanitary appliances shall be of a proprietary type approved by the Engineer and shall be white and complete with all necessary fittings.  (2) Wastes, chains, stays, taps and combination tap assemblies shall be chromium plated brass.  (3) Lavatory basins shall be vitreous china or porcelain size 635 mm x 455 mm and shall have a back skirting not exceeding 75 mm high or of other types approved by the Engineer. Basins shall be supported on brackets to suit the basin. The brackets shall be of a proprietary type approved by the Engineer.  (4) Sinks shall be at least 0.9 mm thick satin finish stainless steel Grade 18/8. Overflow and sound deadening pads shall be provided under the sink and drainers.  (5) WC pans shall be pedestal type vitreous china or porcelain washdown with a horizontal outlet. Flushing cisterns shall be provided with valveless syphonic flushing apparatus, discharge pipes, float operated valves and overflows. Flushing cisterns shall be:  low level plastic,  high level plastic,  low level vitreous china, porcelain or  close coupled vitreous china or porcelain  as stated in the Contract. Seats and covers for WC pan shall be of a proprietary type approved by the Engineer. WC pan connectors shall be PVC.  (6) Urinals shall be of a vitreous china or porcelain bowl type and shall be provided with vitreous china or porcelain flushing cistern, uPVC flush pipes and spreaders to suit the number of appliances in the following range:  4.5 litres to serve a single bowl,  9 litres to serve two bowls, and  13.5 litres to serve three bowls.  (7) Traps shall be of a proprietary type approved by the Engineer and shall be provided with a 75 mm deep seal. |
| 22.15.6 | Pipe brackets and fixings | (1) Pipe brackets for plumbing shall suit the type of pipe and the surface to which they are to be fixed and shall be of a proprietary type approved by the Engineer.  (2) Pipe brackets shall include as appropriate:  Fanged ends for building into concrete, brickwork and similar materials,  Plain round ends for fixing in drilled holes with adhesive,  Expanding bolts or stud anchors for fixing to concrete, brickwork and similar materials,  Threaded ends for fixing to steelwork and timber, and  Holed face plates for screwing to timber or plugs.  (3) Bolts for fixing pipe brackets shall be brass, cadmium plated steel or other non-corrodible metal approved by the Engineer. Expanding bolts and stud anchors shall be of a proprietary type approved by the Engineer.  (4) Adhesive for fixing pipe brackets shall be of a proprietary type approved by the Engineer. |
| **22.16** | **SUBMISSIONS** |  |
| 22.16.1 | Particulars of plumbing work | (1) The following particulars of the proposed plumber and materials for plumbing work shall be submitted to the Engineer:  Name and registration number of plumber, and  Manufacturer’s literature for pipework, cisterns, tanks and cylinders, draw-off taps and valves, float operated valves, sanitary appliances and pipe brackets.  (2) The particulars of materials for plumbing shall be submitted to the Engineer at least 14 days before plumbing work starts |
| 22.16.1 | Samples of materials | Unless otherwise permitted by the Engineer, samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:  Pipe work,  Taps and valves, and  Pipe brackets. |
| **22.17** | **STORAGE OF MATERIALS** |  |
| 22.17.1 | Storage of pipes, gutters and fittings | Pipes, gutters and fittings shall be stored in a dry weatherproof store and in such a manner that they are clear of the ground without resting on their sockets. Rubber jointing rings shall be stored in sealed plastic bags and shall be protected from exposure to conditions that may adversely affect the rings. The rings shall be stored in a manner that will not result in deformation of the rings. |
| 22.17.2 | Storage of sanitary appliances | Sanitary appliances shall be stored in a dry weatherproof store. Metal sinks and similar appliances shall be stored on a level surface and in a manner that will not result in contamination by cement or lime. |
| **22.18** | **PLUMBING WORK** |  |
| 22.18.1 | Plumbing work | (1) The ends of pipes and gutters shall be cut clean and square and shall be chamfered internally or externally as required. Cutting and chamfering shall be carried out using purpose-made equipment.  (2) Measures shall be taken to prevent deleterious material entering pipework, by temporarily sealing the ends of pipes and openings and by fitting access covers and cleaning eyes as plumbing work proceeds. Jointing material shall not project into the bore of pipes or fittings.  (3) Pipes passing through walls or floors shall be contained in a plastic pipe sleeve with 5 mm clearance. Pipes passing through fire rated walls or floors shall be contained in a galvanized mild steel pipe sleeve with 20 mm clearance. The clearance shall be caulked for the full depth with mineral wool or other material approved by the Engineer. The galvanized mild steel pipe sleeve shall comply with BS EN ISO 1461: 1999 or otherwise approved by the Engineer. Sleeves shall be finished flush with walls and ceilings and shall project 100 mm above the finished floor levels. Masking plates shall be provided on both sides of walls and ceilings and shall be sealed against the weather.  (4) Above ground foul water drainage shall be carried out in accordance with BS 5572. Bolted access doors or inspection units shall be provided to all branches and bends other than ventilating and anti-syphon pipes.  (5) Cast iron pipes shall be jointed with gaskin and caulked lead or a cold caulking compound. Flexible joints shall be made in accordance with the manufacturer’s recommendations. Cast iron pipes shall be jointed to clay spigot and socket pipes with gaskin and a mixture of cement and sand in the proportions 1:2 by volume.  (6) Plastic pipes shall be fixed and jointed in accordance with the manufacturer’s recommendations. Plastic pipes shall be jointed to pipes of other materials using adapters.  (7) Copper pipes shall be jointed with non-manipulative compression fittings or capillary fittings. Copper pipes shall be jointed to cast iron sockets with copper alloy caulking bushes and with gaskin and lead or a cold caulking compound. Copper pipes shall be jointed to tapped bosses on cast iron pipes with copper alloy threaded connectors.  (8) Water supply installations shall be carried out in accordance with BS 6700. Pipes shall be laid to a gradient of at least 1 in 100 to prevent air locks. Tanks, cisterns and pipe works shall be cleaned out and flushed through with potable water after completion.  (9) Waste outlets to wash basins, sinks and toilets shall be jointed with a proprietary type of jointing compound approved by the Engineer.  (10) WC pans on concrete floors shall be bedded in white lead putty or other non-hardening compound approved by the Engineer and shall be fixed with No. 14 SG round headed brass screws 70 mm long with domed plastic inserts. WC pans shall be jointed to drain pipes with WC pan connectors or other fittings approved by the Engineer. |
| **22.19** | **TESTING: PLUMBING - FOUL DRAINS** |  |
| 22.19.1 | Testing: plumbing – foul drains | (1) Foul drains shall be tested by plugging the lower end of the pipe and filling the pipe with water up to the flood level of the lowest sanitary appliance. Drainage above the flood level of the lowest sanitary appliance shall be tested by visual inspection.  (2) The lengths of foul drains tested in each test shall be as instructed by the Engineer. |
| 22.19.2 | Compliance criteria: plumbing - foul drains | The level of water in tests on foul drains shall remain constant for a 30-minute period without visible leakage. |
| **22.20** | **TESTING: PLUMBING - WATER PIPES** |  |
| 22.20.1 | Testing: plumbing - water pipes | Water pipes inside buildings shall be visually inspected for leaks and shall be tested as follows:  All systems, including cisterns, tanks and cylinders, shall be filled slowly with water to expel all air.  Service pipes connected to mains shall be tested at 1.5 times mains pressure for 1 hour.  Distribution pipes fed from storage tanks shall be tested at 1.5 times working pressure for 1 hour.  Each tap shall be opened and checked for a satisfactory rate of flow. |
| 22.20.2 | Compliance criteria: plumbing - water pipes | Water pipes inside buildings shall show no loss of water or visual evidence of leakage. |
|  | ***PART 5: PLASTERWORK AND OTHER FINISHES*** |  |
| **22.21** | **MATERIALS** |  |
| 22.21.1 | Cement, water and sand | (1) Cement for plasterwork and other finishes shall be PC complying with BS EN 197-1.  (2) Water for plasterwork and other finishes shall be as stated in Clause 15.3.4  (3) Sand for mixes for plasterwork and other finishes which do not incorporate lime shall be clean, hard, durable crushed rock or clean sand and shall have the particle size distribution stated in Table 22.2. Sand for mixes which incorporate lime shall be clean natural sand and shall have the particle size distribution stated in Table 22.3.  (4) The quantity of clay, fine silt and fine dust present in the sand shall not exceed 10% by mass when determined in accordance with BS 812: Part 101, BS 812: Part 102, BS 812: Part 103 and BS 812: Section 105.1. The chloride content of sand or crushed rock shall not exceed 0.03 % by mass when determined in accordance with BS 812: Part 4. |

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| Table 22.2: Particle size distribution of sand for mixes that do not incorporate lime |

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| BS test sieve size | Percentage by mass passing |
| 5.00 mm | 100 |
| 2.36 mm | 90 – 100 |
| 1.18 mm | 70 – 100 |
| 600 µm | 40 – 80 |
| 300 µm | 5 – 40 |
| 150 µm | 0 – 10 |

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| Table 22.3: Particle size distribution of sand for mixes incorporating lime |

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| BS test sieve size | Percentage by mass passing |
| 2.36 mm | 100 |
| 1.18 mm | 90 - 100 |
| 600 µm | 55 - 100 |
| 300 µm | 5 - 50 |
| 150 µm | 0 - 10 |

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| 22.21.2 | Premixed plaster | (1) Premixed plaster shall be factory-produced by weighted combination of plaster raw materials and chemicals. It shall be supplied to sites in bags. Mixing with clean water shall be required before application.  (2) There are two types of premixed plaster, cement-based and gypsum-based. Gypsum based is for internal use only.  (3) Cement-based plaster contains mineral filler material as aggregate and Portland cement as main binder, with additives for improved compressive strength and reduced shrinkage.  (4) Gypsum-based plaster contains pre-mixed minerals, gypsum-based rendering materials and additives that may be applied in one single thick application without cracking and separation from the substrate.  (5) The premixed plaster shall comply with BS 5262, BS 5492 and BS 1191. The premixed plaster manufacturing company shall have acquired ISO certification in their manufacturing process of the premixed plaster product. |
| 22.21.3 | Gypsum plaster | Gypsum plaster for plastering shall comply with BS 1191: Part 1, Grade B. |
| 22.21.4 | Lime | Lime for plastering shall be hydrated lime or quicklime complying with BS 890. |
| 22.21.5 | Stone chippings | Stone chippings for plaster shall be granite, white stone or marble chippings. The chippings shall be free from dust and shall be graded such that 100% passes a 5 mm BS test sieve and 100% is retained on a 2.36 mm BS test sieve. |
| 22.21.6 | Metal lathing | Metal lathing for plastering shall comply with BS 1369: Part 1 and shall be one of the following types:  Zinc-coated or stainless steel expanded metal lathing 6 mm short way of mesh and weighing at least 1.6 kg/m2 , or  Zinc-coated or stainless steel ribbed metal lathing weighing at least 2.25 kg/m2. |
| 22.21.7 | Aggregates for lightweight screeds | Aggregates for lightweight screeds shall be 5 mm exfoliated vermiculite or of a proprietary type of lightweight beads or granules approved by the Engineer. |
| 22.21.8 | Vapour barrier | Vapour barrier for lightweight roof screeds shall be polyethylene sheeting and shall have a nominal thickness of 80 µm. |
| 22.21.9 | Aggregates for terrazzo | Aggregates for terrazzo shall be angular crushed marble of a colour compatible with surrounding finishes. Aggregate shall be free from dust and shall be graded such that 100% passes a 10 mm BS test sieve and 100% is retained on a 5 mm BS test sieve. |
| 22.21.10 | Aggregates for granolithic concrete | Aggregates for granolithic concrete shall be crushed grey granite or white stone complying with BS 882. Aggregate shall be free from dust and shall be graded such that 100% passes a 10 mm BS test sieve and 100% is retained on a 2.36 mm BS test sieve. |
| 22.21.11 | Tiles | Each type of tile and fitting shall be obtained from the same manufacturer and shall match in colour and texture. |
| 22.21.12 | Floor tiles | Clay floor tiles and fittings shall comply with BS 6431: Part 1, BS 6431: Part 2, BS 6431: Section 3.1, BS 6431: Section 3.2, BS 6431: Section 4.1 and BS 6431: Section 4.2. Ceramic floor tiles shall be vitrified and shall have a water absorption not exceeding 3%. Clay floor quarry tiles shall be Group II and shall have a water absorption not exceeding 10%. Anti-slip tiles shall be embossed or treated with carborundum or similar grit to provide an anti-slip surface. |
| 22.21.13 | Non-homogenous floor tiles | Non-homogenous floor tiles shall comply with BS 6431: Part 10, BS 6431: Part 11, BS 6431 : Part 12, BS 6431 : Part 13, BS 6431 : Part 14, BS 6431 : Part 15 and BS 6431 : Part 18. The tiles shall be 200 mm x 200 mm, 300 mm x 300mm or 400mm x 400 mm. |
| 22.21.14 | Ceramic wall tiles | Glazed ceramic wall tiles and fittings shall comply with BS 6431: Part 1, BS 6431: Part 2, BS 6431: Section 3.1, BS 6431: Section 3.2, BS 6431: Section 4.1 and BS 6431: Section 4.2 and shall be eggshell glazed. The tiles shall be 108 mm x 108 mm or 152 mm x 152 mm or 200 mm x 200 mm and shall be at least 5.5 mm thick. The tiles shall have cushion edges. |
| 22.21.15 | Mosaic tiles | (1) Glass mosaic tiles shall be fully vitrified glass tiles free from cracks or sharp edges and shall be uniform in colour and texture. The tiles shall be 20 mm x 20 mm x 4 mm thick and shall be regular in shape.  (2) Glazed ceramic mosaic tiles shall be free from cracks or sharp edges and shall be uniform in colour and texture. The tiles shall be 18 mm x 18 mm x 5 mm thick or 25 mm x 25 mm x 5 mm thick and shall be regular in shape with square edges.  (3) Unglazed vitreous mosaic tiles shall have a water absorption not exceeding 3% and shall be 20 mm x 20 mm or 50 mm x 50 mm and shall be respectively 4 mm or 5 mm thick with matching coved tiles. |
| 22.21.16 | Homogenous coved tile skirting | Homogenous coved tile skirting shall comply with BS 6431: Part 10, BS 6431 : Part 11, BS 6431 : Part 13, BS 6431 : Part 14, BS 6431 : Part 15, BS 6431 : Part 18. The tiles shall be 200 mm x 75 mm x 7mm thick. |
| 22.21.17 | Homogenous wall tiles | Homogenous wall tiles shall comply with BS 6431: Part 10, BS 6431: Part 11, BS 6431 : Part 12, BS 6431 : Part 13, BS 6431 : Part 14, BS 6431 : Part 15 and BS 6431 : Part 18. The tiles shall be 100 mm x 100 mm. |
| 22.21.18 | External facing tiles | External facing tiles shall be of the specified type from an approved manufacturer and comply with BS 6431: Part 10, BS 6431 : Part 11, BS 6431 : Part 12, BS 6431 : Part 13, BS 6431 : Part 15, BS 6431 : Part 17, BS 6431 : Part 19 and BS 6431 : Part 20. The tiles shall be 45 mm x 45 mm x 7mm thick or 45mm x 95 mm x 7 mm thick. |
| 22.21.19 | Concrete roof tiles | Concrete roof tiles shall be precast and shall be manufactured using Grade 20/10 concrete. The tiles shall be flat and shall be 300 mm x 300 mm x 30 mm thick or 400 mm x 400 mm x 35 mm thick. |
| 22.21.20 | Tile adhesive and tile grout | (1) Tile adhesive shall be of a proprietary brand approved by the Engineer.  (2) Tile adhesive and tile grout shall be cement-based compatible with the substrate and tiles to be installed;  (3) Tile adhesive shall be in accordance with BS EN 12004:2001 cementitious adhesive, normal setting type with minimum tensile adhesive strength of 0.5N/mm², and comply with Table 22.4: |

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| Table 22.4: Tensile adhesion strength |

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| Characteristic | Requirement | Test Method |
| Initial tensile adhesion strength | ≥ 0.5 N/mm² | 8.2 of BS EN 1348:1999 |
| Tensile adhesion strength after water immersion | ≥ 0.5 N/mm² | 8.3 of BS EN 1348:1999 |
| Tensile adhesion strength after heat ageing | ≥ 0.5 N/mm² | 8.4 of BS EN 1348:1999 |
| Tensile adhesion strength after freeze-thaw cycles | ≥ 0.5 N/mm² | 8.5 of BS EN 1348:1999 |
| Open time: tensile adhesion strength | ≥ 0.5 N/mm² after not less than 20 min | BS EN 1346: 1999 |

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|  |  | (4) Tile grout shall be in accordance with ANSI A118.6: 1992, and comply with Table 22.5.  (5) The colour of the tile adhesive shall be white or grey and the colour of the grout shall be subject to the approval of the Engineer.  (6) Packed in three ply together with preparation procedures and application methods. Minimum one set of the preparation procedures and application methods shall be printed in English or Dhivehi and diagrammatic forms for each lot that is delivered to site.  (7) Brand name, batch number, shelf life, pot life and open time shall be clearly printed on outside of package;  (8) No prior soaking of tiles is required; |

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| Table 22.5: Tile grout test acceptance standards |

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| Items | Test Method | Acceptance Standards | Remarks |
| Linear Shrinkage | ANSI A118.6 :  1992 Clause H4.3 | 1 day shrinkage < 0.1%  7 days shrinkage< 0.2% | Cast and store grout specimens at 21  - 25°C, 45 - 55% R.H. |
| Water Absorption | ANSI A118.6 :  1992 Clause H3.4 | From 50% R.H. to immersion < 5% From immersion to dry  < 7% | Determine water absorption from 50% R.H. to immersion and from immersion to dry. |
| Compatibility  with Tile  Adhesive | BS 5980: 1980 Appendix D with modification. | Requirements of BS 5980: 1980 are taken  > = 950N for 14 days in laboratory condition  > = 560N for 7 days curing in laboratory condition followed by 7 days immersion in water | A layer of tile grout (1.5 mm thick) is applied over tile adhesive 1.5 mm thick (brand to be the one selected by the Engineer) which shall have been embedded in standard test piece tiles to harden for 24 hours. Ten such assemblies are prepared and cured for 14 days at laboratory condition and then subject to tensile force. Further ten assemblies are required for similar tensile tests under 7 days |
| (Tensile Adhesion) | A layer of tile grout is applied on tile adhesive for tensile adhesion test | Laboratory Condition: 20°± 2°C  45 to 75% R.H. | curing at laboratory condition followed by 7 days immersion in water. |
| Resistance to Mould Growth | BS 5980: 1980 Appendix B | No sign or evidence of mould growth on tile grout. | 3 mm thick tile grout is applied over biscuit side of test piece tile and the assembly be placed in Petri dishes for incubation at 29°± 1°C for 24 hrs after addition of potato dextrose agar. Aspergillus niger is inoculated into the grout. The whole assemble is incubated for 14 days at 29°± 1°C. |

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| 22.21.21 | Bitumen | Bitumen for tiles shall be as stated in Clause 22.1.3 |
| **22.22** | **SUBMISSIONS** |  |
| 22.22.1 | Particulars of plasterwork and other finishes | (1) The following particulars of the proposed materials for plasterwork and other finishes shall be submitted to the Engineer:  A certificate for cement, gypsum plaster and lime showing the manufacturer’s name, the date and place of manufacture and showing that the material complies with the requirements stated in the Contract,  A certificate for sand, stone chippings and each type of aggregate showing the source of the material and showing that the material complies with the requirements stated in the Contract, and including results of tests as appropriate, for  Grading  Silt content,  Manufacturer’s literature and a certificate for each type of tile and fittings showing the manufacturer’s name, the date and place of manufacture and showing that the tiles comply with the requirements stated in the Contract.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 22.22.2 | Particulars of tile adhesive and tile grout | (1) The following particulars of the proposed material for tile adhesive and tile grout shall be submitted to the Engineer:  Catalogue, brand name/model name and job reference;  Name, address and contact person of the local supplier;  Name, address and contact person of the manufacturer;  Where applicable, either the document from the manufacturer showing his authorization for the supplier as the agent/distributor in the Maldives or document from the supplier showing the appointment of the manufacturer and manufacturer’s agreement for the production of the proposed product;  Detailed Method Statement for the installation of the tiling systems, showing all work procedures from the preparation of background through to the cleaning of the completed assembly;  Original or certified true copy (issued or certified by the accredited laboratory) of the test reports showing full compliance with the requirements of sub-clauses 22.21.20 and 22.25.2. The date of the test shall be generally within two years before the date of commencement of the Contract.  Original or certified true copy (certified by the certification body) of the ISO 9000 series certification for the manufacturing plant for the Engineer’s inspection. The certification body shall be either accredited by an Accreditation Service or considered as having equivalent standard by the Environment, Transport and Works Bureau.  (2) The particulars, including test reports, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 22.22.3 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:  Sand, stone chippings and aggregates,  Tiles and fittings, and  Tile adhesives and tile grout. |
| **22.23** | **DELIVERY AND STORAGE OF MATERIALS** |  |
| 22.23.1 | Delivery and storage of cement, gypsum plaster and lime | Cement, gypsum plaster and lime shall be delivered in sealed bags or containers bearing the manufacturer’s name. The bags and containers shall be stored in a dry weatherproof store with a raised floor. |
| 22.23.2 | Storage of tile adhesive | Tile adhesive shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions which may adversely affect the adhesive. The adhesive shall be stored in accordance with the manufacturer’s recommendations and shall not be used after the recommended shelf life has been exceeded. |
| 22.23.3 | Storage of premixed plaster | Bagged premixed plaster shall be stored separately by types, off the ground in dry, well-ventilated and covered space. Use in order of delivery and within manufacturer recommended time limit. |
| **22.24** | **ON SITE DELIVERY CHECK** |  |
| 22.24.1 | General | When instructed by the Engineer, all necessary and calibrated equipment shall be provided and the following tests shall be carried out for non-slip homogenous floor tiles, glazed ceramic wall tiles, unglazed vitreous mosaic wall tiles, glass mosaic tiles, homogenous coved tile skirting, homogenous wall tiles and external facing tiles upon delivery on Site in the presence of Engineer’s Representatives: |

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| Test Items | Test Method | Acceptance Standards |
| 1. Dimension Check | By measurement |  |
| 2. Surface  Quality Check | Visual | No discolouration, no damage, no staining, no blemish, acceptable colour consistency |
| 3. Check Identification Mark | Visual | Same as the Engineer’s Approved sample |

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|  | In case of doubtful results, laboratory tests shall be carried out for confirmation;  Sampling frequency for the above tests for non-slip homogenous floor tiles, glazed ceramic wall tiles, unglazed vitreous mosaic wall tiles, glass mosaic tiles, homogenous coved tile skirting, homogenous wall tiles and external facing tiles upon delivery on Site shall be as follows: |

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| Test Items | Sample Frequency | Representative Consignment |
| 1. Dimension Check | 3 samples for each delivery per each type | One delivery per each type |
| 2. Surface Quality Check | 3 samples for each delivery per each type | One delivery per each type |
| 3. Check Identification Mark | 3 samples for each delivery per each type | One delivery per each type |

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|  | * In the event of samples failing to meet the requirements for test upon delivery on Site, remove the representative consignment off Site. * When instructed by the Engineer, the following checks shall be carried out for tile adhesives and tile grout upon delivery on Site in the presence of Engineer’s Representatives: |

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| Test Items | Test Method | Acceptance Standards |
| 1. Manufacturer’s Certificate of Origin & Delivery Note | Document Check | From an Approved origin with information of product identification numbers |
| 2. Product Identification Number | Document Check | As Approved |
| 3. Expiry Date | Check information printed on the packing | Not expired |

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|  | * In the event of the checking results failing to meet the checking requirements upon delivery on Site, the failed consignment shall be removed off Site. | |
| **22.25** | **TRIAL PANELS** |  |
| 22.25.1 | Trial panels | (1) A trial panel shall be constructed for each type of plastering and rendering, each textured finish to screeds, terrazzo, granolithic concrete and each type of tile to demonstrate that the proposed materials will produce a finish which complies with the specified requirements.  (2) Trial panels shall be constructed at least 7 days before the relevant work starts.  (3) The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before constructing trial panels.  (4) Trial panels shall be constructed using the materials submitted to the Engineer.  (5) Each trial panel shall be 1 m x 1 m and shall be constructed at a location agreed by the Engineer.  (6) Trial panels shall be used as a means of comparison against which the Engineer shall determine the compliance or otherwise of the finish in the permanent work. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal. |
| 22.25.2 | Trial panels for tile adhesive | (1) Tile adhesive compatibility with panel wall shall be demonstrated via the following test method:  The tile adhesive shall be tested against the panel wall partition selected for the Contract complete with moisture sealer. Acceptance standard shall be minimum 0.3 N/mm²;  Four specimens of 200x200mm ceramic glazed wall tile shall be selected and fixed vertically without additional support according to the manufacturer’s specification;  The interval between applying tile adhesive and placing tiles shall not be more than 5 minutes. The extent to which slip occurs per the first minute after placing tile specimen shall be recorded. The tile specimens shall be fixed by adhesive tape to prevent further slip;  The sample shall be subjected to tests of Tensile Adhesion Strength with an adhesive not exceeding 3mm in final bed thickness;  Tiles shall be pulled off on a minimum of 28 days after fixing;  An aluminium/steel dolly shall be attached onto the surface of the specimen by a suitable adhesive resin;  Strong adhesive tape shall be used to fix the position of dolly until strength of the resin is developed as advised by the resin manufacturer;  he dolly shall be connected to the Pull-off Test device. The pull-off equipment shall be capable of increasing the load steadily without jerking at a rate of 5 mm/min to 6 mm/min, and must be provided with a measurement device which shall retain the maximum force exerted, the so called failure load to the nearest 0.01KN. The measurement inaccuracy of the equipment must be less than 2%, in accordance with accuracy Grade 2 of BS 1610: Part 1: 1985;  A tensile force shall be applied gradually by the device;  The failure force, location of failure and any other observations or abnormalities shall be recorded;  The force shall be recorded from the readout unit;  Steps as described in sub-clauses (vi) to (xi) of this Clause shall be repeated until Pull-off Tests to all four tiles are completed;  Photographs shall be taken.  (2) Tile adhesive compatibility with off-form concrete shall be demonstrated via the following test method:  The tile adhesive shall be tested against a mass concrete wall Grade 35/20 of 200mm thick. Dimensions of the wall shall be determined by the laboratory carrying out the test;  Method as described in sub-clauses (1)(ii) to (1)(xiii) of this Clause shall be followed. |
| 22.25.3 | Non-compliance: trial panels | If in the opinion of the Engineer the specified finish or tile adhesive has not been produced in the trial panel, particulars of proposed changes to the materials and methods of construction shall be submitted to the Engineer; further trial panels shall be constructed until the specified finish or tile adhesive is produced in the trial panel. |
| 22.25.4 | Commencement of plasterwork and other finishes | Plasterwork and other finishes shall not commence until in the opinion of the Engineer the specified finish has been produced in the trial panel. |
| 22.25.5 | Changes in materials | Unless permitted by the Engineer, the materials used to produce the specified finish in trial panels and the trial panels for adhesive shall not be changed. |
| **22.26** | **PLASTERING AND RENDERING** |  |
| 22.26.1 | Applying spatterdash to new concrete | (1) Concrete surfaces which are to be plastered or rendered shall be spatterdashed immediately after the formwork has been removed or shall be treated with a proprietary type of bonding agent approved by the Engineer. Existing concrete surfaces shall be hacked uniformly over the complete area to expose the aggregate over at least 50% of the area. The joints in brickwork surfaces shall be raked out to a depth of at least 10 mm.  (2) Spatterdash shall consist of cement and coarse sand or granite fines in the proportions 1:2 by volume mixed with the minimum amount of water necessary to achieve the consistency of a thick slurry. Spatterdash shall be thrown with a hand trowel onto the surface to a thickness not exceeding 6 mm and shall cover at least 60% of the area that is to be plastered or rendered. Spatterdash shall be wetted one hour after application and shall be allowed to cure and harden before undercoats are applied. |
| 22.26.2 | Joint inspection to spatterdash | (1) Joint inspection to minimum 10% of spatterdash shall be carried out with the Engineer’s Representative.  (2) After hardening and curing, the adhesion of the spatterdash coat shall be checked by brushing with a stiff wire brush.  (3) Where spatterdash is easily removed, loosened spatterdash shall be completely removed. Spatterdash shall be re-applied and re-inspected after 7 days.  (4) Subsequent works on any affected area re-inspection shall not start until is to the satisfaction of the Engineer. |
| 22.26.3 | Background preparation for plastering and rendering | (1) Background for plastering and rendering shall comply with BS 385:1995 and BS 8000:1989.  (2) High pressure water jet shall be used to remove efflorescence, laitance, oil, formwork release agent, grease, dirt and loose materials from the concrete surfaces before application of subsequent finishes.  (3) Minimum 4 weeks continuous drying out shall be allowed for new concrete wall after curing before cement sand plastering/rendering commence.  (4) After application of cement sand plastering/rendering to concrete wall, additional 2 weeks drying out shall be allowed before tiling. Drying time in damp weather conditions should be extended and programme should be adjusted accordingly to ensure satisfactory installation.  (5) The prepared concrete surfaces shall be protected from the weather and contamination from concreting run-offs. |
| 22.26.4 | Preparation of hardened concrete to receive cementitious renders | Concrete surface shall be prepared by: Either:  1. a) Shortly before applying the finish, thoroughly hacking the concrete surface to remove any laitance or, where approved, with an electric spade;  b)Thoroughly cleaning and wetting the surface as required, to adjust its suction, before applying finish and remove surplus water;  c) Brushing neat cement slurry into the damp surface immediately before applying the finish;  Or  2. Applying bonding agent in accordance with the manufacturer’s recommendations. |
| 22.26.5 | Preparation of hardened concrete to receive gypsum renders | Concrete surface shall be prepared by applying bonding agent in accordance with the manufacturer’s recommendations. |
| 22.26.6 | Dubbing out | When it is necessary to correct inaccuracies in the background, dubbing out shall be as follows:  In layers of a maximum thickness of 10 mm;  In the same mix as the first coat;  Allowing each coat to dry out before applying the next;  Cross scratching each coat to provide a key for the next; and  To a total thickness not exceeding 25 mm. |
| 22.26.7 | Fixing steel lathing | (1) Exposed external arrises of plastering or rendering shall be formed at right angles made with galvanized steel corner beads, which shall comply with BS EN ISO 1461: 1999 or otherwise approved by the Engineer.  (2) Junctions between dissimilar solid backgrounds in the same plane that are to be plastered or rendered shall be jointed with a strip of metal lathing. The largest dimension of the mesh shall be perpendicular to the direction of the supports. The lathing shall extend at least 150 mm along each side of the junction and shall be fixed at 100 mm centres with galvanized steel staples, nails or tying wire as appropriate to the nature of the background. The galvanized steel staples and nails shall comply with BS EN ISO 1461: 1999 while the tying wire shall be in accordance with BS EN 10244-2: 2001 or otherwise approved by the Engineer. Laps shall be at least 50 mm where end laps occur between supports and shall be at least 25 mm at other locations. Laps shall be secured with tying wire at 75 mm centres. Cut ends of lathing shall be painted with one coat of bituminous paint complying with Clause 22.32.7  (3) Base coats and first coats of plastering and rendering shall be cross scratched to provide a key for the next coat. |
| 22.26.8 | Mixing plaster and render | (1) Mixing plaster and render shall be in accordance with BS 8000: Part 10: 1989. Too strong or too wet render mix that will increase the render drying shrinkage should be avoided. Plaster and render shall be mixed using the minimum amount of water necessary to achieve the required consistency making due allowance for the moisture content of sand and shall be used within one hour after mixing. The mixed materials shall not be reconstituted and shall not be used after the initial set has taken place. Unless otherwise permitted by the Engineer, the materials shall be mixed by mechanical methods.  (2) Renders containing plasticizers shall not be over-mixed and the constituents shall be dried before mixing with lime putty or water. |
| 22.26.9 | Premixed plaster | (1) Premixed plaster and clean water shall be mixed on site with portable electrical mixer or other equipment according to manufacturer’s recommendations.  (2) Tolerance of evenness of substrate shall be ± 5 mm for internal concrete wall, block wall and beams, and ± 3 mm for internal ceiling soffit.  (3) Substrate shall be clean; free from dust, contamination, paint, oil and loose scale. Dampen dry substrate before plastering.  (4) Premixed plaster may require the substrate to be treated with spatterdash or to be keyed before application depending on manufacturer’s recommendations.  (5) Do not use mixes after initial set has taken place and do not re-temper or reconstitute mixes unless permitted by the manufacturer’s instructions.  (6) Premixed plaster shall be carried out by experienced applicators. All the workers and supervisory staff employed for the work shall be fully instructed and trained on the method of preparation and application in accordance with the manufacturer’s recommendations.  (7) Cement based premixed plaster shall be applied with trowel or spraying machine in several coats. Application method, thickness, number of coats and drying time between coats shall be strictly in accordance with manufacturer’s recommendations.  (8)  Gypsum based premixed plaster shall be applied with trowel or spraying machine in single coat of thickness in accordance with manufacturer’s recommendations.  Half-set plaster shall be levelled with featheredge, scraped off surplus material and worked from bottom to top of wall.  Allow drying time of 30-60 minutes in accordance with manufacturer’s recommendations. Sprinkle surface with clean water and smooth with a hard sponge float to remove trowel and featheredge marks in circular motion |
| 22.26.10 | Cement render | (1) Cement render shall consist of cement and sand or granite fines in the proportions 1:3 by volume.  (2) Cement render with a specified finished thickness of 10 mm or less shall be applied in one layer. Cement render with a specified finished thickness exceeding 10 mm but not exceeding 20 mm shall be applied in two layers of equal thickness. |
| 22.26.11 | Gypsum plaster | (1) Gypsum plaster shall be applied in two coats on solid backgrounds. The first coat shall consist of Browning plaster and sand in the proportions 1:2 by volume and the finishing coat shall consist of neat finish plaster to give a total thickness not exceeding 10 mm.  (2) Gypsum plaster shall be applied in three coats on metal lathing. The first coat shall consist of metal lathing plaster and sand in the proportions 1:1½ by volume. The second coat and the finishing coat shall be as stated in Clause 22.26.11 for the first coat and the finishing coat respectively. The total thickness shall not exceed 13 mm measured from the outer face of the metal lathing. |
| 22.26.12 | Lime plaster | (1) Lime plaster for internal use shall be applied in two coats on solid backgrounds. The first coat shall consist of cement, lime and sand in the proportions 1:4:16 by volume and shall not exceed 10 mm thick on walls and 5 mm thick on soffits. The second coat shall consist of cement, lime and sand in the proportions 1:12:30 by volume and shall be 5 mm thick. The total thickness shall not exceed 15 mm on walls and 10 mm on soffits.  (2) Lime plaster for internal use shall be applied in three coats on metal lathing. The first coat and the second coat shall consist of cement, lime and sand in the proportions 1:2:6 by volume. The finishing coat shall consist of cement, lime and sand in the proportions 1:12:30 by volume and shall be 5 mm thick. The total thickness shall not exceed 13 mm measured from the outer face of the metal lathing. |
| 22.26.13 | Plaster | (1) plaster shall be applied in two coats, each 10 mm thick. The base coat shall consist of cement and sand in the proportions 1:3 by volume. The finishing coat shall consist of cement and stone chippings or marble chippings in the proportions 1:1 by volume. The chippings shall be mixed in one of the proportions stated in Table 22.6.  (2) After the finishing coat has set, the surface shall be scrubbed to expose the aggregate. |

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| Table 22.6: Proportions of chippings in plaster |

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| --- | --- | --- | --- | --- | --- | --- |
| Colour of Plaster | Cement | Proportions of chippings by mass (%) | | | | |
| Stone chippings | | | Marble chippings | |
| Dark grey | Light grey | White | Black | White |
| Dark | Ordinary | 70 | - | 20 | 10 | - |
| Medium | White | 60 | 20 | 20 | - | - |
| Light | White | 5 | 75 | - | - | 20 |
| White | White | - | - | - | - | 100 |

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| **22.27** | **SCREEDS, CONCRETE TERRAZZO AND GRANOLITHIC** |  |
| 22.27.1 | Preparation for screeds, terrazzo and granolithic concrete | (1) Concrete surfaces which are to receive screeds, terrazzo or granolithic concrete shall be hacked uniformly over the complete area to expose the coarse aggregate. Laitance shall be removed from fresh concrete by using stiff brushes or other methods agreed by the Engineer.  (2) The surfaces shall be cleaned to remove dirt, dust, oil and other deleterious material. The surfaces shall be dampened for 12 hours before applying the finish in such a manner that surplus water will not be left. Neat cement slurry shall be brushed onto the existing surface immediately before applying the finish. A proprietary type of bonding agent approved by the Engineer may be used instead of cement slurry. |
| 22.27.2 | Mixing screeds, terrazzo and granolithic concrete | Screeds, terrazzo and granolithic concrete shall be mixed as stated in Clause 22.26.8 for plaster and render. |
| 22.27.3 | Screeds | (1) Floor screeds exceeding 40 mm thick shall consist of cement, sand or granite fines and coarse aggregate in the proportions 1:1½:3 by volume. The coarse aggregate shall be graded such that 100% passes a 10 mm BS test sieve and 75% is retained on a 5 mm BS test sieve.  (2)Lightweight screeds shall consist of cement and lightweight aggregate in the proportions 1:8 by volume for roofs and 1:6 by volume for floors unless otherwise approved by the Engineer. The screed shall be finished with cement and sand or granite fines in the proportions 1:4 by volume.  (3) Other screeds shall consist of cement and sand or granite fines in the proportion 1:3 by volume.  (4) Wall screeds shall be at least 10 mm thick. The surface shall be lightly scratched to form a key.  (5) Floor screeds that are to be laid monolithically with the base shall be at least 15 mm thick and shall be applied within 3 hours after laying the base. Floor screeds that are to be bonded to a hardened concrete base shall be at least 20 mm thick.  (6) Lightweight screeds shall be at least 50 mm thick excluding the topping. The topping shall be at least 15 mm thick and shall be laid monolithically with the screed.  (7) Vapour barriers for lightweight roof screeds shall be laid flat without creases. Laps shall be at least 150 mm.  (8) Screeds shall be laid between timber battens and in bays not exceeding 15 m2. The length of each bay shall not exceed 1½ times the width of the bay and the top surface of the batten shall be set to the required level. Screeds shall be compacted to a uniform density throughout.  (9) Screeds shall be completed with one of the following surface finishes as stated in the Contract:  A smooth untextured finish using a steel trowel or power float,  An even textured finish using a wood float, or  A slightly roughened textured finish using a stiff brush. |
| 22.27.4 | Terrazzo | (1) Terrazzo shall be applied in two coats. The minimum thickness of each coat shall be as stated in Table 22.7. The first coat shall consist of cement and sand or granite fines in the proportions 1:3 by volume. The finishing coat shall consist of white or coloured cement and marble aggregate in the proportions 1:2½ by volume. The finishing coat shall be applied before the first coat has set.  (2) Terrazzo shall be laid in bays not exceeding 1 m2. The length of each bay shall not exceed 1½ times the width of the bay. Bays shall be laid in a chequer board pattern and 24 hours shall be allowed between laying adjacent bays. Bays shall be separated from other bays and from adjacent finishes to the complete depth of both coats by 3 mm thick brass strips. Terrazzo shall be compacted to a uniform density throughout.  (3) After curing has been completed as stated in clause 22.29.1, the surface of terrazzo shall be ground to a smooth finish and to expose the aggregate. Voids in the surface shall be filled with matching cement.  (4) One coat of wax polish shall be applied to the surface of wall finishes. Floor finishes shall not be highly polished or wax polished. |

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| Table 22.7: Thickness of finish of Terrazzo |

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| --- | --- | --- |
| Location | First coat | Finishing coat |
| Floors | 10 mm | 15 mm |
| Walls and dadoes | 10 mm | 10 mm |
| Treads | - | 20 mm |
| Risers | - | 15 mm |

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| --- | --- | --- |
| 22.27.5 | Granolithic concrete | (1) The proportions and surface finish of the different types of granolithic concrete shall be as stated Table 22.8.  (2) Granolithic concrete that is to be laid monolithically with the base shall be at least 20 mm thick and shall be applied within 3 hours after laying the base. Granolithic concrete that is to be bonded to a hardened concrete base shall be at least 40 mm thick.  (3) Granolithic concrete shall be laid and compacted as stated in clause 22.27.3for screeds and 24 hours shall be allowed between laying adjacent bays.  (4) Trowelled surface finishes to granolithic concrete shall be formed by trowelling the surface with a steel trowel at least 3 times over a period of 6 hours to 10 hours after compaction to give a smooth finish. Cement shall not be used to absorb surplus water. Laitance produced by trowelling shall be removed and shall not be worked into the surface.  (5) Rubbed surface finishes to granolithic concrete shall be formed by rubbing down a trowelled surface finish after it has set with fine carborundum stone to form a smooth finish and to expose the aggregate.  (6) Washed surface finishes to granolithic concrete shall be formed by brushing off a trowelled surface finish before it has set to expose the aggregate. |

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| Table 22.8: Proportions and surface finish of granolithic concrete |

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| --- | --- | --- | --- | --- | --- |
| Type of granolithic concrete | Proportions by volume | | | | Type of surface finish |
| Cement | Granite fines | Granite aggregate | White stone |
| A | 2 | 1 | 4 | - | Trowelled or rubbed |
| B | 2 | 1 | - | 4 |
| C | 1 | - | 2 | - | Washed |
| D | 1 | - | - | 2 |

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| --- | --- | --- |
| **22.28** | **TILING** |  |
| 22.28.1 | Floor tiles | (1) Floor tiles on concrete bases shall be laid by the semi-dry method as stated in clause 22.28.1.  (2) The tiles shall be laid on a bed of cement and sand in the proportions 1:4 by volume. The bed shall be mixed semi-dry and shall be at least 20 mm thick. The concrete base that is to receive the tiles and bed shall be prepared and cleaned as stated in clause 22.27.1.  (3) The tiles shall be immersed in water for 30 minutes and shall be allowed to drain immediately before laying. The cement and sand bed shall be compacted and finished to the required level. A slurry of cement and sand in the proportions 1:1 by volume shall be mixed with the minimum amount of water necessary to achieve a creamy consistency and shall be spread and trowelled over the bed to a nominal thickness of 3 mm. The tiles shall be firmly bedded into the slurry to leave straight and even joints. Tiles with minor variation in colour shall be placed at random locations.  (4) After the bed has set, the tiles shall be grouted with a mix of cement and sand in the proportions 1:1 by volume together with the minimum amount of water necessary to achieve the required workability. Surplus grout shall be cleaned from the face of tiles as work proceeds.  (5) Floor tiles on floor screeds shall be laid by the thick bed method as stated in clauses 22.28.1.  (6) The tiles shall be laid on a bed of cement and sand or granite fines in the proportions 1:3 by volume. The bed shall be approximately 15 mm thick and shall not be thicker than the tiles. The screed shall be dampened with clean water to prevent water being absorbed from the bed.  (7) Before laying, the tiles shall be immersed in water for 30 minutes and allowed to drain and the back of tiles shall be coated with a slurry of cement together with the minimum amount of water necessary to achieve a creamy consistency. The tiles shall be firmly tamped into the bed to leave straight and even joints. Tiles with minor variations in colour shall be placed at random locations.  (8) After the bed has set, the tiles shall be grouted with a mix of cement and sand in the proportions 1:1 by volume together with the minimum amount of water necessary to achieve the required workability. Surplus grout shall be cleaned from the face of tiles as work proceeds.  (9) After lying floor tiles, no traffic shall be allowed on the floor for the first 4 days and after that only light traffic as approved by the Engineer is allowed for the next 10 days. |
| 22.28.2 | Wall tiles | (1) Wall tiles shall be fixed to wall screeds as stated in clause 22.28.1 except as stated in clause 22.28.2.  (2) Glazed wall tiles shall be laid on a bed of cement and sand or granite fines in the proportions 1:3 by volume. The bed shall be at least 5 mm, and shall not exceed 15 mm, thick. Mosaic tiles shall be laid on a bed of cement and granite fines in the proportions 1:3 by volume. The bed shall be 10 mm thick. Plain or coloured cement and water shall be mixed to a creamy consistency and white cement shall not be used except otherwise stated. Tiles with minor variations in colour shall be placed at random locations.  (3) Glazed wall tiles shall be soaked in clean water for at least 30 minutes and stacked to drain and fix as soon as the surface water has drained from them. Mosaic tiles shall not be soaked but the wall render shall be dampened with clean water sufficiently to prevent the mosaic tiles absorbing water from the bedding mortar.  (4) The backs of glazed wall tiles shall be coated with a mortar of cement and sand or granite fines in the proportions 1:3 by volume. The glazed wall tiles shall be tamped firmly into position so that the bed is uniformly spread throughout to a minimum thickness of 3 mm and not more than 6 mm at localised areas for rectification of slight variations in the trueness of the render background. The tiles and joints shall be cleaned before the bedding hardens.  (5) The backs of sheets of mosaic tiles shall be coated with a slurry of cement of the same colour as the final grout. The backing paper of mosaic tiles shall be removed and final straightening of the tiles shall be carried out as the sheets are fixed firmly into position. The surface shall be rubbed with grout and coloured, as required, to fill the joints and clean any surplus from the face of the tiles as the work proceeds.  (6) Glazed wall tiles and mosaic tiles shall be grouted with a final grout of white cement and powdered limestone in the proportions 1:3 by volume.  (7) When cement-based adhesive bedding method is used to fix wall tiles, the tiling work shall be carried out in accordance with BS 5385-1:1995 and the followings:  Site demonstration is to be carried out by the adhesive supplier on the whole application procedures before commencing the tiling works.  Tiles shall be cleaned free of dust and loose powder and left thoroughly dry before immediate application.  Tiles shall not be wetted when fixing with tile adhesive unless stated in the manufacturer’s recommendations.  Tile adhesive shall be prepared and mixed in strict accordance with the manufacturer’s recommendations.  The adhesive shall be applied by notched trowelling and buttering method.  For fixing mosaic tiles with adhesive, in addition to (i) to (v) of this sub-clause, BS 5385: Part 1: 1995 with particular attention to 5.4.1 for internal wall and BS 5385: Part 2: 1991 with particular attention to 27.1 for external wall are required. The joints shall be grouted with a proprietary grout applied in accordance with the grout manufacturer’s recommendations. |
| 22.28.3 | Roof tiles | (1) Roof tiles shall be laid on a bed of cement and sand in the proportions 1:4 by volume.  (2) Roof tiles shall be laid loose and hot bitumen shall be poured between the joints and pointed.  (3) 25 mm wide joints shall be formed for each 3 m of roof tiles, and 75 mm wide joints shall be formed around the perimeter of roof tiles, to allow for expansion. |
| **22.29** | **PROTECTION OF PLASTERWORK AND OTHER FINISHES** |  |
| 22.29.1 | Protection of plasterwork and other finishes | Completed and partially completed surfaces of plasterwork and other finishes shall be protected from rapid or localised drying out for at least 7 days by covering with polythene sheeting, damp hessian, or a layer of damp sand at least 50 mm thick, or by other methods agreed by the Engineer. |
| **22.30** | **TOLERANCES** |  |
| 22.30.1 | Tolerances: plasterwork and other finishes | There shall be no abrupt irregularities in the surface of plasterwork and other finishes and there shall be no gradual irregularities exceeding 5 mm in a 2 m length. |
| **22.31** | **TESTING** |  |
| 22.31.1 | Non-slip homogenous floor tiles | The quality tests for non-slip homogenous floor tiles shall be as follow:  a) Dimensions and surface quality |

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| --- | --- | --- | --- | --- | --- | --- |
| Test Items | | | Test Method BS 6431 | Acceptance Standards | | |
| Nominal Size (mm) | | |  | 200 x 200 | 300 x 300 | 400 x 400 |
| BS 6431 Classification | | | BI | BI | BI |
| 1. Length and Width | Deviation from Work Size (%) | | Part 10 :1984 | ± 0.75 | ± 0.6 | ± 0.6 |
| Deviation from Average Size (%) | | ± 0.5 | ± 0.5 | ± 0.5 |
| 2. Thickness | | | ± 5 | ± 5 | ± 5 |
| 3. Straightness of sides (%) | | | ± 0.5 | ± 0.5 | ± 0.5 |
| 4. Rectangularity (%) | | | ± 0.6 | ± 0.6 | ± 0.6 |
| 5. Surface flatness | | Centre curvature (%) | ± 0.5 | ± 0.5 | ± 0.5 |
| Edge curvature (%) | ± 0.5 | ± 0.5 | ± 0.5 |
| Warpage (%) | ± 0.5 | ± 0.5 | ± 0.5 |
| 6. Surface quality (%) | | | = > 95 | = > 95 | = > 95 |

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| --- | --- | --- |
|  |  | b) Physical properties: |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test Items | | | Test Method BS 6431 | Acceptance Standards | | |
| Nominal Size (mm) | | |  | 200 x  200 | 300 x 300 | 400 x 400 |
| BS 6431 Classification | | | BI | BI | BI |
| 1. \*Water absorption (%) | | Average | Part 11 : 1983 | < = 3 | < = 3 | < = 3 |
| Individual | < = 3.3 | < = 3.3 | < = 3.3 |
| 2. \*Modulus of rupture (N/mm2) | | Average | Part 12 : 1983 | > = 27 | > = 27 | > = 27 |
| 3. \*Scratch hardness of surface (Moh’s Scale) | | | Part 13 : 1986 | > = 6 | > = 6 | > = 6 |
| 4. \*Abrasion resistance | Deep abrasion (mm3) | | Part 14 :1983 | < = 205 | < = 205 | < = 205 |
| 5. \*Coefficient of linear thermal expansion (x106 oC | | | Part 15 :1983 | < = 9.0 | < = 9.0 | < = 9.0 |

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| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards | | |
| Nominal Size | |  | 200 x 200 | 300 x 300 | 400 x 400 |
| BS 6431 Classification | | BI | BI | BI |
| 1. \*Resistance to acids and alkali | Sulphuric acid | Part 18 :  1983 | Required | Required | Required |
| Lactic acid | Required | Required | Required |
| Potassium hydroxide | Required | Required | Required |
| 2.\*Resistance to household chemicals | Ammonium chloride | Required | Required | Required |
| Standard cleaning agent | Required | Required | Required |
| 3.\*Resistance to swimming pool salts | Sodium hypochlorite | Required | Required | Required |
| Copper sulphate | Required | Required | Required |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction; | |
|  |  | d) Slip resistance: |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test Items | Test Method | Acceptance Standards | | |
| Nominal Size (mm) |  | 200 x 200 | 300 x 300 | 400 x 400 |
| BS 6431 Classification | BI | BI | BI |
| 1. Static Coefficient of Friction | ASTM – C1028 – 89 | > = 0.5 | > = 0.5 | > = 0.5 |

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| --- | --- | --- |
| 22.31.2 | Glazed ceramic wall tiles | The quality tests for glazed ceramic wall tiles shall be as follow: |
|  |  | a) Dimensions and surface quality |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards | | |
| Nominal Size (mm) | |  | 108 x 108 | 152 x 152 | 200 x 200 |
| BS 6431 Classification | | BIII | BIII | BIII |
| 1. Length and | Deviation | Part 10 :1984 | 0.75 / | ± 0.5 / | ± 0.5 / |
| Width | from | (-0.3, +0.6) | (-0.3, +0.6) | (-0.3, +0.6) |
| Work |
| Size (%) |
| Deviation | ± 0.5 / | ± 0.3 / | ± 0.3 / |
| from | (± 0.25) | (± 0.25) | (± 0.25) |
| Average |
| Size (%) |
| 2. Thickness | | ± 0.5 | ± 0.5 | ± 0.6 |
| 3. Minimum thickness (mm) | | 5.5 | 5.5 | - |
| 4. Straightness of sides (%) | | ± 0.3 | ± 0.3 | ± 0.3 |
| 5. Rectangularity (%) | | ± 0.5 / (± 0.3) | ± 0.5 / (± 0.3) | ± 0.5 / (± 0.3) |
| 6. Surface | Centre | - 0.3, + 0.5 | - 0.3, + 0.5 | - 0.3, + 0.5 |
| flatness | curvature | (-0.1 / +0.8 | (-0.1 / +0.8 | (-0.1 / +0.8 |
| (%) | mm) | mm) | mm) |
| Edge | - 0.3, + 0.5 | - 0.3, + 0.5 | - 0.3, + 0.5 |
| curvature | (-0.1 / +0.8 | (-0.1 / +0.8 | (-0.1 / +0.8 |
| (%) | mm) | mm) | mm) |
| Warpage (%) | ± 0.5 /  (± 0.5 mm) | ± 0.5 /  (± 0.5 mm) | ± 0.5 /  (± 0.5 mm) |
| 7. Surface quality (%) | | > = 95 | > = 95 | > = 95 |
| 8. Tile with spacer lugs | Width of tile grout at tiled surface (mm) (G) | Part 9 : 1984 | - | - | G = 3 mm ± 20% |

|  |  |  |
| --- | --- | --- |
|  | Note: Values in brackets are for tiles with spacer lugs only. | |
|  |  | b) Physical properties: |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards | | |
| Nominal Size (mm) | |  | 108 x 108 | 152 x 152 | 200 x 200 |
| BS 6431 Classification | | BIII | BIII | BIII |
| 1. \*Water | Average | Part 11 : 1983 | = > 10 & | = > 10 & < | = > 10 & |
| absorption | < = 18 | = 18 | < = 18 |
| (%) |
| 2. \*Modulus of rupture (N/mm2) | Average | Part 12 : 1983 | > = 15 | > = 15 | > = 15 |
| 3. \*Scratch hardness of surface (Moh’s Scale) | | Part 13 : 1986 | > = 3 | > = 3 | > = 3 |
| 4. \*Abrasion resistance | Surface abrasion (Class  I-IV) (PEI  Method) | Part 20 : 1983 | Minimum Class II | Minimum Class II | Minimum Class II |
| 5. \*Coefficient of linear thermal expansion (x106 oC | | Part 15 : 1983 | < = 9.0 | < = 9.0 | < = 9.0 |
| 6. \*Crazing resistance | | Part 17 : 1983 | Required | Required | Required |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards | | |
| Nominal Size | |  | 108 x 108 | 152 x 152 | 200 x 200 |
| BS 6431 Classification | | BIII | BIII | BIII |
| 1. \*Resistance to acids and alkali | Hydrochloric acid | Part 19 : 1984 | Minimum Class B | Minimum Class B | Minimum Class B |
| Citric acid | Minimum Class B | Minimum Class B | Minimum Class B |
| Potassium hydroxide | Minimum Class B | Minimum Class B | Minimum Class B |
| 2.\*Resistance to household chemicals | Ammonium chloride | Minimum Class B | Minimum Class B | Minimum Class B |
| Standard cleaning agent (See Note 2) | Minimum Class B | Minimum Class B | Minimum Class B |
| 3. \*Resistance to swimming pool salts | Sodium hypochlorite | Minimum Class B | Minimum Class B | Minimum Class B |
| Copper sulphate | Minimum Class B | Minimum Class B | Minimum Class B |
| 4. \*Resistance to staining | Methylene blue | Minimum Class B | Minimum Class B | Minimum Class B |
| Potassium permanganate | Minimum Class B | Minimum Class B | Minimum Class B |

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| --- | --- | --- |
|  | Note:  1. For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction | |
| 22.31.3 | Unglazed vitreous mosaic wall tiles | The quality tests for unglazed vitreous mosaic wall tiles shall be as follow: |
|  |  | a) Dimensions and surface quality |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 20 x 20, 50 x 50 |
| BS 6431 Classification | | BI |
| 1. Length and Width | Deviation from Work Size (%) | Part 10 :1984 | ± 1.2 |
| Deviation from Average Size (%) | ± 0.75 |
| 2. Thickness | | ± 10 |
| 3. Minimum thickness (mm) | | 4 (20 x 20) |
| 5 (50 x 50) |
| 4. Straightness of sides (%) | | ± 0.75 |
| 5. Rectangularity (%) | | ± 1.0 |
| 6. Surface flatness | Centre curvature (%) | ± 1.0 |
| Edge curvature (%) | ± 1.0 |
| Warpage (%) | ± 1.0 |
| 7. Surface quality (%) | | > = 95 |

|  |  |  |
| --- | --- | --- |
|  |  | b) Physical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 20 x 20, 50 x 50 |
| BS 6431 Classification | | BI |
| 1. \*Water absorption (%) | Average | Part 11 : 1983 | < = 3 |
| Individual | < = 3.3 |
| 2. \*Modulus of rupture (N/mm2) | Average | Part 12 : 1983 | > = 27 |
| 3. \*Scratch hardness of surface (Moh’s Scale) | | Part 13 : 1986 | > = 6 |
| 4. \*Abrasion resistance | Deep abrasion (mm) | Part 14 : 1983 | < = 205 |
| 5. \*Coefficient of linear thermal expansion (x106 oC) | | Part 15 : 1983 | < = 9.0 |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size | |  | 20 x 20, 50 x 50 |
| BS 6431 Classification | | BI |
| 1. \*Resistance to acids and alkali | Sulphuric acid | Part 18 : 1983 | Required |
| Lactic acid | Required |
| Potassium hydroxide | Required |
| 2. \*Resistance to household chemicals | Ammonium chloride | Required |
| Standard cleaning agent | Required |
| 3. \*Resistance to swimming pool salts | Sodium hypochlorite | Required |
| Copper sulphate | Required |

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| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
| 22.31.4 | Glass mosaic wall tiles | The quality tests for glass mosaic wall tiles shall be as follow: |
|  |  | a) Dimensions and surface quality |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test Items | | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | | |  | 20 x 20 |
| 1. Length and Width | | Deviation from Work Size (%) | Part 10 :1984 | ± 2.0 |
| 2. Thickness | | | ± 10 |
| 3. Minimum thickness (mm) | | | 4 |
| 4. Surface flatness | Centre curvature (%) | | ± 1.0 |
| Edge curvature (%) | | ± 1.0 |
| 5. Surface quality (%) | | | > = 95 |

|  |  |  |
| --- | --- | --- |
|  |  | b) Physical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 20 x 20 |
| 1. \*Water absorption (%) | Average | Part 11 : 1983 | < = 3 |
| 2. \*Modulus of rupture (N/mm2) | Average | Part 12 : 1983 | > = 27 |
| 3. \*Scratch hardness of surface (Moh’s Scale) | | Part 13 : 1986 | > = 6 |
| 4. \*Coefficient of linear thermal expansion (x106 oC) | | Part 15 : 1983 | < = 9.0 |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size | |  | 20 x 20 |
| 1.\*Resistance to acids and alkali | Sulphuric acid | Part 18 : 1983 | Required |
| Lactic acid | Required |
| Potassium hydroxide | Required |
| 2. \*Resistance to household chemicals | Ammonium chloride | Required |
| Standard cleaning agent | Required |
| 3. \*Resistance to swimming pool salts | Sodium hypochlorite | Required |
| Copper sulphate | Required |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
| 22.31.5 | Homogenous coved tile skirting | The quality tests for homogenous coved tile skirting shall be as follow: |
|  |  | a) Dimensions and surface quality |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 200 x 75 x 7 |
| BS 6431 classification | | BI |
| 1. Length and Width | Deviation from Work Size (%) | Part 10 :1984 | ± 0.75 |
| Deviation from Average Size (%) | ± 0.5 |
| 2. Thickness (%) | | ± 5 |
| 3. Surface quality (%) | | > = 95 |

|  |  |  |
| --- | --- | --- |
|  |  | b) Physical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 200 x 75 x 7 |
| BS 6431 classification | | BI |
| 1. \*Water absorption (%) | Average | Part 11 : 1983 | < = 3 |
| Individual | < = 3.3 |
| 2. \*Scratch hardness of surface (Moh’s Scale) | | Part 13 : 1986 | > = 6 |
| 3. \*Abrasion resistance | Deep abrasion (mm3) | Part 14 : 1983 | < = 205 |
| 4. \*Coefficient of linear thermal expansion (x106 oC) | | Part 15 : 1983 | < = 9.0 |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size | |  | 200 x 75 x 7 |
| BS 6431 classification | | BI |
| 1. \*Resistance to acids and alkali | Sulphuric acid | Part 18 : 1983 | Required |
| Lactic acid | Required |
| Potassium hydroxide | Required |
| 2. \*Resistance to household chemicals | Ammonium chloride | Required |
| Standard cleaning agent | Required |
| 3. \*Resistance to swimming pool salts | Sodium hypochlorite | Required |
| Copper sulphate | Required |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
| 22.31.6 | Homogenous wall tiles | The quality tests for homogenous wall tiles shall be as follow: |
|  |  | a) Dimensions and surface quality |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 100 x 100 |
| BS 6431 classification | | BI |
| 1. Length and Width | Deviation from Work Size (%) | Part 10 :1984 | ± 1.0 |
| Deviation from Average Size (%) | ± 0.5 |
| 2. Thickness (%) | | ± 10 |
| 3. Straightness of sides (%) | | ± 0.5 |
| 4. Rectangularity (%) | | ± 0.6 |
| 5. Surface flatness | Centre curvature (%) | ± 0.5 |
| Edge curvature (%) | ± 0.5 |
| Warpage (%) | ± 0.5 |
| 3. Surface quality (%) | | > = 95 |

|  |  |  |
| --- | --- | --- |
|  |  | b) Physical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 100 x 100 |
| BS 6431 classification | | BI |
| 1. \*Water absorption (%) | Average | Part 11 :  1983 | < = 3 |
| Individual | < = 3.3 |
| 2. \*Modules of rupture (N/mm2) | Average | Part 12 :  1983 | > = 27 |
| 3. \*Scratch hardness of surface (Moh’s Scale) | | Part 13 :  1986 | > = 6 |
| 4. \*Abrasion resistance | Deep abrasion (mm3) | Part 14 :  1983 | < = 205 |
| 5. \*Coefficient of linear thermal expansion (x106 oC) | | Part 15 :  1983 | < = 9.0 |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size | |  | 100 x 100 |
| BS 6431 classification | | BI |
| 1. \*Resistance to acids and alkali | Sulphuric acid | Part 18 : 1983 | Required |
| Lactic acid | Required |
| Potassium hydroxide | Required |
| 2. \*Resistance to household chemicals | Ammonium chloride | Required |
| Standard cleaning agent | Required |
| 3. \*Resistance to swimming pool salts | Sodium hypochlorite | Required |
| Copper sulphate | Required |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
| 22.31.7 | External facing tiles | The quality tests for external facing tiles shall be as follow: |
|  |  | a) Dimensions and surface quality |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 45 x 45 x 7 &  45 x 95 x 7 |
| BS 6431 classification | | BI |
| 1. Length and Width | Deviation from Work Size (%) | Part 10 :1984 | ± 1.2 |
| Deviation from Average Size (%) | ± 0.75 |
| 2. Thickness (%) | | ± 10 |
| 3. Straightness of sides (%) | | ± 0.75 |
| 4. Rectangularity (%) | | ± 1.0 |
| 5. Surface flatness | Centre curvature (%) |  | ± 1.0 |
| Edge curvature (%) | ± 1.0 |
| Warpage (%) | ± 1.0 |
| 3. Surface quality (%) | |  | > = 95 |

|  |  |  |
| --- | --- | --- |
|  |  | b) Physical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size (mm) | |  | 45 x 45 x 7 &  45 x 95 x 7 |
| BS 6431 classification | | BI |
| 1. \*Water absorption (%) | Average | Part 11 :1983 | < = 3 |
| Individual | < = 3.3 |
| 2. \*Modules of rupture (N/mm2) | Average | Part 12 :1983 | > = 27 |
| 3. \*Scratch hardness of surface (Moh’s Scale) | | Part 13 :1986 | > = 5 |
| 4. \*Abrasion resistance | Surface abrasion (Class I – IV) (PEI Method) | Part 20 :1983 | Minimum Class III |
| 5. \*Coefficient of linear thermal expansion (x106 oC) | | Part 15 :1983 | < = 9.0 |
| 6. \*Crazing resistance | | Part 17 :1983 | Required |

|  |  |  |
| --- | --- | --- |
|  | Note: For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  |  | c) Chemical properties: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | | Test Method BS 6431 | Acceptance Standards |
| Nominal Size | |  | 45 x 45 x 7 & 45 x 95 x 7 |
| BS 6431 classification | | BI |
| 1. \*Resistance to acids and alkali | Hydrochloric acid | Part 19 : 1984 | Minimum Class B |
| Citric acid | Minimum Class B |
| Potassium hydroxide | Minimum Class B |
| 2. \*Resistance to household chemicals | Ammonium chloride | Minimum Class B |
| Standard cleaning agent (See Note 2) | Minimum Class B |
| 3. \*Resistance to swimming pool salts | Sodium hypochlorite | Minimum Class B |
| Copper sulphate | Minimum Class B |
| 4. \*Resistance to Staining | Methylene blue | Minimum Class 2 |
| Potassium permanganate (See Note 2) | Minimum Class 2 |

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| --- | --- | --- |
|  | Note:  1. For the tests marked with \*, valid test certificates (original or certified true copies issued by the testing laboratories) for tests carried out within the past 12 months are acceptable as evidence of compliance to the Engineer’s satisfaction. | |
|  | ***PART 6: PAINTING*** |  |
| **22.32** | **MATERIALS** |  |
| 22.32.1 | Paint and associated materials | (1) Unless otherwise approved by the Engineer, paint and associated materials in a coating system shall be obtained from the same manufacturer and shall be supplied in sealed containers marked to identify the contents, the manufacturer’s brand label and recommendations for use.  (2) Paint and associated materials for general use shall be a proprietary type approved by the Engineer and shall be obtained from manufacturers approved by the Engineer.  (3) Paint and associated materials which will be applied to surfaces which may come into contact with potable or fresh water shall be of a proprietary type approved by the Engineer which is listed in the current version of the ‘Water Fittings and Materials Directory’ issued by the United Kingdom Water Research Council as being suitable for such use.  (4) Undercoats and finishing coats shall be compatible with the primer and with each other and shall be obtained from the same manufacturer. Undercoats and primary finishing coats shall be of slightly different tints to each other and to the finishing coat.  Flat finish undercoats shall be used for hard gloss finishes. |
| 22.32.2 | Aluminium primer | Aluminium primer shall comply with BS 4756, Type 1. |
| 22.32.3 | Zinc chromate primer | Zinc chromate primer and metallic zinc-rich primer Type 2 shall comply with BS 4652. |
| 22.32.4 | Lead primer | Lead primer shall comply with BS 2523. |
| 22.32.5 | Calcium plumbate primer | Calcium plumbate primer shall comply with BS 3698. |
| 22.32.6 | Bitumastic paint | Bitumastic paint shall be quick drying Type B complying with BS 1070. |
| 22.32.7 | Bituminous paint | Bituminous paint shall comply with BS 6949. |
| 22.32.8 | Knotting | Knotting shall comply with BS 1336. |
| 22.32.9 | Stopping | Stopping shall comply with BS 544. |
| 22.32.10 | Rust inhibitor | Rust inhibitor shall be a chemical agent that is capable of converting rust into iron phosphate. |
| 22.32.11 | Sealers | Sealers for plaster, masonry and similar materials shall be a stabilising solution or oil based plaster sealer. |
| 22.32.12 | Wood preservative | Wood preservative shall be as stated in clause 22.6.3 |
| 22.32.13 | Polyurethane paint | Polyurethane paint shall be a two-pack type. |
| 22.32.14 | Epoxy paint | Cold cure epoxy paint shall be a two-pack type. |
| 22.32.15 | Textured paint | Textured paint for external use shall be a heavy duty masonry paint incorporating a fine aggregate filler. |
| 22.32.16 | Plastic emulsion paint | Plastic emulsion paint shall be a vinyl or acrylic based emulsion incorporating a fungicide. |
| 22.32.17 | Cement paint | Cement paint shall be a waterproof cement based paint supplied in drums and shall not be mixed with lime or similar materials. |
| 22.32.18 | Gloss paint | Synthetic gloss paint for internal and external use shall have an alkyd resin base combined with drying oils and pigments. |
| 22.32.19 | Volatile organic compound content | The Volatile Organic Compound (VOC) content, in grams per litre, of all paint applied on surfaces of building fabrics, building elements and any installations/equipment inside semi-enclosed/enclosed areas of the building shall not exceed:  Type of Internal Paint Type of External Paint  water-based Paint : 80 g/litre Water-based Paint : 100 g/litre Solvent-based Paint : 450 g/litre Solvent-based Pain t: 450 g/litre  The VOC content of paint shall be determined either by recognized method of calculation or laboratory testing. |
| 22.32.20 | Selection of colours for paintwork | (1) The colours of paintwork shall be provisionally selected by the Engineer from a catalogue showing the range of colours offered by the manufacturers. The catalogue shall be submitted to the Engineer at least 14 days before painting starts.  (2) Trial panels shall be painted in each of the colours provisionally selected by the Engineer. Each trial panel shall be 1 m x 1 m and shall be painted with the complete paintwork system.  (3) The Engineer shall select the final colour of paintwork from the trial panel.  (4) Trial panels shall be used as a means of comparison for the colour of the finished paintwork. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal. |
| **22.33** | **STORAGE OF MATERIALS** |  |
| 22.33.1 | Storage of paint and associated materials | (1) Paint and associated materials shall be stored in a dry weatherproof store. The store shall be maintained in a cool, well-ventilated condition.  (2) Tins of paint shall be labelled as being for external use, internal use, undercoating and finishing, as appropriate, and shall be protected from exposure to conditions that may adversely affect the material. Paint and associated materials shall be stored in accordance with the manufacturers’ recommendations and shall not be used after the recommended shelf life has been exceeded. |
| **22.34** | **ON-SITE DELIVERY CHECK** |  |
| 22.34.1 | Emulsion paint, synthetic paint and multi-layer acrylic paint | a) The checking requirement are in the following table: |

|  |  |  |
| --- | --- | --- |
| Test Items | Test Method | Acceptance Standards |
| 1. Manufacturer’s Certificate of origin  &Delivery Note | Document check | From Approved origin with information of product identification number |
| 2. Colour Code/Label/Serial Number | Check information printed on the packing | As Approved |
| 3. Expiry Date | Check information printed on the packing | Not expired |

|  |  |  |
| --- | --- | --- |
|  |  | b) In the event that the checking results fail to meet the checking requirements upon delivery on Site, the failed consignment shall be removed off Site. |
| 22.34.2 | Preparation of surfaces for painting | (1) Surfaces that are to be painted shall be dry and clean, and deleterious and loose material shall be removed.  (2) Absorbent surfaces which are to be painted with cement paint shall be thoroughly dampened to provide even suction.  (3) Knotting shall be applied to knots in timber.  (4) Screws and nails in timber and building board surfaces shall be recessed or punched below the finished surface and the whole surface shall be stopped.  (5) Plaster, cement render, masonry, concrete and similar surfaces shall be stopped and sealed.  (6) Scale and rust shall be removed from non-galvanized steel and ironwork. The surface shall be painted with rust inhibitor at least 12 hours before priming or shall be blast-cleaned in accordance with the paint manufacturer’s recommendations.  (7) Surfaces adjacent to paintwork shall be temporarily masked to prevent contamination during painting |
| 22.34.3 | Type and number of coats for painting system | The type and number of coats applied to different surfaces for each painting system shall be as stated in Table 22.9. |
| 22.34.4 | Application of paint and associated materials | (1) Paint and associated materials shall be applied in accordance with BS 6150 and shall be mixed and applied in accordance with the manufacturers’ recommendations.  (2) Painting shall not be carried out in wet or misty weather, in direct strong sunlight, or if in the opinion of the Engineer there is excessive dust in the atmosphere.  (3) Paint and associated materials shall be applied with bristle brushes or rollers. If mechanical spraying is permitted by the Engineer the primer coat, or the first undercoat if a primer coat is not required, shall be applied by brush.  (4) Primer coats shall be thoroughly brushed into all surfaces including joints, angles and sawn ends. Primer coats shall be applied to surfaces that will be inaccessible before fittings are fixed in position.  (5) Paint and associated materials shall not be applied until the underlying surface has been rubbed down with fine glass paper and is clean and dry.  (6) Undercoats and finishing coats shall be applied in an even film free from brush marks, sags and runs. If two hard gloss finishing coats are to be applied, the second coat shall be applied within 48 hours after the first coat.  (7) Cement paint shall be applied within 1 hour after mixing. A minimum of 12 hours drying time shall be allowed between coats.  (8) “Wet Paint” signs in English and Dhivehi shall be prominently displayed adjacent to newly painted surfaces. |
| 22.34.5 | Health and safety | (1) Lead based primers and calcium plumbate primers shall not be applied by spaying.  (2) Respirators, which supply clean air during blasting cleaning, paint spraying or in a situation where toxic fumes are generated, shall be worn.  (3) Precautions shall be taken to avoid skin and eye contact with paints and their solvents. All precautionary measures as recommended by the paint manufacturers shall be followed. |

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| Table 22.9: Type and number of coats for painting systems |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Painting system | Surface type | Primer | | No. of under­ coats | Finishing coat | |
| Type | No. of coats | Type | No. of coats |
| A | Internal woodwork | Aluminium primer | 1 | 1 | Hard gloss | 1 |
| B | Internal woodwork natural finish | Polyurethane primer | 1 | 1 | Polyurethane paint | 1 |
| C | External woodwork | Aluminium primer | 1 | 2 | Hard gloss | 1 |
| D | Hidden surfaces of woodwork and rough sawn timbering | - | - | - | Wood preservative | 2 |
| E | Non-structural internal bright steel | Zinc chromate metallic zinc-rich or  lead primer | 1 | 1 | Hard gloss | 1 |
| F | Non-structural external bright steel | as for E above | 1 | 1 | Hard gloss | 2 |
| G | Internal galvanized steel | Calcium plumbate primer | 1 | 1 | Hard gloss | 1 |
| H | External galvanized steel | as for G above | 1 | 1 | Hard gloss | 2 |
| I | Galvanized steel adjacent to the coast or in sewage treatment works | Epoxy red oxide chromate primer | 1 | 1 | Cold cure epoxy paint | 1 |
| J | Ironwork | - | - | 1 before fixing | Bitumastic paint | 2 |
| K | Internal walls and ceilings | Alkali resistant primer | 1 | - | Semi-gloss plastic emulsion paint | 2 |
| L | External walls without tile or similar finishes | - | - | - | Cement paint | 2 |
| M | Structural steelwork | as stated in Section 16 | | | | |

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| **22.35** | **TESTING** |  |
| 22.35.1 | Emulsion paint | The quality tests for emulsion paint shall be as follows: |

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| --- | --- | --- | --- |
| Test Items | | Test Method | Acceptance Standards |
| Preliminary Examination of paint | Surface skin | BS 3900 : A2 : 1983 | - No surface skin |
| Consistency | - No gelling |
| Colour separation into layers | - No colour separation |
| Visible impurities | -No visible impurities |
| Sediment | - No hard settling |
| Drying times | Hard drying | BS 3900 : C3 : 1990 | < = 1 hour |
| Fineness of grind (μm) | | BS 3900 : C6 : 1983 | < = 50μm |
| Hiding power (contrast ratio %) | | BS 3900 : D4 : 1974 | > = 75% |
| Specular gloss | 85o | BS 3900 : D5 : 1980 | < = 20 |
| Viscosity (procedure B) | | ASTM : D562 : 81 | 65 – 85 KU |
| Scrub resistance (cycle) | | ASTM : D2486 - 96 | > = 400 cycles |

|  |  |  |
| --- | --- | --- |
| 22.35.2 | Synthetic paint | The quality tests for emulsion paint shall be as follows: |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test Items | | | | Test Method | Acceptance Standards |
| Preliminary examination of paint | | | Surface skin | BS 3900 : A2 : 1993 | - No surface skin |
| Consistency | - No gelling |
| Colour separation into layers | - No colour separation |
| Settling | -No hard settling |
| Extraneous matter | - extraneous matter |
| Viscosity (Flow Cup No. 6) (sec) | | | | BS 3900 : A6 : 1996 | 45 to 60 sec |
| Drying times | Surface drying (hour) | | | BS 3900 : C2 : 1994 | < = 4 |
| Hard drying | | | BS 3900 : C3 : 1990 | < = 18 |
| Fineness of grind (μm) | | | | BS 3900 : C6 : 1983 | < = 25μm |
| Hiding power (contrast ratio %) | | | | BS 3900 : D4 : 1974 | > = 85% |
| Specular gloss | | 60o | | BS 3900 : D5 : 1997 | > 80 |
| Bend test | | | | BS 3900 : E1 : 1995 | No coating crack at 3 mm mandrel |
| Scratch test (g) | | | | BS 3900 : E2 : 1992 | > = 600 |

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| --- | --- | --- |
| 22.35.3 | Multi-layer acrylic paint | The quality tests for emulsion paint shall be as follows: |

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | Test Method | Acceptance Standards | Remarks |
| 1. Low Temperature Stability | BS or similar | No lumps and free from separation and aggregation of the composing materials | Respective coatings of primer coating, main coating and top coating are regarded as samples. |
| 2. Change in Consistency | BS or similar | ± 15% | Respective coatings of primer coating, main coating and top coating are regarded as samples. |
| 3. Cracking Resistance due to Initial Stage Drying | BS or similar | No cracking shall occur. |  |
| 4. Adhesion Strength | BS or similar | Standard condition > =  68.6 N/cm2  Immersion in water > = 49.0 N/cm2 |  |
| 5. Repeated Warning and Cooling | BS or similar | No peering, cracking and blistering and remarkable discolouration and degradation in luster on the surface. |  |
| 6. Permeability | BS or similar | < = 0.5 ml |  |
| 7. Impact Resistance | BS or similar | Cracking, remarkable deformation and peeling shall not occur. |  |
| 8. Weather Resistance | ASTM G-53-88 | Cracking and peeling shall not occur and the discolouration shall be No. 3 or over in grey scale | The test conditions: Fluorescent UV Lamp: UVA-340  Cycle: 24 hrs UV at 60oC  Total exposure time: 250 hours |
| 9. Determination of Resistance to humid atmospheres containing sulphur dioxide | BS 3900: F8 : 1976 | No blistering, loss of adhesion, rust staining, change of colour, embrittlement and other signs of deterioration. | The amount of sulphur dioxide to be used in testing is one litre. The test cycle to be 12 cycles |
| 10. Resistance to Fungal Growth | BS 3900: G6 : 1989 | Rating 0, no fungal growth |  |
|  | Note:  1. The colour of paint to be tested shall be selected by the Engineer.  2. The base plate for testing to be 20 mm thick cement mortar board. | | |

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|  | ***PART 7: BRICKWORK AND BLOCKWORK*** |  |
| **22.36** | **MATERIALS** |  |
| 22.36.1 | Clay bricks | (1) Clay bricks shall be a brand approved by the Engineer and shall be well burnt, hard, sound, square and clean.  (2) The nominal dimensions of clay bricks shall be 225 mm x 112.5 mm x 75 mm, 200 mm x 100 mm x 75 mm, and special sizes and shapes in accordance with the requirements stated in the Contract.  (3) Clay bricks for fair-faced work shall be selected for evenness, texture, sharpness of arrises and uniformity of colour.  (4) The compressive strength of the clay bricks shall be at least 7.0 MPa. |
| 22.36.2 | Concrete bricks and blocks | (1) Concrete bricks and blocks shall be obtained from a manufacturer approved by the Engineer. The compressive strength of the concrete bricks shall be at least 7.0 MPa and for blocks and fixing bricks at least 2.8 MPa.  (2) The nominal dimensions of concrete bricks shall be 225 mm x 105 mm x 70 mm. The size of concrete blocks shall be as approved by the Engineer.  (3) Concrete bricks and blocks for fair-faced work shall be selected for evenness, texture and sharpness of arrises. |
| 22.36.3 | Concrete hollow blocks | The compressive strength of the concrete hollow blocks shall be at least 2.8 MPa over the gross area. |
| 22.36.4 | Brickwork reinforcement | Brickwork reinforcement shall be expanded metal or mild steel rods and shall be galvanized in accordance with BS EN ISO 1461: 1999 or otherwise approved by the Engineer, or painted with two coats of bituminous paint complying with clause 22.32.7 |
| 22.36.5 | Damp proof course | Damp proof course shall be two layers of 2-ply bituminous paper or other types complying with BS 743. Hessian based types of bitumen damp proof course shall not be used. |
| 22.36.6 | Wall ties | (1) Wall ties between the ends of walls and concrete shall be:  6 mm diameter steel rods 350 mm long galvanized or painted with two coats of bituminous paint complying with clause 22.32.7, or  20 mm x 3 mm galvanized mild steel flats 350 mm long and fanged at both ends.  (2) Wall ties for walls built against the face of concrete structures shall be 20 mm x 3 mm galvanized mild steel flats 150 mm long and fanged at both ends.  (3) The length of mild steel flat ties that are fixed by shot firing into concrete walls may be reduced if permitted by the Engineer.  (4) The galvanized mild steel flats shall comply with BS EN ISO 1461: 1999 or otherwise approved by the Engineer. |
| 22.36.7 | Mortar for brickwork and blockwork | (1) Cement, water and sand for mortar for brickwork and blockwork shall be as stated in clause 22.21.1  (2) Lime putty shall be prepared by mixing hydrated lime with the minimum amount of water necessary to achieve a thick creamy consistency. The putty shall be left undisturbed for at least 16 hours before use.  (3) Cement mortar shall consist of cement and sand in the proportions 1:3 by volume. Cement lime mortar shall consist of cement, lime putty and sand in the proportions 1:1:6 by volume for external walls and in the proportions 1:2:9 by volume for internal walls. |
| **22.37** | **SUBMISSIONS** |  |
| 22.37.1 | Particulars of brickwork and blockwork | (1) The following particulars of the proposed materials for brickwork and blockwork shall be submitted to the Engineer:  A certificate showing the manufacturer’s name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract and including results of tests for crushing strength of clay bricks, concrete bricks and blocks and concrete hollow blocks,  Details of brickwork reinforcement, damp proof course and wall ties, and  Details of materials for mortar.  (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site. |
| 22.37.2 | Samples of materials | Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:  Each type of brick and block, and  Brickwork reinforcement, damp proof course and wall ties. |
| **22.38** | **TRIAL PANELS** |  |
| 22.38.1 | Trial panels | (1) A trial panel shall be constructed for each type of faced and fair-faced brickwork or blockwork to demonstrate that the proposed materials will produce brickwork or blockwork that complies with the specified requirements.  (2) Trial panels shall be constructed at least 14 days before the relevant work starts.  (3) The Contractor shall inform the Engineer 24 hours, or such shorter period agreed by the Engineer, before constructing trial panels.  (4) Trial panels shall be constructed using the materials submitted to the Engineer.  (5) Each trial panel shall be 1 m x 1 m and shall be constructed at a location agreed by the Engineer.  (6) Trial panels shall be used as a means of comparison against which the Engineer shall determine the compliance or otherwise of the brickwork or blockwork in the permanent work. Trial panels shall be protected from damage and shall be left in position until the Engineer instructs their removal. |
| 22.38.2 | Non-compliance: brickwork and blockwork | If in the opinion of the Engineer the brickwork or blockwork in the trial panel does not comply with the specified requirements for brickwork or blockwork, particulars of proposed changes to the materials and methods of construction shall be submitted to the Engineer. Further trial panels shall be constructed until the trial panel complies with the specified requirements. |
| 22.38.3 | Commencement of brickwork and blockwork | Brickwork and blockwork shall not commence until in the opinion of the Engineer the trial panel complies with the specified requirements. |
| 22.38.4 | Changes in materials | Unless permitted by the Engineer, the materials used to produce a trial panel that complies with the specified requirements shall not be changed. |
| **22.39** | **HANDLING AND STORAGE OF MATERIALS** |  |
| 22.39.1 | Handling and storage of bricks and blocks | (1) Bricks and blocks shall be unloaded and handled in a manner which will not result in soiling, chipping or other damage to the bricks and blocks.  (2) Bricks and blocks shall be stored on a dry, levelled and maintained hard-standing ground base on level supports and in a manner which will not result in damage or deformation to the bricks or blocks or in contamination of the bricks or blocks.  (3) Bricks and blocks shall be stored horizontally.  (4) Bricks and blocks shall be protected from damage and damaged bricks and blocks shall not be used in the permanent work unless permitted by the Engineer. |
| **22.40** | **LAYING BRICKS AND BLOCKS** |  |
| 22.40.1 | Type of mortar | (1) Cement mortar shall be used for brickwork and blockwork:  Below the damp proof course, including basement walls,  For brickwork and blockwork not exceeding 150 mm thick,  In load-bearing walls, and  For pointing where the bed is cement mortar or where stated in the Contract.  (2) Cement lime mortar shall be used for brickwork and blockwork other than those stated in clause 22.33.1  (3) Mortar shall be mixed using the minimum amount of water necessary to achieve the required consistency and shall be used within one hour after mixing. Unless otherwise permitted by the Engineer, the materials shall be mixed by a mechanical method. |
| 22.40.2 | Bond and gauge of brickwork and blockwork | (1) Stretcher bond shall be used for half brick walls and English bond shall be used for brick walls exceeding half brick thick. Stretcher bond shall be used for blockwork.  (2) Brick courses shall be gauged with four courses to 300 mm including joints.  (3) Bricks and blocks shall be laid on a full bed of mortar and the joints shall be filled solid to a thickness of 10 mm.  (4) Single frog bricks in load-bearing walls shall be laid with the frog facing upward and filled with mortar.  (5) Courses shall be kept level and perpends shall be kept in line vertically. Quoins and other angles shall be plumbed as the work proceeds and shall be constructed in advance of the remainder of the wall, but not exceeding five courses, and shall be racked back between levels.  (6) Bricks and blocks shall be wetted before laying during dry weather using the minimum amount of water necessary to prevent premature drying out of the mortar. During wet weather, freshly laid brickwork and blockwork shall be protected at the completion of each day’s work or in heavy rain. |
| 22.40.3 | Laying damp proof courses | (1) Brickwork shall be flushed up with cement mortar to form a level and even bed to receive the horizontal damp proof course.  (2) Damp proof courses shall be laid in a continuous strip with 150 mm laps at the end of the length and at returns. The mortar joint shall be completed to the normal thickness. |
| 22.40.4 | Fixing wall ties | (1) At junctions of walls and concrete, wall ties shall be fixed at 300 mm centres vertically and shall project 250 mm into the wall.  (2) Wall ties shall be fixed for walls built against the face of concrete structures and shall be spaced at intervals of 900 mm horizontally and 300 mm vertically in a staggered pattern. The ties shall project 75 mm into the wall. |
| 22.40.5 | Finishing of joints in brickwork and blockwork | Joints that will not be visible in the finished brickwork and blockwork shall be struck off as the work proceeds. Joints that will be exposed shall be struck flush and weather pointed as the work proceeds. Joints in brickwork to which plaster or other wet applied finishes will be applied shall be raked out to a depth of 10 mm. |
| **22.41** | **TOLERANCES** |  |
| 22.41.1 | Tolerances: brickwork and blockwork | Brickwork and blockwork shall comply with the following requirements:  The position on plan shall be within 15 mm of the specified position.  The length shall be within 15 mm of the specified length.  The height shall be within 10 mm of the specified height.  The level of bed joints shall be within 10 mm of the specified level in any 5 m length.  The brickwork and blockwork shall be straight to within 15 mm in any 5 m length.  The brickwork and blockwork shall be vertical to within 15 mm in any 3 m height. |
| **22.42** | **TESTING: BRICKS AND BLOCK** |  |
| 22.42.1 | Batch: bricks and blocks | A batch of bricks or blocks is any quantity of bricks or blocks of the same type, manufactured or produced at the same time in the same place, covered by the same certificates and delivered to the Site at any one time. |
| 22.42.2 | Samples: bricks and blocks | (1) Unless otherwise permitted by the Engineer, one sample of each type of bricks or blocks shall be provided at the same time as particulars of the material are submitted to the Engineer and one sample of each type of bricks or blocks shall be provided from each batch of the material delivered to the Site.  (2) The number of bricks or blocks in the sample shall be 10 for each batch of 15,000 bricks or blocks or part thereof.  (3) The method of sampling shall be in accordance with BS 3921. |
| 22.42.3 | Testing bricks and blocks | (1) Each brick or block in the sample shall be tested to determine the crushing strength of the brick or block.  (2) The method of testing shall be in accordance with BS 3921.  (3) The average of the 10 crushing strengths of the bricks or blocks shall be calculated and referred to as the compressive strength. |
| 22.42.4 | Compliance criteria: bricks and blocks | The compressive strength of bricks and blocks shall be as stated in clauses 22.36.1, 22.36.2 and 22.36.3, or as stated elsewhere in the Contract. |
|  | ***PART 8: METAL WINDOWS AND DOORS*** |  |
| **22.43** | **MATERIALS** |  |
| 22.43.1 | Materials for metal  windows and doors | (1) Materials for metal windows and doors shall be as stated in clause 22.43.1  (2) Steel shall be weldable structural steel complying with BS 4360. Hot dipped galvanized plain steel sheet and coil shall comply with BS 2989. Steel tubing shall comply with BS 1387 medium grade and shall be galvanized. Slotted steel angles shall be self-finished angles complying with BS 4345 and shall have cadmium plated steel fittings.  (3) Aluminium alloy plate, sheet and strip shall comply with BS 1470 and shall be of the specified alloy designation. Aluminium alloy bars, extruded tube sections and hollow sections shall comply with BS 1474, alloy designation 6063. Aluminium sections for structural purposes shall comply with BS 1161. Aluminium alloy drawn tubes shall comply with BS 1471, alloy designation 6063.  (4) Brass rods and sections shall comply with BS 2874, designation CZ 106, condition M.  (5) Stainless steel shall be of the 18/9 chromium nickel group. Stainless steel plate, sheet and strip shall comply with BS 1449: Part 2 and shall be Finish No. 2B for mill finish and Finish No. 4 for polished finish. Stainless steel tubes for structural and general engineering purposes shall comply with BS 6323: Parts 1 and 8, and shall have the same finish as for plate, sheet and strip.  (6) Fixings shall be the same material and shall have the same finish as the material to be fixed.  (7) Stud anchors and fixing bolts shall be of a proprietary type of expanding bolt approved by the Engineer.  (8) Polysulphide-based sealant shall be a one-pack gun-grade type complying with BS 5215.  (9) Adhesive for bonding metal to wood or metal to metal shall be of a proprietary type approved by the Engineer. |
| **22.44** | **DESIGN AND FABRICATION OF METAL WINDOWS AND DOORS** |  |
| 22.44.1 | Steel windows and doors | (1) Steel windows and doors shall be designed and fabricated by the Contractor in accordance with BS 6510 and as stated in clause 22.44.1  (2) Sections shall be 32 mm universal steel rolled medium or equivalent W20 sections, dovetail grooved for a weatherstrip when specified, and shall be hot rolled, cold straightened and free from rolling defects. Manufacturer’s fabrication holes shall be sealed by welding before delivery to the Site.  (3) Frames shall be square and flat with mitred, welded corners and with glazing bars machine-tenoned or welded to frames.  (4) Water bars shall be welded to frames for the complete width of the window or door.  (5) Weather bars shall be welded to the heading of frames for the complete width of the window or door.  (6) Slotted adjustable lugs for building in windows and doors shall project at least 60 mm beyond the metal frames.  (7) Loose mullions and transoms to suit window or door openings shall have an additional 75 mm length at each end for building-in purposes.  (8) Mastic and bolts shall be used for assembly of composite units. Mullions and transoms shall be bedded in mastic with all interstices completely filled.  (9) Windows shall be suitable for external glazing. Rolled steel heavy channel section glazing beading shall be 13 mm x 10 mm for windows and 20 mm x 10 mm for doors. The beading shall be mitred at corners and fixed with galvanized mild steel flat headed countersunk screws at centres not exceeding 225 mm. Frames shall be tapped to receive screws.  (10) Members shall be hot-dip galvanized in accordance with BS EN ISO 1461: 1999 or zinc sprayed to 0.2 mm nominal thickness in accordance with BS 2569: Part 1.  (11) Chloroprene rubber or polyvinyl chloride weatherstrips of a proprietary type approved by the Engineer shall be securely fixed into the dovetail groove in the window or door section to provide continuous contact between the opening casement and the fixed frame.  (12) Temporary steel clamps shall be provided at the top and bottom of opening lights of casements before transportation from the factory and shall be left in position until installation is complete. |
| 22.44.2 | Fittings and furniture to steel windows and doors | (1) Fittings and furniture to steel windows and doors shall be of a proprietary type approved by the Engineer and shall comply with the requirements stated in clause 22.44.2  (2) Hinges shall be steel with brass pins and shall be welded or riveted to frames.  (3) Fittings, including friction grip pivots, casement fasteners, spring catches, brackets, slide arms, shoes, slip bolts, cabin hooks and eyes, and handles shall be manganese brass with bronze finish and shall be capable of retaining the opening parts rigidly in both the open and closed positions.  (4) Handle plates and round headed stay brackets shall be welded to the fixed frames and shall have interchangeable handles and stays.  (5) Windows and doors which are to be hung to open shall be fitted with the fittings and furniture stated in clause 22.44.2  (6) Side-hung casements and vertically centre-hung ventilators shall be fitted with a two-point nose fastener or a two throw casement fastener with mild steel adjustable connecting rod and a 250 mm peg stay or bronze sliding stay as stated in the Contract.  (7) Projecting casements shall be fitted with bronze sliding shoes, pivots and friction side arms and one spring catch with a ring for hand or pole operation and two square-shank barrel bolts.  (8) Top-hung ventilators shall be fitted with a 200 mm peg stay with a round-headed stay bracket welded to the fixed frame and with a second peg to secure the stay firmly and horizontally against the first peg when the ventilator is closed.  (9) Bottom-hung ventilators shall be fitted with a spring catch and fanlight roller stay to limit opening and to permit the ventilator to swing free for cleaning.  (10) Horizontally centre-hung ventilators shall be fitted with a spring catch with ring and eye for cord or pole operation.  (11) Doors shall be fitted with sliding bolts of suitable length, striking plates at top and bottom, magnetic catch, panic bolt, three-lever mortice lock with two keys, lever or knob handles and escutcheon plates as stated in the Contract.  (12) Flyscreens shall be extruded aluminium with plastic covered fibre-glass mosquito gauze with 7 x 7 mesh per 10 mm square. Side-hung casements for use with flyscreens shall have a locking handle and an opening and closing mechanism consisting of a bronze cam handle and bronze roto operator. Top-hung casements for use with flyscreens shall have bronze through-the-frame type stays.  (13) Window poles shall be 25 mm diameter teak with a strong brass hook at one end suitable for opening and closing high windows. |
| 22.44.3 | Aluminium windows and doors | (1) Aluminium windows and doors shall be designed and fabricated by the Contractor in accordance with BS 4873 and as stated in clauses 22.44.3 and 22.44.4.  (2) Fixed windows and doors shall be capable of withstanding a wind load calculated in accordance with the wind Effects in Maldives or similar with a minimum of 3 kPa with a permissible maximum deflection of less than 1/180th of the length of the particular member. Mild steel cores, anchors, brackets and similar fittings shall be used as stiffeners where necessary.  (3) Sections shall be extruded aluminium alloy complying with BS 1470 and BS 1474, British alloy designation 6063. The sections shall have a wall thickness of at least 1.6 mm and shall be dovetail grooved for a weatherstrip.  (4) Aluminium sections shall be:  Clear anodised in accordance with BS 1615, AA/20,  Colour anodised in accordance with BS 3987, average 25 µm thick, or  Treated with a proprietary type of hardcoat anodic finish approved by the Engineer with wearing qualities better than those stated in clause 22.44.3  (5) Frames shall be mechanically jointed of mortice and tenon construction to provide rigid and secure connections. Sash members shall develop the full strength of other members using solid block angle pieces and shall provide a neat weathertight joint with adequate drainage in bottom members.  (6) Galvanized steel fixing lugs shall be provided at centres not exceeding 300 mm for outer frames of each unit. Lugs shall be fixed with rag-bolts or with proprietary stud anchors or fixing bolts of a type approved by the Engineer.  (7) Galvanized steel water bars shall be provided for the complete width of the window or door where the design requires.  (8) Mullions, transoms and corner posts in composite units shall have an additional 75 mm length at each end for building-in purposes. Mullions and transoms exceeding 1.5 m in length shall be reinforced with galvanized steel with extended ends for building-in purposes.  (9) Composite units shall be assembled on Site using all necessary bolts, screws and other fixings. Joints shall be sealed with a proprietary type of sealant approved by the Engineer.  (10) Chloroprene rubber, plasticized PVC or nylon pile weatherstrips of a type approved by the Engineer shall be securely fixed into the dovetail groove in the window or door section to provide continuous contact between each opening part and its fixed frame.  (11) Windows and doors shall be suitable for internal glazing with a glazing system and aluminium beading of a type approved by the Engineer. Beading shall either form an integral part of the frame or shall be securely fixed to the frame.  (12) Aluminium alloy, stainless steel or nylon matching the surrounding finish shall be used for exposed fixings including screws, nuts, bolts, washers and rivets. Concealed fastening devices shall be galvanized or cadmium plated steel.  (13) Window and door units and other associated materials shall be wrapped in strong waterproof paper or polythene sheeting to protect against damp and scratching before transportation from the factory. The wrapping shall not be removed until installation starts.  (14) The galvanization of the steel, fixing lugs, steel water bars and concealed fastening devices above shall comply with BS EN ISO 1461: 1999 or otherwise approved by the Engineer. |
| 22.44.4 | Fittings and furniture to aluminium windows and doors | (1) Fittings and furniture to aluminium windows and doors shall be of a proprietary type approved by the Engineer and shall comply with the requirements stated in clause 22.44.4.  (2) Friction pivots and sliding stays shall be stainless steel capable of providing a maximum opening of 100° and with a minimum clearance of 100 mm between the frame and window for cleaning purposes.  (3) Casement fasteners, locking handles, spring catches, casement stays, brackets, slipbolts and similar fittings and furniture shall be either diecast zinc alloy complying with BS 1004 suitably coloured to match the anodised window or door metal or moulded stainless steel with satin finish.  (4) Locks shall be cadmium-plated steel with stainless steel or brass parts.  (5) Pull handles shall be anodized aluminium.  (6) Rollers, guides and similar fittings shall be cadmium-plated steel with nylon or brass rollers to suit the weight of the door or window and shall be adjustable after installation.  (7) Windows and doors which are to be hung to open shall be fitted with fittings and furniture as stated in clause 22.44.4.  (8) Side and top hung windows shall be fitted with friction pivots, sliding stays, casement fastener or pull handle, and locking handle. Casement fasteners and locking handles shall be dual where required.  (9) Sliding windows shall be fitted with rollers, guides and similar fittings, pull handle and stops and sliding bolts or locking mechanism. The window shall be constructed such that it cannot be lifted off its rollers without the removal of a safety device.  (10) Side hung doors shall be fitted with floor springs and adjustable top pivots, single or double action to stand open or not as stated in the Contract, mortice dead lock, top and bottom flush lever bolts and push plates and pull handles as required.  (11) Sliding doors shall be fitted with heavy-duty rollers, guides and similar fittings, pull handle and stops, hook bolt locking latch and four bolts.  (12) Flyscreens shall be fitted on the inside surface with frames of extruded aluminium and plastic covered mosquito gauze of 7 x 7 mesh per 10 mm square. Screens shall be fixed to window frames by wing nuts. The windows shall be fitted with locking handles and an opening and closing mechanism comprising a cam handle and roto operator.  (13) All steel framework, cores, anchors and brackets shall be primed with zinc chromate primer complying with clause 22.32.3 and painted with two coats of bituminous paint complying with clause 22.32.7  (14) Concealed aluminium or stainless steel surfaces that may come into contact with wet mortar, cement, plaster or similar materials shall be painted with one coat of bituminous paint complying with clause 22.32.7. Exposed aluminium or stainless steel surfaces shall be protected with a strippable coating or masking tape that shall not be removed until instructed by the Engineer. |
| 22.44.5 | Roller shutters and doors | The design of roller shutters and doors, including boxes, hoods, guides and all other parts shall be carried out by the Contractor in accordance with the requirements stated in the Contract. |
| **22.45** | **SUBMISSIONS** |  |
| 22.45.1 | Particulars of metal windows and doors | (1) The following particulars of the proposed materials and methods of construction for metal windows and doors shall be submitted to the Engineer:  Name and address of manufacturer,  Manufacturer’s literature, and  Tree sets of working drawings.  (2) The particulars shall be submitted to the Engineer at least 14 days before fabrication of the window or door starts. |
| 22.45.2 | Samples of materials | Samples of materials for metal windows and doors, including fittings and furniture, shall be submitted to the Engineer at the same time as particulars of the windows or doors are submitted. Details of the samples to be provided shall be as agreed by the Engineer. |
| 22.45.3 | Instruction manuals | Two copies of instruction manuals shall be provided for motorised roller shutters and doors. The manuals shall include detailed operating and maintenance instructions, including wiring and schematic drawings, a schedule of component parts and a priced list of recommended spares. The manuals shall be provided at the same time as the particulars of the roller shutters and doors are submitted. |
| **22.46** | **HANDLING AND STORAGE OF MATERIALS** |  |
| 22.46.1 | Handling and storageof metal windows and doors | (1) Metal windows and doors shall be handled and stored in a manner which will not result in damage or distortion. Opening lights shall be kept closed.  (2) Temporary steel clamps in steel windows and doors shall be left in position until installation is complete. Wrapping to aluminium windows and doors shall not be removed until installation starts. |
| **22.47** | **FIXING METAL WINDOWS AND DOORS** |  |
| 22.47.1 | Fixing metal windows and doors | (1) Metal windows and doors which consist of composite units shall be assembled using all necessary bolts, screws and other fixings. Joints shall be sealed using polysulphide-based sealant.  (2) Windows and doors shall be positioned plumb, level and square.  (3) Pockets shall be formed in heads, jambs, cills and other parts of structures to receive fixing lugs. The pockets shall be made good after building in the lugs and screws to frames. Frames shall be screwed using packing pieces where necessary.  (4) Steel frames shall be bedded in mortar to form a waterproof seal.  (5) Aluminium frames shall be bedded in a proprietary type of butyl mastic bedding compound approved by the Engineer to form a waterproof seal.  (6) Joints around external edges of steel frames shall be raked out and pointed with a proprietary type of oil based mastic sealant approved by the Engineer to form a smooth, flat joint.  (7) Joints around external edge of aluminium frames shall be raked out and pointed with polysulphide-based sealant to form a smooth, flat joint.  (8) Adjoining surfaces to joints shall be temporarily masked to prevent contamination during pointing. |
|  | ***PART 9: MASONRY*** |  |
| **22.48** | **MATERIALS** |  |
| 22.48.1 | Stone | Stone for masonry shall be local granite and shall be free from defects that will adversely affect the strength or appearance of the masonry. |
| 22.48.2 | Mortar | Cement mortar for masonry shall be as stated in clause 22.36.7 |
| 22.48.3 | Wall ties | Wall ties between masonry walls and concrete shall be galvanized mild steel flats complying with BS EN ISO 1461: 1999 or otherwise approved by the Engineer. The ties shall be at least 40 mm wide, 3 mm thick and 150 mm long and shall be fanged at both ends. |
| 22.48.4 | Damp proof course | Damp proof course for masonry shall be as stated in clause 22.36.5 |
| **22.49** | **SUBMISSIONS** |  |
| 22.49.1 | Samples of materials | Samples of the following proposed materials for masonry shall be submitted to the Engineer for approval of the source and type of each material at least 14 days before the masonry work starts:  Each type of stone,  Wall ties, and  Damp proof course. |
| **22.50** | **TRIAL PANELS** |  |
| 22.50.1 | Trial panels | A trial panel shall be constructed for each type of masonry as stated in clauses 22.38.1 to 22.38.4 for brickwork and blockwork. |
| **22.51** | **HANDLING AND STORAGE OF MATERIALS** |  |
| 22.51.1 | Handling and storage of stone | Stone for ashlar stone walling shall be transported with the minimum amount of handling and shall be stacked in the vehicle using packing pieces to prevent damage. The stone shall be stored in stacks on battens and protected from exposure to rain. |
| **22.52** | **RUBBLE STONE WALLING** |  |
| 22.52.1 | Preparation of stone for rubble stone walling | (1) Stones for random rubble walling shall be irregular in shape and roughly cut to between 75 mm and 300 mm high, at least 75 mm deep and between 75 mm and 600 mm long on bed. The length or depth on bed of each stone shall be greater than the height.  (2) Stones for squared rubble walling shall be trimmed roughly square to between 75 mm and 300 mm high, varying in 75 mm stages. Each stone shall be between 100 mm and 150 mm deep and between 100 mm and 600 mm long on bed. The length or depth on bed of each stone shall be greater than the height.  (3) Stones for square coursed rubble walling shall be trimmed roughly square as stated in clause 22.52.1 to suit courses of regular height varying from 150 mm to 250 mm. |
| 22.52.2 | Laying and jointing rubble stone walling | (1) Stones in rubble stone walling shall be laid dry on a full even bed of cement mortar. All joints shall be filled and shall be between 5 mm and 15 mm wide.  (2) Stones of random shapes and sizes in random rubble walling shall be bonded together over each face of the wall. Stones shall be selected and rough dressed to keep joint widths to a minimum. At least one bonding stone of minimum size 450 mm x 150 mm shall be provided and carried through the full thickness of the wall per square metre. Not more than 3 stones shall be provided adjacent to a vertical joint.  (3) Roughly squared stones of random sizes in square rubble walling shall be bonded together with continuous straight horizontal joints. The number of vertical joints shall be kept to a minimum.  (4) Roughly squared stones in square coursed walling shall be laid as stated in clause 22.52.2 but brought up to courses at centres not exceeding 750 mm to line up with quoin and jamb stones.  (5) Squared rubble walling exceeding 300 mm thick and faced one side shall be constructed in accordance with the following requirements:  Roughly squared stone at least 300 mm thick shall be provided with a backing of random rubble.  At least two bonding stones per square metre shall be regularly spaced and carried through the full thickness of the wall or at least 450 mm into the backing, whichever is less.  (6) Squared rubble walling exceeding 300 mm thick and faced both sides shall be constructed in accordance with the following requirements:  Roughly squared stone at least 150 mm thick shall be provided with a core of random rubble.  Bonding stones shall be provided as stated in clause 22.52.2 but shall be carried through the full thickness of the wall or 450 mm into the core. |
| 22.52.3 | Pointing rubble stone walling | Joints in rubble stone walling shall be raked out to a depth of 15 mm as the work proceeds. The joints shall be pointed in cement mortar on completion with a flush, weathered or recessed joint as required. |
| **22.53** | **ASHLAR STONE WALLING** |  |
| 22.53.1 | Preparation of stone for ashlar stone walling | The exposed faces and joint faces of each stone for ashlar stone walling shall be dressed square and true, free from hollows or rough areas. Exposed faces shall be finished to a finely squared dressed surface. Stones shall be at least 300 mm high. Each stone shall be clearly marked to indicate its position in the finished work. |
| 22.53.2 | Laying and jointing ashlar stone walling | Stones in ashlar stone walling shall be laid on a full, even bed of mortar consisting of cement and fine crushed stone in the proportions 1:3 by volume. All joints shall be filled and shall be 5 mm wide. Stones shall be laid to bond together throughout the wall, and to the backing, using projecting bonding stones. |
| 22.53.3 | Pointing ashlar stone walling | Joints in ashlar stone walling shall be raked to a depth of 15 mm as the work proceeds and shall be pointed with a flush joint on completion using bedding mortar. |
| **22.54** | **PROTECTION OF MASONRY** |  |
| 22.54.1 | Protection of masonry | Newly erected masonry shall be protected from exposure to conditions which may adversely affect the masonry. Arrises, projections and similar features shall be covered with protective sheeting lapped and securely held in position. Facework shall be kept clean at all times. |
| **22.55** | **WALL TIES FOR MASONRY** |  |
| 22.55.1 | Wall ties for masonry | (1) Wall ties in masonry which is to face an existing or newly constructed wall shall be fixed at a rate of 5 per m2. Ties shall be fixed 100 mm into the wall and 75 mm into the masonry.  (2) Wall ties shall be fixed between the ends of walls and concrete or brickwork at centres of at least 450 mm vertically and shall project 250 mm into the masonry. |
| **22.56** | **TOLERANCES** |  |
| 22.56.1 | Tolerances masonry | (1) Rubble stone walling shall comply with the following requirements:  The position on plan shall be within 25 mm of the specified position.  The length shall be within 25 mm of the specified length.  The height shall be within 25 mm of the specified height.  The level of bed joints shall be within 25 mm of the specified level in any 5 m length.  The walling shall be straight to within 25 mm in any 5 m length.  The walling shall be vertical to within 20 mm in any 3 m height.  (2) Ashlar stone walling shall comply with the following requirements:  The position on plan shall be within 15 mm of the specified position.  The length shall be within 15 mm of the specified length.  The height shall be within 10 mm of the specified height.  The level of bed joints shall be within 10 mm of the specified level in any 5 m length.  The walling shall be straight to within 15 mm in any 5 m length.  The walling shall be vertical to within 15 mm in any 3 m height. |
| **23.** | **SECTION 23 ENVIRONMENTAL PROTECTION** |  |
| **23.1** | **GENERAL** |  |
| 23.1.1 | General requirements | (1) The Contractor shall undertake environmental protection measures to reduce the environmental impacts arising from execution of the Works. In particular, he shall arrange his method of working to minimize the effects on the air, noise, water quality as well as nuisance of waste within and outside the Site, on transport routes and at the stockpiling, loading, dredging and dumping areas.  (2) The Contractor shall observe and comply with all the current enactments, relevant environmental protection and pollution control regulations, and any additions or amendments thereto coming into effect before completion of the Works. The Contractor shall provide his staff and the Engineer on site at all times with on-line access through the Internet to such regulations. If on-line access is not possible and when required by the Engineer, the Contractor shall maintain on site legal copies of the relevant regulations, and provide one legal copy for the Engineer.  (3) The Contractor shall design, construct, operate and maintain pollution control measures to ensure compliance with the contract provisions as well as the relevant regulations.  (4) The Contractor shall cooperate with and assist the Environmental Team in conducting compliance monitoring and audit on the environmental aspects of the construction activities as described in clauses 23.6.1 to 23.6.6 below.  (5) Where the activities on Site are found not in compliance with the requirements as specified or cause unacceptable environmental impacts, the Contractor shall immediately carry out appropriate environmental mitigation measures to rectify the situation to the Engineer’s satisfaction. |
| **23.2** | **WATER POLLUTION CONTROL** |  |
| 23.2.1 | Water pollution control |  |
| 23.2.2 | general requirements | (1) The Contractor shall observe and comply with the Water Pollution Control regulations and the Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters and any additions or amendments thereto coming into effect before completion of the Works.  (2) The Contractor shall carry out the Works in such a manner as to minimize adverse impacts on the water quality during execution of the Works. In particular he shall arrange his method of working to minimize the adverse effects on the water quality within and outside the Site, on the transport routes and at the stockpiling, loading, dredging and dumping areas.  (3) The Contractor shall follow the practices and be responsible for the design, construction, operation and maintenance of all the necessary mitigation measures, as specified in the relevant regulations |
| 23.2.3 | Marine plant and equipment | (1) Two weeks before commencement of any marine works, the Contractor shall submit to the Engineer for approval the proposed methods of working and the marine plant and equipment to be used.  (2) The marine plant and equipment to be used on the Works shall meet the requirement in sub-clauses (1) and (3) of clause 23.2.4 and shall be operated accordingly to achieve the water quality requirements. The Contractor shall provide all necessary facilities to the Engineer for inspecting or checking such plant and equipment and shall not use such plant and equipment for execution of the Works without the agreement of the Engineer. The Engineer may require the Contractor to carry out trials of any plant and equipment to prove their suitability.  (3) After commencement of the Works, if the plant and equipment or working methods are, in the opinion of the Engineer, not in compliance with the requirements of the Effluent Standards issued under the Water Pollution Control regulations, the Engineer may notify the Contractor in writing, and the Contractor shall immediately initiate remedial measures to halt deterioration. Where such remedial measures include the use of additional or alternative plant and equipment, such plant and equipment shall not be used on the Works until agreed by the Engineer. Where remedial measures include maintenance or modification of previously approved plant and equipment, such plant and equipment shall not be used on the Works until the necessary maintenance or modification is completed and the adequacy of the maintenance or modification is demonstrated to the satisfaction of the Engineer.  (4) The Contractor shall comply with the conditions of dumping permits obtained from the Director of Environmental Protection. The permits shall be prominently displayed in both Dhivehi and English languages on site and also on the dredgers and barges. |
| 23.2.4 | Avoidance of pollution during dredging, transporting and dumping of marine mud | (1) Pollution-avoidance measures shall include but not be limited to the following:  All equipment shall be designed and maintained to minimise the risk of silt and other contaminants being released into the water column or deposited in locations other than designated location;  Mechanical grabs shall be designed and maintained to avoid spillage and shall be sealed tightly while being lifted;  Where trailing suction hopper dredgers for dredging of marine mud are in use, overflow from the dredger and the operation of lean mixture overboard systems shall not be permitted unless expressly approved by the Engineer in consultation with the Director of Environmental Protection;  Cutter heads of suction dredgers shall be suitable for the material being excavated and be designed to minimize overbreak and sedimentation around the cutter;  All vessels shall be sized so that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;  All leaking pipes shall be repaired promptly and plant shall not be operated with leaking pipes;  Before moving vessels that are used for transporting dredged material, the excess material shall be cleaned from the decks and exposed fittings of vessels. The excess material shall not be dumped into the sea except at the approved locations;  Adequate freeboard shall be maintained on barges to ensure that decks are not washed by wave action;  The Contractor shall monitor all vessels transporting material to ensure that no dumping outside the approved location takes place. The Contractor shall keep and produce logs and other records to demonstrate compliance and that journey times are consistent with designated locations and copies of such records shall be submitted to the Engineer;  All bottom-dumping vessels shall be fitted with tight fitting seals to their bottom openings to prevent leakage of material;  Loading of barges and hoppers shall be controlled to prevent splashing of dredged material to the surrounding water, and vessels shall not be filled with material to a such level that will cause overflowing of material or polluted water during loading or transportation; and  The Engineer may monitor any or all vessels transporting material to check that no dumping outside the approved location or loss of material during transportation takes place. The Contractor shall provide all reasonable assistance to the Engineer for this purpose.  (2) The Contractor shall be responsible for obtaining all necessary dumping permits. All fees in respect of applications for disposal permits shall be borne by the Contractor. The dredged marine mud shall only be disposed of at the disposal site or sites designated in the dumping permit.  (3) When dredging, transporting and disposing of contaminated marine mud, the Contractor shall implement adequate measures for avoidance of pollution, which shall include but not be limited to the following:  Dredging of contaminated marine mud shall be undertaken with a suitable grab dredger using closed watertight grab;  Contaminated marine mud shall be transported by split barge of not less than 750 m3 capacity, well maintained and capable of rapid opening and discharging at the disposal site;  The material shall be placed into the disposal pit by means of bottom dumping;  Discharge from split barges shall take place within a radius of 100 metres of centre of the area allocated for the disposal of contaminated marine mud;  Discharge shall be undertaken rapidly and the hoppers shall then be closed immediately. Ensure that material adhering to the sides of the hopper is not washed out of the hopper and the hopper remains closed until the barge returns next to the disposal site; and  The dumping vessel shall be anchored throughout the dumping operation.  (4) The Contractor shall ensure that all marine mud is disposed of at the approved locations. He shall be required to ensure accurate positioning of vessels before the discharge, and submit proposals for accurate position control at the disposal sites to the Engineer for approval before commencing dredging and dumping.  (5) The Contractor shall ensure that all material unsuitable for reuse as fill material is disposed of at the approved landfill or other designated locations.  (6) The Contractor shall only employ vessels equipped with automatic self-monitoring devices specified by the Director of Environmental Protection for disposal operation. He shall co-operate with and facilitate the Director of Environmental Protection in inspection of the device and retrieval of the record stored in the device on a regular basis.  (7) The Contractor shall provide experienced full-time personnel on board all dumping vessels to ensure that appropriate methods to minimize pollution are implemented. |
| 23.2.5 | Protection of water quality at water intakes and storage | When dredging mud or placing fill in the vicinity of a water intake, the Contractor shall protect the water intake by surrounding it with a suitable silt curtain to prevent excessive suspended solids from entering the intake. The silt curtain shall be designed to ensure that the concentration of suspended solids entering the intake meets the intake user requirements. |
| 23.2.6 | Discharge into sewers, drains and water bodies | (1) In accordance with the Water Pollution Control regulation requirements, the Contractor shall apply for the respective licence before discharging any effluent, including but not limited to any trade effluent or foul or contaminated water or cooling or hot water, from the Site into any public sewer, stormwater drain, channel, stream-course or sea. The Contractor shall provide a copy of the application and licence to the Engineer. The content of effluent to be discharged into the waters from the Site shall strictly comply with the limits set in the respective regulations and discharge licence.  (2) The discharge licence may include conditions to require the Contractor to provide, operate and maintain at the Contractor's own expense to the satisfaction of the Engineer suitable works for the treatment and disposal of such trade effluent or foul or contaminated or cooling or hot water. The design of such treatment works, if required, shall be submitted to the Engineer for approval not less than one month before commencement of the relevant works.  (3) If any toilet or shower facilities are erected, foul water effluent from these facilities shall be discharged to a foul sewer either directly or indirectly by means of pumping or other means approved by the Engineer. Wastewater collected from a kitchen or canteen, including that from basins, sinks and floor drains, shall be discharged into four sewers via grease traps of adequate retention capacities as appropriate. If no sewer connection is available, the Contractor shall arrange for a licensed sub-contractor to collect the sewage generated from the Site or implement an on-site packaged sewage treatment system approved by the Engineer. |
| 23.2.7 | Wastewater from construction activities | (1) The following mitigation measures shall be carried out to mitigate environmental impacts from wastewater due to construction activities:  Water used for water testing, boring, piling, drilling works, concrete batching, washing of concrete trucks, and precast concrete casting and the like shall be re-circulated and re-used for such beneficial uses as dust suppression, wheel washing and general cleaning. The discharge of wastewater shall be kept to a minimum.  Online standby sump pumps of adequate capacity and with automatic alternating devices shall be provided to prevent overflow of wastewater from any water recycling system.  Wastewater from concrete batching, bored piling and precast concrete casting activities shall be treated for pH adjustment and silt removal before discharge.  Sand, silt or other materials present in the wash-water resulting from wheel washing facilities shall be removed before discharge of the wastewater. That section of access road between any site exit and the public road shall be paved with concrete or bituminous surfacing and provided with a suitable backfall to prevent the site run-off from entering the public road.  Drainage of groundwater, including water pumped out of trenches and excavations, shall only be discharged after removal of silt.  All fuel tanks and fuel storage areas shall be provided with locks and sited on bunded sealed areas of a capacity equal to 110% of the storage capacity of the largest tank.  Site compounds and plant/vehicle service areas shall be, unless it is practically impossible, located within roofed areas. The drainage in these areas shall be discharged to a proper wastewater system (e.g. foul sewer, septic tank or storage tank) via a properly maintained oil interceptor to prevent release of oil into the surface water drainage system after accidental spillages. The interceptor shall have a bypass to prevent flushing during periods of heavy rain. Waste-oil shall be collected and stored for recycling or disposal in accordance with the Waste Disposal regulation.  (2) The drainage system for stormwater run-off shall be designed as segregated from the system for wastewater discharge arising from construction activities, unless it is practically impossible to reduce the risk of cross contamination. |
| 23.2.8 | Surface runoff | (1) Surface run-off from the Site shall be discharged into stormwater drains or natural streams via adequately designed silt-removal facilities such as sand traps, silt traps, silt retention pond, sediment basins and mechanical water treatment plant. Channels or earth bunds or sand bag barriers shall be provided on the Site to properly direct stormwater to such silt-removal facilities. Perimeter channels at the Site boundaries shall be provided where necessary to intercept storm run-off from outside the Site so that it will not wash across the Site. Catchpits and perimeter channels shall be constructed in advance of site formation works and earthworks. Manholes shall be adequately covered or temporarily sealed.  (2) Silt-removal facilities shall be designed with adequate capacity and constructed within the surface-water drainage systems at appropriate locations.  (3) The Contractor shall be responsible for adequately maintaining any existing Site drainage system at all times including removal of solids from sand traps, manholes and stream beds. The Contractor shall carry out dredging of water-courses after informing the Engineer and all work in natural streams/rivers shall follow the requirements in clause 23.2.9  (4) Silt-removal facilities, channels and manholes shall be maintained and the deposited silt and grit shall be removed regularly, and after each rainstorm, to ensure that these facilities are functioning properly at all times. Disposal of material shall be carried out properly subject to the knowledge and approval of the Engineer. These facilities shall be regularly inspected as required by the Engineer.  (5) Temporary access roads shall be protected with crushed stone or gravel, particularly during the rainy seasons. Intercepting channels shall be provided to prevent storm runoff from washing across exposed soil surfaces.  (6) The Contractor shall pay particular attention to prevention of erosion during earthwork operations, including but not limited to the following works:  Construction works shall be programmed to minimize soil excavation in the rainy seasons as far as possible.  Earthwork surfaces, whether temporary or final, shall be adequately compacted and subsequent permanent works shall be performed immediately, whenever possible, to prevent erosion and silty runoff. Temporary protection of such surfaces with hydroseeding shall be carried out as required by the Engineer if they have to remain exposed for more than 10 calendar days.  Arrangements shall always be in place to ensure that adequate surface protection measures be safely carried out well before the arrival of a rainstorm.  (7) Exposed stockpiles of construction materials on the Site such as aggregates, sand or fill material shall be protected from erosion during rainstorms (e.g. by means of covering them with tarpaulin or similar fabric) to prevent the stockpiled materials from being washed away into any drainage system. In addition, the Engineer may require a separate run-off collection and treatment system for large stockpiles. |
| 23.2.9 | Protection of natural streams/rivers | (1) For the purpose of the Contract, a natural stream/river shall refer to a natural channel including the natural banks and riparian zones, with natural water fed from upper terrains with water flowing throughout the year or intermittent water-flow only during wet seasons, and any other water-carrying channels, ponds or the like and the extents are as defined on the Drawings. The Contractor shall keep on the Site records of photographs of the existing natural streams and rivers within the Site, and provide the Engineer with a copy of the same records before any works commence in or near natural streams/rivers.  (2) Natural streams/rivers on the Site where work is not being carried out shall be maintained in clean and tidy conditions and shall be free of any floating debris. Natural streams/rivers shall not be used to store materials or to park constructional plant or other vehicles.  (3) The natural bottom and existing flow in the river shall be maintained as far as possible to avoid disturbance to the river habitats. Tracked vehicles shall not use the river-bed/stream-bed unless protection against damage is provided to the satisfaction of the Engineer. Temporary river crossings should be supported on stilts or pontoons or the like above the riverbed. Temporary river crossings and temporary access to the works site shall be carefully planned and located to minimize disturbance to the substrates of streams/rivers and riparian vegetations caused by the construction plant. Temporary river crossings and temporary access shall not be constructed without the prior consent in writing from the Engineer.  (4) Where specified in the Contract, the Contractor shall use smaller construction plant of a type approved by the Engineer for works in or near natural streams and rivers to reduce disturbance to the stream-bed/river-bed where aquatic inhabitants are located.  (5) Excavated or backfilling materials shall not be stored adjacent to natural streams/rivers unless permitted by the Engineer.  (6) No excavated material, silt, debris, rubbish, cement slurry or such construction waste shall be deposited into natural streams/rivers. The Contractor shall submit preventive measures to prevent soil/ mud from slipping into the streams/rivers to the Engineer for agreement before any works commence in or near natural streams/rivers. Should such deposits be found, the Contractor shall remove them, and restore the affected natural streams/rivers to their original state to the satisfaction of the Engineer. If the works site is inside or in the proximity of natural rivers/streams, the Contractor shall temporarily isolate the construction works with proper methods, such as by placing of sandbags or silt curtains with lead edge at bottom and properly supported props, to prevent adverse impacts on the water quality.  (7) Without the prior consent of the Engineer, the Contractor shall not excavate boulders, gravel or sand or other substrata materials from the natural streams/rivers, whether these materials are for the purpose of temporary, long-term or off-site use as construction material, or for any other purposes. |
| **23.3** | **NOISE CONTROL** |  |
| 23.3.1 | Noise control - general requirements | (1) The Contractor shall observe and comply with the the Noise Control regulation including their subsidiary regulations and technical memoranda and any additions or amendments thereto coming into effect before completion of the Works if existing  (2) Where a QPME is used, the plant shall be registered with EPA, and the label issued by EPA from such registration shall be affixed on the plant at all times and kept legible. The Engineer shall deem a constructional plant or equipment as non-compliant for the purpose of this sub-clause if it does not have its registration label so affixed.  (3) To facilitate monitoring and control, the Contractor shall establish a register to record all QPME referred to in sub-clause (2) used on the Site.  (4) The Contractor shall devise, arrange methods of working and carry out the Works in such a manner so as to minimize noise impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.  (5) The Contractor shall submit for the Engineer’s prior approval, at least 2 weeks before commencement of any work, method statements, the plant and equipment to be used, and the sound-reducing measures to be adopted on the Site for the work. Noise reduction methods shall include but not be limited to scheduling of the work, locating of facilities, selection of plant and equipment and use of purpose-built acoustic panels and enclosures. The Contractor’s submission shall also include a statement explaining why his proposed methods of working, plant and equipment are able to minimize the noise impacts arising from the work. The method statements shall be updated and resubmitted for agreement from time to time as required by the Engineer.  (6) In considering the submissions made under sub-clause (6) above, the Engineer may require the Contractor to demonstrate the proposed methods of working, plant equipment and sound-reducing measures to be used on the Site in trials or make them available for inspection, to ensure that they are suitable for execution of the Works. |
| 23.3.2 | Allowable noise limits | (1) For carrying out any construction work other than percussive piling during the time period from 0700 to 1900 hours on any day not being a general holiday (including Sundays), the Contractor shall comply with the following requirements  The noise level at 1m from the most affected external facade of the nearby noise sensitive receivers from the construction works alone during any 30-minute period shall not exceed an equivalent sound level (Leq) of 75 dB(A). All domestic premises, hotels, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, performing arts centre or office building shall be considered as noise sensitive receivers.  In addition to the requirement in sub-clause (1)(a), the noise level at 1m from the most affected external facade of the nearby schools from the construction works alone during any 30-minute period shall not exceed an equivalent sound level (Leq) of 70 dB(A). The allowable equivalent sound level is reduced to 65 dB(A) during school examination periods. The Contractor shall liaise with the schools and/or the Examination Authority to ascertain the exact dates and times of all examination periods during the course of the Contract.  If the limits stated in the above sub-clauses (1)(a) and (1)(b) are exceeded, the construction activities shall stop and shall not re-commence until appropriate measures acceptable to the Engineer that are necessary for compliance have been implemented.  (2) Notwithstanding the requirements and limitations set out in sub-clause (1) above and subject to the Contractor’s compliance with sub-clauses (2) to (5) of Clause 23.3.1 above, the Engineer may, upon application in writing by the Contractor, allow the use of equipment and carrying out of any construction activities for any duration, provided that he is satisfied with the application and in his opinion, such application is considered to be of absolute necessity and adequate noise insulation has been provided to the noise sensitive receivers affected, or is of emergency nature, and is not in contravention with the Noise Control regulation in any respect. |
| 23.3.3 | Noise mitigation measures | (1) All hoods, cover panels and inspection hatches of powered mechanical plant such as generators, air compressors etc. shall be closed during operation.  (2) Diesel hammer shall not be used for piling works. The Contractor shall use non-percussive pile driving methods such as hydraulic hammer, vibration or jacking method for installing or extracting sheet piles.  (3) Blasting shall not be carried out during the period specified in the blasting clauses under Section 6 to avoid noise impact at sensitive hours.  (4) The Contractor shall use non-percussive equipment such as hydraulic crusher, sawing, coring machines, etc. for demolition and concrete breaking work. Where percussive breakers are used, the Contractor shall enclose/wrap the breaker tip of any percussion breaker used with sound absorbing material to reduce the noise. This requirement may be exempted for works under emergency, or with prior agreement from the Engineer that the provision of such is not necessary. Mufflers or silencers, and damping layer with steel collars shall be fitted to hand-held pneumatic breakers.  (5) The Contractor shall provide damping materials inside and outside refuse chutes during breaking construction. |
| 23.3.4 | Construction Noise Permits | The Contractor shall, when necessary, apply for a Construction Noise Permit in accordance with the Noise Control (General) Regulations before commencing the relevant part(s) of the works, display the Permit as required and provide a copy to the Engineer. Construction activities and noise shall not deviate from or exceed the terms and conditions defined in the Construction Noise Permits. |
| **23.4** | **AIR POLLUTION CONTROL** |  |
| 23.4.1 | Air pollution control - general requirements | (1) The Contractor shall observe and comply with the Air Pollution Control and its subsidiary regulations, and any additions or amendments thereto coming into effect before completion of the Works.  (2) The Contractor shall submit for the Engineer’s prior approval, at least 2 weeks before commencement of any work, method statements identifying operations and plant likely to cause air pollution or dust emissions from the Site, together with measures to be implemented to mitigate and control such pollution and emissions.  (3) In considering the submissions made under sub-clause (2) above, the Engineer may require the methods of working, plant, equipment and air pollution control system to be used on the site to be demonstrated or made available for inspection to ensure that they are suitable for the project.  (4) If during the course of construction, the equipment or work methods submitted in sub-clause (2) above are in the opinion of the Engineer not effective in controlling air quality impacts to meet the Contract requirements, the Contractor shall update and resubmit the proposals for agreement promptly.  (5) The Contractor shall undertake at all times to prevent dust nuisance and smoke as a result of his activities. |
| 23.4.2 | Dust suppression | (1) The Contractor shall devise, arrange methods of working and carrying out the works in such a manner as to minimize dust impact on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.  (2) Material storage and handling areas shall be located on a hard-core surface or the like to facilitate cleaning and minimise dust generation. Screens, dust-sheets, tarpaulins or other methods agreed by the Engineer shall be used to prevent generation of dust.  (3) In the process of material handling, any material that has the potential to create dust shall be treated with water or sprayed with a wetting agent unless this would have a detrimental affect on the material.  (4) All conveyors carrying materials that have the potential to create dust shall be totally enclosed and fitted with belt cleaners. Conveyor transfer points and hopper discharge areas shall be housed in three-sided roofed enclosures with a flexible curtain on the fourth side to minimize emission dust. Exhaust ventilation shall be provided for this enclosure and vented to a fabric filter system.  (5) Cement and other fine-graded materials delivered in bulk shall be stored in closed silos fitted with high-level alarm indicator. The high-level alarm indicators shall be interlocked with the filling line so that in the event of the hopper approaching an overfull condition, an audible alarm will operate, and the pneumatic line to the filling tanker will close automatically. All air vents on cement silos shall be fitted with suitable fabric filters provided with either shaking or pulse-air cleaning mechanisms. The filter must be thoroughly cleaned after cement is blown into the silo to ensure adequate dust collection capacity for subsequent loads.  (6)The Contractor shall restrict the speed of all vehicles moving within the Site to minimize fugitive dust emission. Haulage and delivery vehicles shall be confined to designated roadways inside the Site. Unpaved roads shall be regularly compacted and the road surface shall be kept clear of loose material. The Contractor shall ensure that areas within the Site where there is regular traffic of vehicles are paved with either concrete or bituminous material and kept clear of any loose surface material.  (7)The Contractor shall undertake regular cleaning and watering of the Site, including access roads, construction areas and material stockpiles, after starting work each day to minimize fugitive dust emission as follows:  The frequencies, extent and amount of watering shall be adequate for the respective areas of the Site during the operational day to attain the invisible dust emission level.  The Contractor shall ensure that there is adequate water supply/storage for dust suppression at all times.  The Contractor shall, from commencement to completion of the Contract, ensure that the watering facilities are available on the Site in good working conditions at all times.  The Contractor shall ensure that the watering facilities are properly maintained and operating efficiently at all times and replacement facilities are deployed in full operating conditions immediately in the event of down time owing to mechanical repairs or any other reasons.  (8) Earth, rock or debris including any deposits arising from the movement of plant or vehicles shall not be deposited on public roads or private rights of way as a result of the Contractor's activities. Wheel-washing and vehicle-cleaning facilities shall be provided as specified in clause 23.5.7. Cement and concrete trucks in particular shall be thoroughly cleaned before leaving the site.  (9) Any vehicle with an open load compartment used for transferring dusty materials off site shall have properly fitted side-boards and tail-boards. Dusty materials shall not be loaded to a level higher than the side-boards and tail-boards, and shall be covered with a suitable tarpaulin (or any other impervious covering material approved by the Engineer) in good conditions before leaving the Site. The tarpaulin shall be properly secured and extended at least 300 mm over the edges of the side-board and tail boards and be properly secured and maintained throughout the journey to the off-loading destination. For the purpose of this sub-clause, “dusty materials” include cement, earth, pulverized fuel ash, excavated and crushed rock, aggregates, silt, stone fines, sand, debris, saw dust and wooden chips, etc.  (10) Earth-moving operations shall be carefully controlled with enhanced dust-suppression measures when winds are strong and particularly blowing towards the adjacent sensitive receivers. Sheltered areas of the Site shall be used for dusty operations, especially during windy periods.  (11) The areas with earthwork activities, including the final compaction activities, shall be completed as quickly as possible and in compliance with good practices, to limit creation of wind-blown dust.  (12) The location of dust-producing plant or facilities, either fixed or temporary, shall be subject to the agreement of the Engineer.  (13) For activities that are likely to generate a substantial amount of dust and where there are no effective measures or it is not possible to adequately control the dust level, vacuum cleaners should be used where practicable to suppress such dust. |
| 23.4.3 | Smoke and exhaust control | (1) The Contractor shall not light bonfires on the Site for burning of debris or other materials.  (2) Use Ultra-low-sulphur diesel (ULSD) (defined as diesel fuel containing not more than 0.005% by weight of sulphur) for all diesel-operated plant and equipment on the Site. The Contractor shall demonstrate his compliance by maintaining a summary record of all the delivery notes of ULSD delivered to the Site, including those ordered by his sub-contractors, together with the details of replenishment of such fuel by the individual plant and equipment on the Site. The record shall be supported by the original receipts of delivery notes from the oil companies. |
| 23.4.4 | Prior consent for pollutant emitting equipment | The Contractor shall not, upon the Site or any part thereof, install or use any machinery, furnace boiler or other equipment, or use any fuel that may result in the discharge or emission of any pollutant or any noxious, harmful or corrosive matter, whether it be in the form of gas, smoke, liquid, solid or otherwise, without the prior written consent of the Engineer in consultation with the Director of Environmental Protection. |
| 23.4.5 | Odour Mitigation | (1) The Contractor shall take necessary measures, including but not limited to masking sprays and suitable covering, to minimize odour problems arising from the construction activities and the temporary stockpile of odorous material.  (2) Temporary stockpiling of odorous material and the mitigation measures shall be subject to the prior approval of the Engineer. Approved odorous stockpiles shall be placed as far away from air sensitive receivers as possible. |
| 23.4.6 | Hoardings adjoining public areas | (1) In addition to the fences for security and safety required in other parts of the Contract, the Contractor shall provide and remove upon completion of the Contract, hoarding of height not less than 2.4m from ground level along the entire length of the portion of the site boundary which adjoins a road, street, footway, cycle track, service lane or other area accessible to the public, except at site entrances and/or exits or for road opening or resurfacing work, before any works commence in the vicinity.  (2) Where the work is carried out adjacent to a public premise not screened off by the hoarding pursuant to sub-clause (1), the Contractor shall provide a screen, with dimensions and details agreed by the Engineer, to shield the public from the dust or exhaust fume generated by the plant or equipment, except for works under emergency, or with prior agreement of the Engineer that the provision of such is not necessary. |
| **23.5** | **WASTE MANAGEMENT** |  |
| 23.5.1 | Waste management - general requirement | (1) The Contractor shall observe and comply with the Waste Disposal regulation and its subsidiary regulations and any additions or amendments thereto coming into effect before completion of the Works.  (2) The Contractor shall be responsible for the control of waste within the Site, removal of the waste material arising from the Site and implementation of any mitigation measures to minimize waste or reduce problems arising from the waste produced on the Site. |
| 23.5.2 | Measures to reduce/minimize generation of C&D materials | (1) The Contractor shall identify and list out the work processes or activities that will generate Construction and Demolition (C&D) materials during construction activities, and the proposed measures to reduce/minimize such generation in particular metallic waste, timber, paper/cardboard packaging and chemical waste. The Contractor shall submit the list of work processes/activities and the proposed measures to the Engineer for approval within 45 days of the date of the Employer’s letter of acceptance of the Tender. The submission should also include the Contractor’s proposed organizational structure and lines of responsibilities for implementation of the waste management measures on the Site.  (2) The proposed measures shall include proper planning of works, good site management, minimizing over-ordering, avoiding cross contamination to reusable and/or recyclable materials collected, optimizing the use of metal formwork or other work processes to reduce or minimize the use of timber in temporary works construction, maximizing the reuse of excavated inert C&D materials within the Site, etc. |
| 23.5.3 | Reduced use of timber in temporary works | (1) The Contractor shall not use tropical hardwood for formwork, falsework and shoring for trenches and pits. Alternative materials to tropical hardwood shall be used for such works.  (2) The Contractor shall avoid, reduce or minimize the use of any timber in temporary works construction as far as possible. Where the Contractor has to use timber for temporary works construction for one process/activity with an estimated quantity exceeding 5m3, he shall submit a method statement to the Engineer’s Representative for agreement before commencement of the works. The method statement should include the justifications for and the measures taken to minimize the use of timber in the temporary works. |
| 23.5.4 | Works involving demolition | For works involving demolition, the Contractor shall submit a method statement for the works to the Engineer for approval before commencing demolition on the Site. The Contractor shall include in the method statement the sequence of demolition and the works programme to facilitate effective recovery of reusable and/or recyclable portions of the demolition materials at the earliest stage, so as to minimize the need for subsequent sorting. The Contractor shall pay particular attention to materials that will cause contamination or ill-health to workers. Demolition materials shall be separated into the following categories:  Broken concrete  Other inert materials (i.e. blockwork, brickwork, etc.)  Metals (e.g. reinforcement bars, metal from mechanical and electrical fittings, and other building services fittings)  General refuse |
| 23.5.5 | Sorting of C&D materials | (1) All C&D materials (which mean both the inert and non-inert materials generated from construction and demolition activities) arising from or in connection with the Works shall be sorted on site to recover the inert portion of these materials, and reusable and/or recyclable materials before disposal of the waste portion off site. The inert portion of the C&D materials includes soil, building debris, broken rock, concrete, etc. and the non-inert portion comprises timber, paper, plastics, general refuse, etc.  (2) The Contractor shall devise a system for on-site sorting of C&D materials. The system shall include the identification of the source of generation, estimated quantity, arrangement for on-site sorting and/or collection, temporary storage areas, frequency of collection by recycling contractors or frequency of removal off the Site, etc. The Contractor shall submit details of the proposed system for sorting of C&D materials to the Engineer for approval within 45 days of the date of the Employer’s letter of acceptance of the Tender.  (3) The Contractor shall ensure that different types of C&D materials are sorted on site and stored in different containers, skips or stockpiles to facilitate reuse/recycling and disposal at different outlets as appropriate.  (4) The Contractor shall identify the inert portion of C&D materials that are suitable for recycling into aggregates, in particular hard rock and broken concrete generated from demolition or road improvement works, and recover the materials for delivery to recycling facilities or a location as notified by the Engineer. All inert C&D materials shall also be broken down according to the Dumping Licence conditions before disposal.  (5) For other C&D materials, the Contractor shall be required to check and ensure that the general refuse, as far as reasonably practicable, contains no observable inert or reusable/recyclable C&D materials (e.g. metal, and paper/cardboard packaging) before disposal to landfills. If it is found that the Contractor cannot meet this requirement, the Engineer shall request the Contractor to review the system for retrieval of reusable or recyclable materials that are observed. In addition, sorted inserted C&D materials for disposal to public filling outlets shall contain no observable non-inert materials, such as general refuse, timber etc.  (6) Equipment and material packaging (i.e. paper and cardboard) shall be recovered, properly stockpiled in a dry and covered condition to prevent cross-contamination by other C&D materials before disposal by recycling sub-contractors. The Contractor shall pay particular attention to avoiding cross-contamination in the course of collecting paper for recycling.  (7) The Contractor shall identify and provide sufficient space for temporary storage of C&D materials to facilitate collection and/or sorting on the Site. The space provided shall be commensurate with the estimated quantity for each type of C&D materials generated from the Site.  (8) Except for those inert C&D materials to be reused on the Site, the Contractor shall remove all other C&D materials off the Site as soon as practicable in order to optimize the use of the on-site storage space.  (9) The Contractor shall make arrangements with the potential recycling contractors to facilitate the collection of recyclable materials sorted from the Site with reasonable care.  (10) The Contractor shall establish a system for proper handling and storage of chemical wastes generated from the Site, and arrange collection and disposal of such chemical wastes by specialist contractors. The Contractor shall record the details about the nature of the chemical wastes, method of storage (e.g. type, size and materials of the container), the collection and disposal arrangements, etc.  (11) The Contractor shall record the quantities of C&D materials generated, and submit the data at quarterly intervals to the Engineer within two weeks of the end of each February, May, August and November, until completion of the Works. |
| 23.5.7 | Avoidance of nuisance | (1) All works are to be carried out in such a manner as to cause no damage and as little inconvenience as possible to all nearby residents, property, business and the public in general.  (2) The Contractor shall not permit any sewage, wastewater, effluent or surface runoff to flow from the Site onto any adjoining land or allow any waste matter or refuse which is not part of the final product from waste processing plant to be deposited anywhere within the Site or onto any adjoining land.  (3) In the event of any spoil or debris from the Site being deposited on adjacent land or any silt being washed down to any area, the Engineer shall be informed immediately. The Contractor shall arrange for removal of such matter in a proper manner to the satisfaction of the Engineer. If the spoil or debris is found contaminated, special precautions shall be taken during removal of the material to ensure that the environmental impacts are minimized. After removal of the spoil, debris or material and silt, the Contractor shall restore to the satisfaction of the Engineer the affected land or areas to their natural state.  (4) The Contractor shall ensure that no earth, rock or debris including any deposit arising from the movement of plant or vehicles is deposited on public roads or private rights of way as a result of the activities of the Contractor, his Sub-contractors, and other contractors working on the Site. At all exit points leading out of the Site, the Contractor shall provide wheel-washing bay installations to wash mud and the like from the wheels and bodywork of all vehicles leaving the site as follows:  High pressure water jet shall be used to remove all visible signs of mud from all vehicles to the satisfaction of the Engineer. Heavy-duty metal grating capable of supporting the heaviest vehicles and a trough for collecting wastewater, etc. should be installed.  The whole of the area around the wheel-washing bay and any length of access road between the bays and the Site boundary shall be paved with concrete or bituminous surfacing to facilitate cleaning and shall be kept free of mud.  The wheel-washing bays shall be provided at the start of the Contract unless otherwise agreed by the Engineer. Details of the proposed facilities shall be submitted to the Engineer for approval. The Contractor shall be responsible for the operation, maintenance and any necessary replacement of such installations throughout the Contract.  Water used in the wheel-washing facilities shall be changed at frequent intervals to maintain the effectiveness of the washing operation. The wheel-washing facility shall be regularly desilted.  (5) If any earth, rock or debris generated from activities on the Site are deposited on public roads or private rights of way, the Contractor shall immediately remove all these materials and restore the affected roads and rights of way to their original state to the Engineer’s satisfaction. |
| 23.5.8 | Handling and disposal of waste | (1) General refuse shall be stored in enclosed bins separate from inert C&D material and chemical wastes and shall be removed from the Site on a regular basis in order to minimize odour, pest and litter impacts. Burning of refuse on site is not permitted.  (2) The Contractor shall take the following general measures to minimize adverse impacts while handling waste:  Handle and store waste in a manner which ensures that it is held securely without loss or leakage, thereby minimizing the potential for pollution;  Remove waste in a timely manner;  Maintain and clean waste storage areas regularly;  Use reputable and authorized waste collectors to collect specific categories of waste for recycling or disposal;  Minimize windblown litter and dust during transportation by either fitting trucks with mechanical covers or transporting waste in enclosed containers; |
| 23.5.9 | Chemical waste control | (1) The Contractor shall observe and comply with the Waste Disposal (Chemical Waste) (General) Regulation and any additions or amendments thereto coming into effect before completion of the Works.  (2) The Contractor shall apply for registration as chemical waste producer under the Waste Disposal (Chemical Waste) (General) Regulation when chemical waste is produced. All chemical waste shall be properly identified, stored and disposed in accordance with the actual Regulation and Code of Practices.  (3) The Contractor shall ensure that the disposal of chemical waste is:  Handled by a licensed waste collector; and  At a recycling, treatment or disposal facility that is licensed under the Waste Disposal regulation to receive chemical waste  Carried out with appropriate preventive measures to minimize adverse impacts and leakage of the waste.  (4) The Contractor must ensure that all the necessary waste disposal permits are obtained and the conditions specified in these permits are fully complied with. |
| **23.6** | **ENVIRONMENTAL MONITORING AND AUDIT** |  |
| 23.6.1 | Environmental monitoring and audit – general requirements | The Environmental Monitoring and Audit (EM&A), as detailed in the Particular Specification, includes measurement, sampling, laboratory testing, analysis of monitoring results, reporting and auditing. |
| 23.6.2 | Environmental Team | (1) EM&A shall be carried out by the Environmental Team (ET) which shall be employed by the Employer separately and independent of the Contractor. The Engineer shall advise the Contractor of the details of the ET before commencement of Contract.  (2) The duties of the ET shall include but not limited to the following:  To investigate and audit the Contractor’s equipment and work methodologies with respect to pollution control and environmental mitigation, and anticipated environmental issues for proactive action before problems arise;  To monitor the various environmental parameters and collecting/ monitoring all necessary data as required in the Contract;  To audit and prepare audit reports on the environmental monitoring data and the site environmental conditions;  To report the environmental monitoring and audit results to the Contractor, the Engineer as well as the Employer and the Director of Environmental Protection as necessary;  To recommend suitable mitigation measures to the Contractor, through the Engineer, in the case of exceedance of the environmental limits specified in the Contract.  To undertake investigation procedures for complaints on environmental matters  (3) The Contractor shall provide assistance and attendance to the ET in discharging the above duties during the EM&A. Such assistance and attendance to be provided to the ET should include but not be limited to allowing site access and provision of construction information. |
| 23.6.3 | Vetting of Contractor’s proposals by the Environmental Team | (1) All method statements submitted by the Contractor to the Engineer for approval shall be copied to the ET for vetting to see whether sufficient environmental protection and pollution control measures have been included to comply with contractual and statutory requirements. The ET shall advise the Engineer of their views to enable the Engineer to make a decision on the submission.  (2) The ET shall also review the progress and programme of the Works from time to time to check whether relevant environmental laws have been violated, and to ensure that any foreseeable potential for violating such laws can be prevented. The Contractor shall regularly copy relevant documents to the ET so that the checking work can be carried out. The documents shall at least include the updated Work Progress Reports, updated Works Programme, application letters for different licences/permits under the environmental protection laws, and all the valid licences/permits. The site diary and other relevant documents shall also be available for the ET's inspection upon his request.  (3) If the ET's review concludes that the current status on the license/permit is not compatible with the works programme or may result in potential violation of environmental protection and pollution control requirements by the works in due course, he shall advise the Engineer accordingly.  (4) Upon receipt of the ET’s advice through the Engineer, the Contractor shall undertake immediate action to correct the situation. The Engineer shall follow up to ensure that the Contractor has taken appropriate action in order that the environmental protection and pollution control requirements are fulfilled. |
| 23.6.4 | Environmental monitoring | (1) The ET shall carry out baseline monitoring and impact monitoring during the course of the Works in accordance with the requirements laid down in the Particular Specification.  (2) If the impact monitoring results indicate non-compliance with the criteria and limits specified in the Contract, the Contractor shall immediately carry out corrective or mitigation actions in accordance with the Event and Action Plan detailed in the Particular Specification.  (3) The ET shall carry out more frequent monitoring as specified and shall continue with the additional monitoring until the recorded levels are reduced to acceptable levels as a result of the Contractor’s corrective or mitigation measures, or until it is proved that the exceedance is not caused by the construction activities. |
| 23.6.5 | Environmental site audit inspections | (1) The ET shall be responsible for formulation of the environmental site inspection, deficiency and action reporting system, and for carrying out the site inspection works. Within 21 days of the commencement of the Contract, the ET shall submit a proposal on the site inspection, deficiency and action reporting procedures to the Contractor through the Engineer for agreement.  (2) Regular site inspections shall be carried out at least once per week. The areas of inspection shall not be limited to the environmental situation, pollution control and mitigation measures within the Site. The site inspections shall also review the environmental situation outside the site area that is likely to be affected, directly or indirectly, by the site activities. ET shall make reference to the following information in conducting the inspection:  Works progress and programme;  Individual works methodology proposals (which shall include proposal on associated pollution control measures);  The requirements specified in the Contract on environmental protection;  The relevant environmental protection and pollution control laws; and previous site inspection results.  (3) The Contractor shall update the ET with all relevant information of the Contract for the ET to carry out the site inspections/audits. The inspection results and its associated recommendations on improvements to the environmental protection and pollution control works shall be submitted to the Employer and copied to the Engineer and Contractor within 24 hours, for reference and for taking immediate action. Upon receipt of the inspection results and recommendations and unless otherwise instructed by the Engineer, the Contractor shall follow the procedures and time-frame as stipulated in the environmental site inspection, deficiency and action reporting system formulated by the ET to report on any corrective /remedial measures subsequent to the site inspections /audits.  (4) The regular site inspections shall also ensure that the work site boundaries are not exceeded and that no damage, especially of an ecological nature, is being caused to the surrounding areas.  (5) Ad hoc site inspections shall also be carried out if significant environmental problems are identified. Inspections may also be required subsequent to receipt of an environmental complaint, or as part of the investigation work, as specified in the Particular Specifications on Event Contingency Plan for environmental monitoring and audit. |
| 23.6.6 | Environmental complaints | (1) Complaints about environmental matters shall be referred to the ET for carrying out complaint investigation procedures. Upon receipt of the complaints, the ET shall undertake the following actions:  Investigate the complaint to determine its validity, and to assess whether the source of the problem is due to works activities;  If a complaint is valid and due to the works, identify mitigation measures;  If mitigation measures are required, advise the Contractor through the Engineer accordingly as soon as possible;  Review the Contractor's response on the identified mitigation measures, and the updated situation;  Undertake additional monitoring and audit to verify the situation if necessary, and review that any valid reason for complaint does not recur;  Report the investigation results and the subsequent action to the source of complaint for responding to complainant, with copies to the Employer, Engineer and the Contractor within the time frame assigned by the source of complaint; and  Record the complaint, investigation, the subsequent action and the results in the monthly EM&A reports.  (2) During investigation of the complaint, the Contractor shall cooperate with the ET in providing all the necessary information and assistance for completion of the investigation. If the investigation establishes that the complaint is valid and mitigation measures are identified, the Contractor shall promptly carry out the mitigation. |

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| **PARTICULAR TECHNICAL SPECIFICATIONS** | |
| GENERAL | |
| 1. Project description |  |
| 1.1 Project Location | The RSWMF have been located, after a site selection process conducted by MEE, reclaimed land at the Hithadhoo Harbour, in Addu City (southern part of the Maldives) |
| 1.2 Climate Conditions | The climate is warm and humid, typical of the tropics. The average temperature ranges between 25°C to 30°C and relative humidity varies from 73 percent to 85 percent. The annual average rainfall is approximately 1,948 mm. The location receives plenty of sunshine throughout the year. On average the location is expected to receive 2704 hours of sunshine each year. Table below provides a summary of key meteorological findings for Maldives that is applicable for the project location.   |  |  | | --- | --- | | **Parameter** | **Data** | | Average Rainfall | 9.1mm/day in May, November; 1.1mm/day in February | | Maximum Rainfall | 184.5 mm/day in October 1994 | | Average air temperature | 30.0 C in November 1973; 31.7 C in April | | Extreme Air Temperature | 34.1 C in April 1973;17.2 C in April 1978 | | Average wind speed | 3.7 m/s in March; 5.7 m/s in January, June | | Maximum wind speed | W 31.9 m/s in November 1978 | | Average air pressure | 1012 mb in December; 1010 mb in April |   The climate of project location is characterised by the monsoons of the Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.  The winds that occur are mostly determined by the monsoon seasons. The two monsoons are considered mild given that the location is close to the equator. As a result, strong winds and gales are infrequent although storms and line squalls can occur, usually in the period May to July. During stormy conditions gusts of up to 60 knots have been recorded at Male’.  Wind has been uniform in speed and direction over the past twenty-plus monsoon seasons in the Maldives (Naseer, 2003). Wind speed is usually higher in central region of Maldives during both monsoons, with a maximum wind speed recorded at 18 ms-1 for the period 1975 to 2001. Mean wind speed is highest during the months May and October in the central region.  Besides the annual monsoonal wind variations there are occasional tropical climatic disturbances (tropical storms or low intensity tropical cyclones) in the central region which increases wind speeds up to 110 km/h, precipitation to 30 to 40 cm over a 24 hour period and storm surges up to 3 m in open ocean (UNDP, 2006).  Table below summarizes the wind conditions in central Maldives throughout a year. Medium term meteorological data from Hulhule Meteorological Centre (see Figure 4, Figure 5 and Figure 6) and findings from long-term Comprehensive Ocean-Atmosphere Data Set (COADS) are used in this analysis.   |  |  |  | | --- | --- | --- | | **Season** | **Month** | **Wind** | | NE - Monsoon | December | Predominantly from NW-NE.  High Speeds from W | | January | |  | February |  | | Transition Period 1 | March | From all directions. Mainly W.  High Speeds from W. | |  | April |  | | SW - Monsoon | May | Mainly from W.  High Speeds from W. | | June | | July | | August | |  | September |  | | Transition Period 2 | October | Mainly from W.  High Speeds from W | | November |   Monthly Frequencies of Wind Direction in Central Maldives based on National Meteorological Center 10 year Data (adapted from Naseer, 2003):  M:\Temp\Thilafushi Baseline Survey\Published maps\Wind frequency.png  24 Year Wind Frequency Recorded at National Meteorological Center:    Mean Daily Wind Speed and Direction Recorded at National Meteorological Centre (1978 – 2004):  M:\Temp\Thilafushi Baseline Survey\Published maps\mean wind speed.png  The Disaster Risk Profile of Maldives (UNDP, 1006) reports 11 cyclonic events over the Maldives in the last 128 years and only one event over the central Maldives. All of these events were of category 1 cyclones. There have been no cyclonic events since 1993.  The island is located in a moderate risk cyclonic hazard zones (UNDP, 2006). The RWMF site is expected to receive regular annual strong winds during the peak SW monsoon.  The average annual rainfall for the Maldives is 2,124 mm. Mean monthly rainfall varies substantially throughout the year with the dry season getting considerably less rainfall. The proportions of flood and drought years are relatively small throughout the archipelago, (UNDP, 2006).  The mean annual rainfall in Hulhule’ is 1991.5 mm with a Standard Deviation of 316.4 mm and the mean monthly rainfall is 191.6 mm. Rainfall varies throughout the year with mean highest rainfall during October, December and May and lowest between February and April.  Mean Monthly Rainfall in Hulhule’ (1975-2004):    Analysis of daily maximum annual rainfall data shows high variability, including extremes. However, no significant long term trends are evident in the Hulhule data.  Maximum daily rainfall by year in Hulhule’ (1975-2005) - (Source: Hay, 2006):  M:\Temp\Thilafushi Baseline Survey\Published maps\maximum daily rainfall.png  The probable maximum precipitation predicted for Hulhule’ by UNDP (2006):   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Station** | **Return Period** | | | | |  | 50 year | 100 year | 200 year | 500 year | | Hulhule’ | 187.4 | 203.6 | 219.8 | 241.1 |   Daily temperatures of Maldives vary little throughout the year with a mean annual temperature of 28°C. The annual mean maximum temperature recorded for Male’ during the period 1967-1995 was 30.4°C and the annual mean minimum temperature for the same period was 25.7°C. The highest recorded temperature for Male’ was 34.1°C on 16th and 28th of April 1973. The hottest month recorded was April 1975 with a maximum monthly average temperature of 32.7°C, the next highest being 32.6°C in April 1998. The lowest minimum average temperature of 23.7°C was recorded in July 1992.  There is considerable inter annual variability in extreme temperatures for Hulhule as shown in Figure 9. A maximum temperature of at least 33.5oC is rare at Hulhule and has a return period of 20 years (Hay, 2006).  Maximum TESIAerature by year in Hulhule’- 1975-2005 (Source: Hay, 2006):    Tides in the Maldives are mixed and semi-diurnal/diurnal. Water levels at the site vary mainly in response to tides, storm surge or tsunamis. Tidal variations are referred to the standard station at Hulhulé. Typical spring and neap tidal ranges are approximately 1.0 m and 0.3 m, respectively (MEC, 2004). Maximum spring tidal range in Hulhulé is approximately 1.1 m. There is also a 0.2 m seasonal fluctuation in regional mean sea level, with an increase of about 0.1 m during February to April and a decrease of 0.1 m during September to November. Table 9 summarizes the tidal elevations reported at Hulhulé, which is representative of tidal conditions at the project site.  Tidal Variations at Hulhule International Airport:   |  |  | | --- | --- | | **Tide Level** | **Referred to Mean Sea level** | | Highest Astronomical Tide (HAT) | +0.64 | | Mean Higher High Water (MHHW) | +0.34 | | Mean Lower High Water (MLHW) | +0.14 | | Mean Sea Level (MSL) | 0.00 | | Mean Higher Low Water (MHLW) | -0.16 | | Mean Lower Low Water (MHLW) | -0.36 | | Lowest Astronomical Tide (LAT) | -0.56 |   There are two major types of waves observed along the islands of Maldives. The first type is wave generated by local monsoon wind with a period of 3-8 seconds and the second type is swells generated by distance storms with a period of 14-20 seconds [Kench et. al (2006), DHI (1999), Binnie Black & Veatch (2000), Lanka Hydraulics (1988a & 1998b)]. The local monsoon predominantly generates wind waves, which are typically strongest during April-July in the southwest monsoon period. Wave data for Male and Hulhulé’ between June 1988 and January 1990 (Lanka Hydraulics 1988a & 1998b) shows that the maximum significant wave height (Hs) recorded for June was 1.23 m with a mean period (Tm) of 7.53s. The maximum recorded Hs for July was 1.51 m with a Tm of 7.74s. The mean wave periods were 5.0 – 9.0s and the peak wave periods were within 8.0 – 13.0s.  Maldives experiences occasional flooding caused by long distance swell waves that are generated by South Indian Ocean storms (Goda 1988). The swell waves of height 3 meters that flooded Male’ and Hulhulé in 1987 are said to have originated from a low pressure system off west coast of Australia. In addition, Maldives has been subject to an earthquake-generated tsunami reaching heights of 4.0m on land (UNEP, 2005). Historical wave data from Indian Ocean countries show that tsunamis have occurred in more than 1 occasion, most notable has been the 1883 tsunami resulting from the volcanic explosion of Karakatoa (Choi et al., 2003). |
| 1.3 Conditions on Site | Apart from a few ground cover species, no other terrestrial flora are observed on site. No vegetation removal is required. |
| *Soil Profiles* | Geology and Geomorphology Soil Profile  Maradhoofeydhoo  Soil profiles taken for the EIA of “Water and Sewerage Network Development in Gan & Maradhoo, Maradhoo-Feydhoo & Feydhoo”, (CDE, 2012) show 6 distinct layers of soil observed at the site. Soil profile was taken at the current RO Plant site.  The top layer comprised of white sand, with a thickness of 0. 15m. Below that, four layers comprising of humus and dark soil were observed, two layers of coarse white sediment followed until the groundwater level. Groundwater was observed at 1.7m from ground level (CDE, 2012).  Bathymetry  The bathymetry of the proposed outfall locations was conducted using echo sounder and RTK GPS system. The bathymetry reports of the locations are attached in Section 16.6 annex 6. Bathymetry for Maradhoo – Feydhoo showed that the lagoon space between reef crest and shoreline was shallow with a very uniform average depth of 0. 5 m with a gradual decrease in slope at the reef crest. |
| *Groundwater* | Groundwater in the project islands is developed in the form of confined freshwater lens in the porous loose coral sand formation. The primary source of the groundwater is rainfall similar to other islands in Maldives. The size of the natural freshwater lens depends on the width, rate of abstraction and type of vegetation. The groundwater lens developed in the project area appears relatively small due to dense population, narrowness of the islands and decreased net recharge.  Key factors which are considered in measuring the size of the groundwater aquifers in small islands are size of the island, width of the island, rainfall pattern and extraction of groundwater. The average freshwater lens area estimated by Falkland (2000) for the Maradhoo, Maradhoo-Feydhoo and Feydhoo are at 19ha, 16ha, and 48 ha respectively. The average percentage of annual recharge from rainfall was obtained as 38.7%. |
| 1.4 Other | Working days and hours: from Sunday to Thursday, 8.30 am to 5.30 pm (with 1 hr lunch break). |
| 1.5 Extent of Works | For the full extent of work refer to the Drawings, Specification and other associated documents. |
| 2.2 Site Examination | Prior to commencement of work at Site, the Contractor, inspect the Site with to review and establish the condition of surface features including existing buildings, wells, trees and other plants, grassed areas, fencing, service poles, wires, paving, and survey benchmarks or monuments on or adjacent to Site which may be affected by the Works. This inventory shall be mutually agreed between the Engineer and the Contractor and shall not thereafter be subject to dispute. Such inventory as may be amended, from time to time, will be used by the Engineer to check compliance by the Contractor with the requirements of Contract Documents.  The Contractor shall arrange for the relocation of any surface features that may become damaged during the course of the project as required.  The cost of utility relocation shall be paid by the Contractor if the relocation is for the convenience or safety of construction, and by the Employer if the relocation is necessary by a direct conflict between the work and the utility which in the opinion of the Engineer cannot be otherwise avoided except as noted herein or on the drawings as being the Contractor's responsibility.  The Contractor shall provide on-going review, inspection, and attendance during performance of Works to properly document conditions, inform the Engineer of any existing condition at Site affected by Works which may require restoration, repair, or replacement. The contractor shall not cover up any Works without prior approval from Engineer. On all occasions photographic evidence shall be taken by the Contractor including date and time.  The Contractor shall verify that existing Site conditions and substrate surfaces are acceptable for subsequent work. Beginning new work means acceptance by Contractor of existing conditions.  The Contractor shall verify that existing substrate is capable of structural attachment of new work being applied or attached and if that is not the case follow regarding benchmarks provided by the employer. |
| 2.3 Site Surveys | In addition to General contract conditions and Particular conditions “measurement and evaluation” and “Setting Out” the Contractor shall employ a qualified surveyor to carry out surveys of the following:  As a minimum it is anticipated that surveys will be required:   1. After completion of clearing 2. After completion of stripping unsuitable ground 3. After completion of excavations as required 4. Of stockpiled soils unsuitable for further use 5. Of all paved surfaces   Additional survey shots may be required by the Engineer.  The Surveyor shall be equipped with a total station instrument capable of sub-cm accuracy on all measurements.  The Surveyor shall be responsible for maintaining existing benchmarks provided by Employer and a ground control grid system. The surveys have to tie in with the Maldivian geodetic system.  The Surveyor shall complete all ground surveys for volumetric measurements as required in the Contract. Sufficient points shall be taken to ensure accuracy of plus / minus 0.01 m, typically, the Engineer expects that surveys taken on a grid of 10 x 10 m will be adequate on surfaces that do not undulate excessively; however, tighter shot spacing may be required.  All work shown on drawings shall be laid out by Surveyor so that the project is constructed as shown on drawings. Maximum acceptable offset error is 0.10 m in X,Y dimensions and 0.025 m in vertical control, except of pipe invert elevations where accuracy of 0.01 m shall be maintained.  The Surveyor shall provide data in electronic X,Y,Z format and as contoured drawing in dwg or dxf-format to the Engineer within three days of the survey being completed. |
| 2.4 Temporary Facilities | The temporary facilities should comply with the general technical specifications and the specifications below |
| Contractors Facilities: | The Contractor shall be mobilized and on site no later than 14 days after commencement date.  In addition to General conditions, “Facilities for staff and labour”, the Contractor shall provide, maintain and finally remove all necessary temporary facilities required for storage of construction material any tools and other equipment in the designated area. The facilities have to comply with all local regulations e.g. with regard to electricity supply etc. In case the Contractor prefers a different location for his temporary facilities he shall obtain written approval by Employer/Engineer prior to setting up. |
| Housekeeping | The Contractor shall not allow the site of the work to become littered with trash and waste material. The site shall remain in a neat and orderly condition throughout the construction period. The Contractor shall collect all non-hazardous solid waste in appropriate containers on a daily basis and not leave any scraps and other construction litter lying around. All recyclable materials shall be collected and dropped off at designated recycling facilities.  On or before the completion of the work, the Contractor shall tear down and remove all temporary structures built by him and shall remove rubbish of all kinds from any of the ground which he has been occupied and leave the ground in first class condition to the satisfaction of the Employer. |
| Site Security | The Contractor shall install suitable fencing (barricades or barriers) along the boundaries of the construction area to prevent the public from accessing the construction site. |
| Pollution/Emission Control | The Contractor shall maintain all required temporary erosion and pollution control features installed under this contract.  The Contractor shall cover or wet down dry materials and rubbish to prevent blowing dust and debris. The Contractor shall undertake dust control by watering roadways and other travelled construction areas to continuously reduce dust to the satisfaction of the Employer.  The Contractor has to provide and run all temporary drainage and pumping facilities to keep excavations and site free from standing water.  Water shall be removed in a manner that will not cause any environmental impact, damage or annoyance to adjacent areas. The discharge of runoff water containing suspended materials or other harmful substances shall not enter into existing water courses, sewer or drainage systems.  The Contractor shall direct potentially contaminated water into a containment area/tank and discharge/treat is according to local law and regulations.  Any waste or volatile materials, such as mineral spirits, oil or paint thinner shall not be rereleased into watercourses, storm or sanitary sewers but discarded appropriately. |
| Fire Protection: | The Contractor shall provide and maintain all required temporary fire protection equipment during the performance of work according to local regulations and bylaws.  Burning rubbish and construction waste materials is not permitted, except land clearing-slash that may be allowed in strict conformance with existing regulations. |
| 2.5 Health and Safety |  |
| General Requirements | The Contractor is obliged to devise a Health and Safety Plan .The health and safety guidelines contained here after are intended to assist the Contractor in preparing a written Site-specific Occupational Health and Safety Program for this project in accordance with the Occupational Health and Safety Regulations  The site-specific Health and Safety Plan must be submitted to the Engineer.  The Plan must address the requirements of this section and reflect an understanding of the specific concerns present at the site.  The Contractor is recognized as the Prime Contractor and is responsible for coordinating the occupational health and safety programs of all workers at the construction site. The Contractor will ensure that his workers, and any other people entering the construction site, including subcontractor staff, follow all occupational health and safety policies and procedures established by the Employer and the Contractor. Contractors, their workers or agents not complying with the Employer’s health and safety expectations will be required to stop work and will not resume work until the safety requirements are met.  The Contractor shall use due care and take all necessary precautions to assure the protection of persons and property at the construction site.  The Contractor shall supervise and enforce compliance with safety procedures that shall be developed and maintained by the Contractor. As part of the safety procedures, the Contractor shall supply and maintain required first aid and safety equipment and attend regularly scheduled meetings with the Employer and Engineer.  The Occupational Health and Safety Program must be designed to prevent injuries and occupational diseases.  The development, implementation, and maintenance of the Program are the Contractor's sole responsibility. The Contractor shall effectively warn and protect contractor employees and employees of subcontractors, agents and invitees, the Employer and associated on-site staff, the Engineer, the public (both those onsite and offsite insofar as may be effected by the actions of the contact), and the environment to the satisfaction of the Employer and other regulatory agencies from any danger as a result of the work being done.  The requirements of the Program shall be implemented, maintained, and enforced until final demobilization of the site is complete.  The Contractor shall give precedence to the safety and health of the public and site personnel over cost and schedule considerations for all project work.  Appointed Health and Safety Officer, Engineer and Employer, shall have the right to stop work for health and safety considerations.  Should any unforeseen or site-peculiar safety-related factor, hazard, or condition become evident during the performance of works at the site, the Contractor shall bring such to the attention of the Engineer verbally and in writing as quickly as possible, for resolution. In the interim, the Contractor shall take prudent action to establish and maintain safe working conditions and to safeguard contractor employees and employees of subcontractors, agents and invitees, the Employer and associated onsite staff, the Engineer, the public (both those onsite and offsite insofar as may be effected by the actions of the contact).  The Contractor alone shall be at all times responsible for the safety of his employees at work and for the safety, adequacy, efficiency and sufficiency of his plant, his equipment and his method of prosecuting the Work of the Contract. |
| 3. Administrative procedures |  |
| 3.1 Project Management and Coordination | With regard to Contractors Representatives, Superintendence and Personnel, refer to GCC  The Contractor shall if not already presented with the tender documents, nominate his:   * Representatives who are enabled to act on his behalf, within 7 day of receiving the Letter of Acceptance. * Staff for superintendence of the works within 7 day of receiving notice of the commencement date.   Furthermore, the Contractor shall provide the Engineer with a complete list of other staff, working on site, giving their profession, part of construction work they are working on and if of foreign origin, the required work permits. The same applies to all subcontractors.. |
| 3.2 Project Meetings |  |
| Pre-Construction-Meeting: | A pre-construction meeting shall be held within 14 days of issue of the Letter of Acceptance.  The Contractor shall be notified at least 3 days in advance of time and place of meeting.  The representatives nominated by the Contractor, representatives of major sub-contractors as presented with the tender documents, the Employer and his representative, the Engineer, shall attend.  Agenda for the meeting shall be drafted by the Engineer, though Contractor shall advise Engineer with due endeavour of further topics to be discussed. |
| Progress Meetings | Apart from regular site meetings to discuss and resolve day to day issues amongst the Construction Company and the Engineer, Progress Meetings shall be held on a monthly bases unless agreed otherwise with the Employer/Engineer throughout the construction period.  The Contractor shall be notified at least 3 days prior to the meeting. The Contractor shall present the work process with reference to the work program, take detailed minutes and distribute them accordingly. The agenda shall be agreed amongst all parties in advance. |
| Other | In case meetings with outside bodies, e.g. presentation of the project to the public or any involved regulating authorities, the Contractor is obliged to send appropriate members of staff and assist the Engineer with any required documentation |
| 3.3 Reporting |  |
| Site Diary | Refer to PCC with regard to its particular contents. |
| Progress Reports | Under GCC (and further sub clauses mentioned hereunder), the contents of the monthly progress report is described in detail.  The information to be collated as mentioned and all data recorded in the site diary shall be and summarized for the monthly report as well as the information required. |
| Programme | The Contractor is obliged to submit a detailed time programme to the Engineer within 28 days after receiving the notice of Commencement of works which has to be updated whenever the previous programme is not in line with actual work progress (Refer to work programme on page 6-361). |
| 3.4 Submission of Documents by Contractor: | The submission of documents refers to, but is not limited to:   * Any documentation with regard to measurements * Work Programs * Method Statements * Health and Safety Program and Instructions * Samples * Minutes of Meetings * Payment documents * Drawings * Documentation referring to Contactor’s design * As Built Drawings * Minutes taken during testing and rest results * Material delivery and check of compliance with contract * Reports and operation and maintenance manuals * etc.   Any submission of documents to the Engineer shall be accompanied by a standard form to be devised and agreed at the beginning of the construction works between the Contractor and the Engineer.  The Contractor shall design and propose one or more system(s) for numbering of:   * Documents and manuals * Drawings * Technical Components etc.   The system shall comprise easy identification of al numbered items and include any document provided by subcontractors. The Engineer shall approve the numbering system(s).  All documents shall be submitted in electronic version and 5 print copies at least.  Any document that requires approval by the Engineer shall be handed in to the Engineer at leaving at least 14 days approval period for Engineer.  Before any document is transmitted for approval the Contractor shall determine and verify the following:  Before transmitting each submittal, determine and verify the following:   * This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents * Identify Contract, Contractor, Subcontractor, or Supplier; pertinent drawing and detail number, and specification Section number, as appropriate. * Review and coordinate each submittal with other submittals and with the requirements of Works and Contract Documents. Coordinate submission of related items * Provide space for Engineer review stamp and comments on submittals. * Submittals not requested will not be recognized or processed. Submittals received directly from Subcontractors, Suppliers, vendors, or other Contractor Representatives will be returned by Engineer without action * Notify Engineer, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations * Verify field measurements and affected adjacent Works are coordinated * Contractor's responsibility for errors and omissions in submission is not relieved by Engineer’s review of submittals * Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Engineer review. * Keep one reviewed copy of each submission on site. * All field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalogue numbers, and similar information with respect thereto. * All materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of Works. * All information relative to Contractor's sole responsibilities in respect of means methods, techniques, sequences and procedures of construction, and safety precautions and progress incident thereto. |
| 3.5 As-Built Records and Drawings | The Contractor shall prepare and submit to the Engineer for approval 28 days of the Time for Completion, duly amended copies of As-Built Records and Drawings. These accurate documents shall be fully dimensioned to show locations, elevations and other pertinent details of the work executed under the contract. Within 21 days of receipt of the above drawings, the Engineer shall return to the Contractor 2 copies of the drawings showing the amendments required by him. Within 21 days of receipt of the amended drawings the Contractor shall issue to the Engineer 5 print copies and one set as electronic version. |
| 1. SITE PREPARATION | |
| 1.1 Site preparation and maintenance | All temporary site installations must comply with the requirements of local utility companies, and the general regulations concerning legal and industrial procedures for health and safety and protection of the environment.  ***Contractors Facilities***  The Contractor shall set up his own temporary facilities (offices, sanitation facilities for his own staff, recreation facilities incl. kitchen, storage facilities for materials and equipment/sheds, small in-situ testing laboratory). The size, lay-out and placement of the facilities will be approved by the Engineer. Hence the Contractor has to deliver a layout plan showing the location and size of the Contractor’s temporary site installations in detail, min. 3 weeks before the start of the construction works. The location is marked on drawing “Site Organisation”. The installation, dismantling and insurance of the temporary facilities etc. shall be performed on the account of the Contractor and before the Provisional Acceptance of works. The Contractor shall be fully responsible for the stored materials and equipment. He shall secure the stored items and make arrangements for protecting them against conditions of extreme heat, cold and moisture. The Contractor is responsible for cleaning, any repair and maintenance of the temporary facilities during the entire construction period as well as keeping the site tidy. Only approved materials may be stored on site, any rejected materials must be removed immediately from the site.  In case the Contractor intends to place his advertisements on a signboard, the location and the manner of placing will be jointly decided by the Contractor and the Engineer.  The signboard may be installed entirely at the expense of the Contractor. A drawing of the signboard (minimum 6 m²) must first be submitted to the Engineer for approval. No other advertisements may be placed on the site.  The signboard shall contain at least:   * The logo of the Ministry of Environment and Energy * The Project title * The Name and logo of the contractor * The duration of the contract with Starting date and expected finish date * The name and the logo of the Engineer   ***Electrical power supply and motive power (to be provided by Contractor)***  Arrangements for temporary power supply and motive power for Contractor’s and Engineer’s facilities shall be the responsibility of the Contractor, who shall also bear the maintenance and consumption costs. The Contractor shall, if so required, make arrangements with the local electricity provider to obtain the supply of electricity from existing installations. The site installation must be independently protected according to local legislation. The Contractor shall ensure the protection of the Site against power failure. Alarm signals which may be necessary for the protection of the Site shall be provided by the Contractor. In case the electricity provider requires inspecting and approving the installations, the Contractor shall arrange for these.  ***Water supply and waste water discharge (to be provided by contractor)***  Arrangements for temporary water supply and wastewater discharge for Contractor’s and Engineer’s facilities shall be the responsibility of the Contractor, who shall also bear the maintenance and consumption costs. The Contractor shall, if so required, arrange with the local water authority to obtain the supply of water from existing installations. The site installation must be executed according to local legislation. In case the water authorities require inspecting and approving the installations, the Contractor shall arrange for these.  ***Telephone / Fax / Internet (to be provided by contractor)***  Arrangements for telephone fax and internet connection for Contractor’s and Engineer’s facilities shall be the responsibility of the Contractor, who shall also bear the maintenance costs. The costs for contracts and units consumed shall be borne by each party individually. Site installation must be executed according to local regulations. In case the relevant authorities require inspecting and approving the installations, the Contractor shall arrange for these.  ***Cleaning and maintenance of the site***  The Contractor shall bear the cost for cleaning and of removing any refuse, dirt and residual materials and cleaning of the site. The refuse etc. must be cleared away not later than the day after the same is generated.  In all cases, this shall be done:   1. When the work relating to a particular assignment is completed in whole or in part; 2. Where such removal is deemed necessary for preventing fire, and for ensuring safety in general; 3. When the Engineer first requests it; 4. This item shall include the cleaning of the construction site and the surrounding area before making provisional delivery and during the work.   Burning of waste or surplus construction material not allowed.  Combustible refuse must be immediately stored in a container in the place designated for it.  If the Contractor fails to carry out the above in time, the Engineer may commission the cleaning work to another Contractor. Twice the amount of the expenses will be retained from the amounts due to against the work done reports of Contractor(s) who is/are in default.  The Engineer shall, if the condition of the site requires the same, itself employ personnel to carry out the required cleaning work. The costs for it will be retained from the amounts due to against the work done reports, with a pro-rata distribution of the amounts for the work done reports submitted for the month in question by the Contractors present on the site .  ***Site roads / traffic management***  The Contractor is responsible for the installation and maintenance of all temporary roads and any traffic management as necessary for the execution of the construction works and shall bear all involved costs.  ***Security / fencing***  The Contractor shall bear the cost of the delivery, installation, maintenance and insurance of the temporary fencing around the entire facilities. The fencing of the site shall consist of wire mesh of up to at least 2 m height, supported on posts and foundations and provide access to the site via minimum 1 gate, width about 7 m. The fencing plan must be submitted to the Engineer for approval.  The Contractor shall bear all the risks associated with this contract, both for materials as well as for the work, until the provisional delivery of the work.  The cost of maintaining security at the construction site during the entire working period and the general measures concerning safety, hygiene, insurance, if necessary police protection as well, shall all be paid by the Contractor.  ***As-built drawings, reporting, operation and maintenance manuals***  The Contractor shall prepare and submit to the Engineer for approval as-built drawings, reporting, operation and maintenance manuals as mentioned in section 3.4 and 3.5 and according to the technical specification.  ***Personal protective equipment (PPE)***  The wearing of protective equipment and/or clothing shall be in conformance with applicable regulations and the Health and Safety Plan (HSP). Only equipment complying with regulations/standards shall be used. Equipment that has been altered in any way may not be worn on the work.  All Contractors’ personnel are required to have the company logo and name displayed prominently on their protective clothing.  ***Equipment and support for tests requested by the Engineer:***  The Contractor has to deliver all necessary equipment for accomplishment of tests / measurement which are described in these Technical Specifications and necessary support for the execution of the tests / measurements requested by the Engineer.  ***Insurance***  The cost for all insurances regulated by law, regulated by the general contract conditions and other usual insurances have to be taken in account and will not be refunded separately  ***Site clearing after completion of works***  After completion of all works the Contractor shall clear the site of all temporary facilities, structures, and all temporary connections to public utility supplies. The entire site has to be cleaned from remaining construction materials and garbage etc. |
|  | Site preparation and maintenance is paid as lump sum. The rates shall cover all expenses and charges for performing the works. |
| **2. SITE CLEARING AND GENERAL EARTHWORKS** | |
| 2.1. Site clearing | Clearing of the site shall be in accordance with the technical specification, the Engineer’s requirements.  This specification applies to surface clearing and preparation of site area before commencing with earthworks or construction works for roads, trenches or pipe works, foundations etc.  Works consist of:   * Clearing ground by leaves, grass, branches, garbage, weeds including appropriate disposal * Excavation of existing soil layer (sand, waste, inert material) up to 1.0 m depth * Evacuation of excavated material and transport to the stockpiling area indicated by the Engineer.   Before commencement of works, the Contractor shall test and propose the technology applied for the works to the Engineer, all in accordance with the General Technical Specifications. Site clearance shall be calculated per m² of cleared surface according to measures provisioned. The size shall be coordinated in collaboration with the Engineer. |
|  | Site clearance shall be paid in m². The rate shall cover all expenses and charges to perform the works. |
| 2.2. Transport of surplus material from general earthworks | This specification applies to transport of surplus soil of excavation works to a stockpiling area within the site limits. The stockpiling of the material has to follow the instructions of the Engineer.  Works consist of:   * transport distance up to 300 m * transport of excavated soil / surplus material to stockpiling area * stockpiling the excavated material (old waste, sand, inert material)   Before commencement of works, the Contractor shall test and propose the technology applied, to the Engineer, all in accordance with the General Technical Specifications. |
|  | Transport of surplus excavation material is paid in m³, geometrically measured at excavation works (excavated soil/backfilled soil). The rate shall cover all expenses and charges to perform the works. |
| 2.3 Dismantling of existing buildings and facilities | Dismantling and removing of buildings, facilities bricks, stones and masonry walls according the engineers requirement. Works consist of:   * dismantling and removing * transport to designated disposal area transport distance less than 1 km |
|  | Dismantling and removing of existing buildings and facilities shall be calculated per m³ measured by volume of truck transport. The rate shall cover all expenses and charges to perform the works |
| **5. CIVIL WORKS** | |
| 5.1 Administration building-RC Part | Construction of an control building and a waste intake building according to the following drawings : MLD-AGL-010 Outside View  MLD-AGL-011 Column Plan, Ground & First floor & Second Floor Plan  MLD-AGL-012 Concrete Structure Elevation  MLD-AGL-013 Reinforcement Placing DWG  MLD-AGL-014 Control Building Section  MLD-AGL-015 Ground Floor Plan  MLD-AGL-016 FL +4, 200 Floor Plan  MLD-AGL-017 FL +8,250 Floor Plan  MLD-AGL-018 FL +15,000 Floor Plan  MLD-AGL-019 Door and Window Details  MLD-AGL-020 Loading Information for ACC  MLD-AGL-021 Foundation Information for ACC  MLD-GML-M101 Plan – Ground Floor  MLD-GML-M102 Plan – FL. 15,000mm  MLD-GML-M103 Plan – FL. 20,900  MLD-GML-M104 Plan – Roof  MLD-GML-M105 Section “A-A”  MLD-GML-M106 Section “B-B”  MLD-GML-M107 Section “C-C”  MLD-GML-M108 Section “D-D”  MLD-GML-M109 Section “E-E”  MLD-GML-M110 Section “F-F”  MLD-GML-M111 Section “G-G”  MLD-GML-M112 Section “H-H”  MLD-GML-M113 Crane Operator Room Section View  MLD-GML-M121 Column Location Plan  MLD-GML-M122 Room Framing Plan  MLD-GML-M123 Wall Y4-1 Line Framing Plan  MLD-GML-M124 Wall Y2 Line Framing Plan  MLD-GML-M125 Wall X3, X7-1, X9 Line Framing Plan  MLD-GML-M126 Door and Window Details  MLD-C-008 Refuse Dike (PT-101) Plan and Section 1  MLD-C-009 Wastewater Pit and Trench Plan and Section  MLD-C-058 Refuse Dike (PT-101) Pan and Section 2  Staircase details (S1) including design and construction of lightning, electricity, water supply and wastewater evacuation (details in part 5 and 6 of Particular Technical Specifications) |
| 5.1.1 Earthworks | The earthworks include mechanical and manual digging, filling and compacting. According to the structural static. The foundation of the building will be made on a ballast layer |
| 5.1.1.1 Wide machinery excavation in soil cat. II | Wide machinery excavation of the ground beneath the control building in soil category II.   * excavation to dimensions/levels mentioned in the drawings; * loading soil in the transportation vehicle; * transport and unloading of soil to authorized dumping area; * verifying the works execution. |
|  | Wide machinery excavation in soil cat. II is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.1.2 Machine and manual excavation for foundation in soil category II. | Machine and manual excavation of foundation in the soil category II. transport/unloading soil to authorized dumping area. The bottom of the excavation plan with an accuracy + 3 cm   * excavation to dimensions/levels mentioned in the drawings; * loading soil in the transportation vehicle; * transport and unloading of soil to authorized dumping area; * verifying the works execution. |
|  | Wide machinery excavation of strip foundation in soil cat. II is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.1.3 Hard-core layer of ballast or compacted gravel | material supply in order to execute the hard-core layer of: ballast or gravel and transport to work place with appropriate transport means;   * Hard-core layer execution in thickness and dimensions, according to the Detailed Structural Design and Technical Specifications. Substrate thickness is 20 cm. * compaction of successive layers with vibrant plate including watering in successive layers; * verifying the works execution |
|  | Hard-core layer of ballast or compacted gravel is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2 Concrete works, formworks, reinforcement | Simple concrete shall be used for the underlay and reinforced concrete for the infrastructure and superstructure. The reinforcement used shall be steel concrete BS 500 placed in the foundations, superstructure and floor plate |
| 5.1.2.1 Lean concrete class C12/15 as equalization layer | Lean concrete with thickness of 5 cm, on the good compacted and flat hard-core layer, below the reinforced concrete slab of the control building, with concrete C 12/15, by making a flat upper surface.   * class and volume concrete supply, including transport, PVC sheet to separate the layers; * pouring blinding concrete, according to design; * watering/cover protecting of the concrete to ensure a regular strengthening; * verifying the works execution. |
|  | Lean concrete is paid in square meter (m²). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.2 Reinforced Concrete slab class C25/30 | Concreting of the reinforced concrete slab C25/30. Concrete should be installed by using machinery with vibration and nurture due to technical regulations. Concrete thickness 15 cm.   * class and volume concrete supply, including transport, PVC sheet to separate the layers; * pouring blinding concrete, according to design; * watering/cover protecting of the concrete to ensure a regular strengthening; * verifying the works execution. |
|  | Reinforced concrete slab is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.3 Reinforced concrete class C 25/30 for core ring | Concreting of the upper part of the concrete core ring with concrete C25/30in the smooth double formwork. Concrete should be installed by using machinery with vibration and nurture due to technical regulations.   * supply of concrete class and volume, including transport; * verifying reinforcement bars before pouring the concrete; * performing infrastructure by concrete casting and transport with crane/concrete pump to works area, according to the design; * watering or cover protecting of the concrete to ensure a normal strengthening; * verifying the works execution. |
|  | Reinforced concrete class C 25/30 for core ring is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.4 Reinforced concrete class C 25/30 for concrete plinths | Concreting of the reinforced concrete Plinths with concrete C 25/30 on a compacted and flat hard-core layer.   * supply of concrete class and volume including transport; * verifying reinforcement bars before pouring the concrete; * performing infrastructure by concrete casting and transport with crane/concrete pump to works area, according to the design; * watering or cover protecting of the concrete to ensure a normal strengthening; * verifying the works execution. |
|  | Reinforced concrete class C 25/30 for concrete plinths is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.5 Formwork for concrete plinths | * formwork supply for the work execution; * formwork transport with mechanical/manual means to the place of work; * formwork pegging, pegging and fixing with cross ties, setting in position, to distances and positions; * checking the works execution; * Formwork removal and cleaning. |
|  | Formwork for concrete in foundations is paid in square meter (m²). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.6 Reinforced concrete class C 25/30 for concrete columns | Concreting of the reinforced concrete Columns with concrete C 25/30, Concrete installed with machinery with vibration and nurture by technical regulations.   * supply of concrete class and volume, including transport; * verifying reinforcement bars before pouring the concrete; * performing infrastructure by concrete casting and transport with crane/concrete pump to works area, according to the design; * watering or cover protecting of the concrete to ensure a normal strengthening; * verifying the works execution. |
|  | Reinforced concrete class C 25/30 for concrete columns is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.7 Vertical formwork for concrete | walls, structural walls and columns; made of reusable panels   * formwork supply for the works execution; * formwork transport with mechanical/manual means to the works site; * formwork pegging, pegging and fixing with crossties, setting in position, to distances and positions indicated; * verifying the works execution; * formwork removal and cleaning. |
|  | Vertical Formwork for concrete is paid in square meter (m²). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.8 Concrete of horizontal beams | Concreting of the reinforced concrete horizontal beams with concrete C 25/30, including necessary support and scaffolds. Concrete installed by machinery with vibration.   * supply of concrete class and volume, including transport; * verifying reinforcement bars before pouring the concrete; * performing infrastructure by concrete casting and transport with crane/concrete pump to works area, according to the design; * watering or cover protecting of the concrete to ensure a normal strengthening; * verifying the works execution. |
|  | Reinforced concrete class C 20/25 for horizontal beams is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.9 Horizontal ceiling formwork | * formwork incl. floor prop, floor centre and fixing material supply for the works execution; * formwork transport with mechanical/manual means to the area of works; * formwork pegging, pegging and fixing with crossties, setting in position, to distances and positions indicated; * verifying the works execution; * formwork removal and cleaning |
|  | Horizontal ceiling formwork for concrete is paid in square meter (m²). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.10 Pre-fabricated concrete slab | Production of semi-prefabricated, brick, reinforced concrete flat monolithic concrete slab thickness 20 + 5 cm. Concrete C 25/30. Brick elements for fulfilment, the ribs in half of the range, supporting the compartment where it is needed. Pressure plate should be with thickness of 5 cm and reinforced with the BS 500 B, and upper surface made flat. |
|  | Pre-fabricated concrete slab is paid in cubic meter (m³). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.11 Formwork for prefabricated slab | * formwork incl. floor prop, floor centre and fixing material supply for the works execution; * formwork transport with mechanical/manual means to the area of works; * formwork pegging, pegging and fixing with crossties, setting in position, to distances and positions indicated; * verifying the works execution; * formwork removal and cleaning |
|  | Formwork for prefabricated slab is paid in square meter (m²). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.12 BS 500 B reinforcements bars mounted in foundations | * (BS 500 B) type reinforcement bars supply, according to bill of reinforcement of the Detail Design, including transport; * reinforcement transport with mechanical/manual means to the area of the works; * cutting the reinforcements bars into dimensions specified; * installing reinforcement, according to details and structural design; * removal of excess materials; * verifying the works execution |
|  | BS 500 B reinforcements bars mounted in foundations are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.13 (BS 500) reinforcement bars mounted in slab | * BS 500 B type reinforcement bars supply, including transport/storage on site; * reinforcement transport with mechanical/manual means to works area; * cutting the reinforcements bars to dimensions specified; * installing reinforcement bars; * joining by welding, in special cases, as specified; * removal of excess materials; * checking the works execution. |
|  | BS 500 B reinforcements bars mounted in slab are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.14 BS 500) reinforcement bars mounted in beam | * supply of BS 500 B type reinforcement bars, including plastic spacers, transport and storage on site; * reinforcement bars transport with mechanical/manual means to the installation area; * cutting and bending of the reinforcement bars to the dimensions specified; * installing of the reinforcement and support, according to the details and reinforcement plans; * joining by welding, in special cases; * cleaning of work site and removal of excess materials and transport to the authorised depositing area; * verifying the works execution |
|  | BS 500 B reinforcements bars mounted in beam are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.2.15 BS 500 reinforcement bars mounted in columns | * supply of BS 500 B type reinforcement bars, including plastic spacers, transport and storage on site; * reinforcement transport with mechanical/manual means to the place of installing; * cutting and bending of the reinforcement bars to the dimensions specified; * installing of the reinforcement and support; * joining by welding, in special cases; * cleaning of work site and removal of excess materials and transport to the authorised dumping area; * checking the works execution. |
|  | BS 500 B reinforcements bars mounted in columns are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.3 Masonry works | * walls setting out; * supply of bricks, reinforcement materials (bolts, metal anchors, reinforcement steel bars) including mortar; * execution of masonry according to plans and details, concrete lintels and beams included; * execution, assembling and maintaining of scaffolds, if necessary; * horizontal and vertical transport and handling of the materials; * cleaning of the work site and horizontal and vertical transport of the remaining residues; * verifying the quality of the materials and the works execution. |
| 5.1.3.1 Interior walls | Masonry walls with hollow brick block thickness of 12 cm with extension cement mortar with ratio of 1:2:6. The walls must be completely straight, without deviation, and the joints filled with mortar. Build in regular rows of mortar joint thickness of 1 cm. |
|  | Interior wall masonry is paid in m³. The rate shall cover all expenses and charges to perform the works |
| 5.1.3.2 Exterior walls | Masonry divided walls with clay hollow blocks of thickness 10+5+10 cm in extended mortar ratio 1:2:6. The walls must be fully straight, without deviation and the joints well filled with mortar. Build in regular rows with a width of 1 cm joints. External walls including 5 cm of polyester in the middle. |
|  | External wall masonry is paid in m³. The rate shall cover all expenses and charges to perform the works. |
| 5.1.4. Wall, ceiling and floor finishes | * preparation of the surfaces to be plastered by brushing and cleaning of the supporting layer; * manufacturing, mounting and maintaining of the scaffold or work platform; * preparing the materials necessary for plastering; * plastering of the areas indicated in plans; * horizontal and vertical transport and handling of the materials; * cleaning and transport of the materials from the work site; * checking of the quality of the materials and the works execution |
| 5.1.4.1 Plastering internal walls | Plastering the interior walls with lime-cement mortar. Mortar should be properly levelled. Plastering internal wall thickness 12 mm. |
|  | Plastering of internal wall is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.2 Plastering ceilings | Plastering ceilings with lime cement mortar. Mortar should be properly levelled. Plastering ceilings thickness 12 mm. |
|  | Plastering of ceiling is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.3 Plastering on concrete surface | Plastering on concrete surface above ground till 45 cm high of external wall with corrugated cement mortar all perimeter surface of building. |
|  | Plastering of concrete surface is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.4 Floor screed | Floor screed of cement mortar 1:3 ratio as surface horizontal ground floor insulation. The thickness of cement prayer is 2 x 2 cm double layer which protects h/isolating layer. |
|  | Floor screed is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.5 Exterior plastering | Treatment of facade with industrial noble facade plaster in colour choice of the Engineer. Everything done by the manufacturer's instructions. Calculated per 1 m² of the finished facade. |
|  | Exterior plastering is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.6 Floor tiling | Delivery and setup ceramic floor tile. Setting in cement mortar ratio of 1:3. The size of tile is 30/30 cm, and the Engineer will choose the design. |
|  | Floor tiling is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.7 Wall tiling | Delivery and setup ceramic wall tile first-class quality. Setting in cement mortar ratio of 1:3. The size of tile is 20/20 cm, and the Engineer will choose the design. Calculated per 1 m² of the finished floor. For toilet and shower purpose in vertical position around the walls. |
|  | Wall tiling is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.8 Ceramic tiles as plinths | Delivery and setup plinths of glazed ceramic tile. Installing by gluing with construction waterproof glue. Plinths height is 10 cm. |
|  | ceramic plinths tiling is paid in linear meter (m) The rate shall cover all expenses and charges to perform the works |
| 5.1.4.9 Painting on interior surfaces of walls | Smoothing and painting the interior surfaces of walls and ceilings half-dispersive colours in two coats in colour choice of the Engineer. Painted surfaces must be completely monotonous tone, and staining should be repeated if it does not achieve the same. Before painting to do all the necessary preparations. |
|  | Painting on interior surfaces of the wall is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.4.10 Painting on exterior surfaces of walls | Painting of exterior surfaces of walls, paint for concrete facade, in the tone selected by the Engineer. Including all the necessary preparations. |
|  | Painting external wall is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.5 Windows, doors and shutter | Supply and installation of windows: 80 micron white powder coated aluminium frame, glazed openable window panel, hinges and lock handle, glazing 6 mm thick clear glass and shall be of approved quality.   * measurement of the wall apertures; * checking of embedded elements fixing; * supply, putting to the correct level and pre-installation of the windows; * supply of the materials for installation and accessories (ironmongery); * definitive mounting of windows, including accessories; * filling of joints and gaps with Polyurethane foam, elimination of excess material, improving the plaster around frame and fixing of the exterior sill boards; * fitting of the glass glazing; * protection of the joinery until completion of the works; * horizontal and vertical handling and transport of the materials; * checking of the quality of the materials and the works execution.   Supply and installation of doors: 80 micron white powder coated aluminium frame, aluminium openable doors, hinges and lock handle and shall be of approved quality.   * measurement of wall apertures; * checking of embedded elements for fixing; * supply, correct levelling and pre-installation of doors; * supply of the materials for installation and accessories (ironmongery); * definitive installation of doors, including accessories; * filling of joints and gaps with Polyurethane foam, elimination of excess material, making good of plaster around the frames and fixing of the exterior aluminium thresholds; * fitting of doors; * protection of the joinery until completion of the works; * horizontal and vertical handling and transport of the materials; * checking of the quality of the materials and the works execution.   Supply and installation of aluminium rolling shutter gates / doors, gear operated by mechanical device with chain, complete with accessories including fixing, joining and all necessary work and shall be of approved quality.   * measurement of wall apertures; * checking of embedded elements for fixing; * supply, putting to the correct level and pre-installation of rolling shutters; * Supply of roller shutter belt winding systems. * supply of the materials for installation and accessories (ironmongery); * definitive installation of rolling shutters, including accessories; * protection of the rolling shutters until completion of the works; * horizontal and vertical handling and transport of the materials |
| 5.1.6 Water proof insulation |  |
| 5.1.6.1 Horizontal insulation on floor | Construction of horizontal insulation of the floor of the administrative building in the following layers: Cold coating, h/isolating layer, two layers, |
|  | Horizontal insulation is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.6.2 Horizontal insulation on roof | Construction of horizontal insulation of the roof, h/isolating layer, two layers |
|  | Horizontal insulation on roof is paid in m². The rate shall cover all expenses and charges to perform the works |
| 5.1.7 Roofing and guttering |  |
| 5.1.7.1 Roof | Corrugated iron roof 8 cm |
|  | This item is paid per m². The rate shall cover all expenses and charges to perform the works |
| 5.1.7.2 Roof eaves 10 cm roof | Roof eaves of sandwich panels 10 cm Roof, Survey items: Beams Paint double layer Purlins Clamps fastened to UPN profiles and set on bitumen board Calculation per m² of area of the roof |
|  | This item is paid in m². The rate shall cover all expenses and charges to perform the works. |
| 5.1.7.3 Sandwich panels 10 cm Walls | Sandwich panels 10cm Walls, Survey items: Beams Paint double layer Purlins Clamps fastened to an anchor and set on bitumen board. Calculation per m² of area of the wall |
|  | This item is paid in m². The rate shall cover all expenses and charges to perform the works. |
| 5.1.7.4 Half round gutter | Installation of semi-circular grooves of galvanized sheet metal thickness of 0.55 mm. gutter diameter is 15 cm. Pipes attached to the roof structure galvanized clamping every 2.00 m.   * supply of the materials necessary for execution of the works: half round gutter manufactured of galvanised steel sheet or other metal sheets; * putting into correct position and fixing; * horizontal and vertical transport and handling of the materials; * cleaning the site work and horizontal and vertical transport of the remaining residues; * checking of the quality of the materials and the works execution. |
|  | This item is paid per m. The rate shall cover all expenses and charges to perform the works |
| 5.1.7.5 Water catcher | Installation of water catcher throat to drain storm water from the roof. Throats made from galvanized sheet metal thickness 0.55 mm. The size of the throat is 25/25/25 cm. |
|  | This item is paid per unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.7.6 Rainwater down pipe | The Rainwater down pipe drains rainwater collected from the roof to the storm water drainage system. Installation of rainwater downpipe made of galvanized sheet metal thickness of 0.55 mm. Cross section of pipe 15/15 cm. Pipes attached to the walls front galvanized clamping every 2.00 m.   * supply of the necessary materials to execute the works: rainwater pipes made of galvanized metal sheet, fasteners etc.; * putting into correct position and fixing; * horizontal and vertical transport and handling of the materials; * cleaning of the work site and horizontal and vertical transport of the remaining residues; * checking of the quality of the materials and the works execution. |
|  | This item is paid per m. The rate shall cover all expenses and charges to perform the works |
| 5.1.8 Electrical installation and communication | Indoor Lighting General aspect  This article describes all the characteristics of interior luminaries: dimensions, lamps, installations, protection rating and wiring.  All the works described below, required for the supply, installation and connection of the interior lighting, shall be included in the contractual works. |
|  |
| 5.1.8.1 Main electrical device | Device junction box 230V, 16A  Supply and place a cable junction box of the device, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A. |
|  | Main electrical device is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.2 Distribution board | Power distribution panel with circuit breakers, fuses and terminals  The distribution is in accordance with applicable regulations, including all necessary accessories, fully assembled and wired, ready for connection to supply and install. |
|  | Distribution board is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.3 Security power outlet | Concealed security power outlets 2-230V, 16A  Supply of power outlets, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A. |
|  | Security power outlet is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.4. Emergency light | Supply of a security and emergency lighting. Placing the lead for the security device, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. |
|  | Emergency light is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.5 Socket | Supply of the socket, starting from the connection point or distribution panel, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A. |
|  | Socket switch is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.6. Downlight | Supply and installation of ceiling lights (downlight)-industrial type LED 10-15 W, water proof protection rating: IP65 protection class 1 including wiring set for connection inside the luminaries (heat-resistant single core cable, 3 pole terminals with a minimum section of 2 x 1,5mm² on both sides and mounting hardware), including break out and cable inlets, lamps delivered, mounted and connected with all necessary additional components included.  Supply of light, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A.  Lighters shall be manufactured and certified according to IEC 598-1 and SR-EN 60598-1/1994 |
|  | Downlights are paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.7 LED linear luminaire | Supply and installation of LED linear luminaire 45 – 60 w water proof protection rating: IP65 protection class 1 including wiring set for connection inside the luminaries (heat-resistant single core cable, 3 pole terminals with a minimum section of 2 x 1,5mm² on both sides and mounting hardware), including break out and cable inlets, lamps delivered, mounted and connected with all necessary additional components included.  Supply of light, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A.  Lighters shall be manufactured and certified according to IEC 598-1 and SR-EN 60598-1/1994 |
|  | LED linear luminaire are paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.8 LED louvre luminaire | Supply and installation of LED louvre luminaire 20 w water proof protection rating: IP65 protection class 1 including wiring set for connection inside the luminaries (heat-resistant single core cable, 3 pole terminals with a minimum section of 2 x 1,5mm² on both sides and mounting hardware), including break out and cable inlets, lamps delivered, mounted and connected with all necessary additional components included.  Supply of light, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A.  Lighters shall be manufactured and certified according to IEC 598-1 and SR-EN 60598-1/1994 |
|  | LED louvre luminaire are paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.9 Junction box universal AC | Supply and installation of Junction box universal air condition |
|  | Junction box universal is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.10 Air conditioner | Air conditioner with room / building data corresponding performance, including delivery, installation, connection and commissioning. |
|  | Air conditioner is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.11 Ceiling Fan 230V | Place and supply a ceiling fan. The supply line of the ceiling fan, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A. |
|  | The Ceiling fan is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.12 Switch | The lead of the switch, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. The cross section of the line is to be dimensioned for 16A. |
|  | One way switch for ceiling fan is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.13 Electrical wiring point | Electrical wiring point is paid in unit. The rate shall cover all expenses and charges to perform the works |
|  |
| 5.1.8.14 Phone Jack | Phone jack  The lead for the phone jack on the basis of the building entry, ready laid in the wall, including caulking and installation of the conduits in the slab formwork as well as the local port is to be included in proportion to the position. |
|  | Phone jack is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.15 Network Socket | Concealed network socket  The lead for the network socket, starting from the connection point or distribution of the circuit, ready laid in the wall, including caulking and installation of conduits for slab on both sides and the connection is to be included in proportion to the position. |
|  | Network socket is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.8.16 Fire alarm sensor | Supply & Installation Sensor fire alarm sensor with power + battery siren |
|  | This item is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.9 Building services (plumbing, wastewater) |  |
| 5.1.9.1 Wastewater connection to sewer system | Transport and installation of all wastewater connection to the existing sewer system of the area. |
|  | wastewater connection is paid as lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.9.2 Wastewater disposal pipe | Transport and installation of a wastewater pipe. PVC or HDPE for the evacuation of the sewage to the sewer system. |
|  | Wastewater disposal pipe is paid as lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.9.3 Pipe fittings and accessories | Transport and installation of all pipe fittings and accessories. |
|  | Pipe fittings and accessories are paid as a lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.10 Water supply |  |
| 5.1.10.1 Pipe for sanitary water | Supply and installation of pipe with thermo-isolation for sanitary water including Inox manifolds. |
|  | This item is paid as lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.10.2 Water connection to water overhead tank system | Supply and installation of 1 overhead tank (1,000 litre) and water supply connection to the overhead tank |
|  | Supply, installation and connection are paid as a lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.10.3 Pipes, fittings and accessories | Supply and installation of pipes, fittings and accessories |
|  | These items are paid as a lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.11 Equipment |  |
| 5.1.11.1 Porcelain wash basin | Porcelain wash basin completed with all necessary installation parts like flexible pipe, filters, clamps etc. |
|  | This item is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.11.2 Porcelain WC | Porcelain WC completed with casing and all necessary installation parts like flexible pipe, filters, clamps et. |
|  | This item is paid in unit. The rate shall cover all expenses and charges to perform the works |
| 5.1.11.3 Connection equipment for sanitation | Connection equipment for sanitation, delivered and placed into service in the bathrooms, toilets, showers and kitchens etc. downstream of the valves located in the local interception, including: said valves, pipes made of galvanized steel or polypropylene FM. Coating of hot water pipes with insulating sheathing in plastic foam self-rated thick isolated, the sewage pipes in high density polyethylene column until the main discharge. Includes construction work for the opening, closing and rehabilitation of the tracks, while excluding the supply and erection of equipment, sanitation and related fittings: sink. |
|  | This item is paid as Lump sum. The rate shall cover all expenses and charges to perform the works |
| 5.1.12 Steel structure |  |
| 5.1.12.1 Column HEA 200 | Steel profile HE 200 A (or similar) for supporting structure including bolding, welding and all necessary work |
|  | Steel profile HE 200 A, are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12..2 Beams HEA 200 | Steel profile HE 200 A (or similar) for beam structure including bolding, welding and all necessary work |
|  | Steel profile HE 200 A for beam structure are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.3 Roof Profiles UPN 80 | Roof profiles UPN 80 (or similar) for roof structure including bolding, welding and all necessary work |
|  | Roof profile UPN 80 , are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.4 Roof Profiles UPN 140 and Bracing | Roof profiles UPN 140 (or similar) for roof structure including bolding, welding and all necessary work |
|  | Roof profile UPN 140 , are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.5 Roof Profiles UPN 200 | Roof profiles UPN 200 (or similar) for supporting structure including bolding, welding and all necessary work |
|  | Roof profile UPN 200, are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.6 Roof Profiles UPN 240 | Roof profiles UPN 240 (or similar) for supporting structure including bolding, welding and all necessary work |
|  | Roof profile UPN 240, are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.7 Column HEA 100 | Steel profile HE 100 A (or similar) for supporting structure including bolding, welding and all necessary work |
|  | Steel profile HE 100 A, are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.8 Wind bracing Tube Φ22 | Wind bracing for supporting structure including bolding, welding and all necessary work |
|  | Wind bracing are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.12.9 Accessories like bolts, plates, | Accessories like bolts and plates according GTS The rate shall cover all expenses and charges to perform the works. |
|  | Accessories like bolts, plates, are paid in kilogram (kg). The rate shall cover all expenses and charges to perform the works. |
| 5.1.13. Staircase | Supply and installation of Staircase according to drawing incl. Anchorage, anti-skid footsteps and platforms to be used. |
|  | The staircase is paid as units. The rate shall cover all expenses and charges to perform the works. |
| **6. ELECTRICAL SUPPLY AND INSTALLATION, DRINKING AND FIRE FIGHTING WATER SUPPLY AND WASTEWATER DISPOSAL** | |

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| 6.1 Power supply and electricity works |  |
| * + 1. General | The electrical works of the Contractor shall comply with Maldivian guidelines, norms and standards, shall take into account international standards and norms in their latest version, and shall meet the requirements of the site that can be operated and controlled in a safe and secure manner under all operational at the given environmental conditions  The Contractor shall also supply an emergency power supply system as specified further below to allow the operations of the facilities in the event of a failure electricity.  For the electricity supply, the Design-Build, the Contractor shall liaise with STELCO and the Maldives Energy Authority (MEA) or Utility Regulating Authority (URA) and shall take into consideration the approvals and permits granted by STELCO and URA. For the Design-Build of the electrical works, the Contractor’s shall, amongst others, consider the following:   1. List of accredited electrical engineers that are licensed to perform electrical works (URA or MEA’s website); 2. Guideline for power systems approval (URA or MEA website); 3. List of approved cables with valid certificates (URA or MEA’s website); 4. Grid connection application/permit and other applicable services provided by STELCO (STELCO website); 5. Approval of technical specs by STELCO;   Electrical components shall be designed and installed so that any damage due to water intrusion, sea water attack or the corrosive marine environment is prevented, thus, resulting in either appropriate protection classes and measures, or in elevated installation of electrical components.  Wherever appropriate, the Contractor shall provide surge arrestors to protect the electrical equipment.  For the design review, the Contractor shall submit a detailed description of the electrical system including, but not limited to, arrangement of the connection to the STELCO grid, electrical consumer list and an analysis of the self-consumption, single line diagrams for all switchboards, set-up of the emergency power supply. Regarding network dimensioning and selection of equipment, transformers, cables protection and switching devices, etc. all requirements according selectivity] and back-up protection shall be fulfilled. |
| * + 1. Connection to STELCO Grid | The interface towards the STELCO grid shall be the feeder terminal towards switchboard. The metering system shall be provided by STELCO. All other electrical components including, but not limited to, circuit breaker(s), control and instrumentation equipment shall be provided by the Contractor. |
| * + 1. LV Switchboards | The design of the LV power distribution systems shall consider availability, safety and redundancy requirements. The configuration of the LV switchboards shall be submitted during the design review. Suitable power supply system according to the type of connection to earth shall be selected carefully for the low-voltage network |
| * + 1. Electrical Cables and Equipment | The Contractor shall consider in his design the cables that are certified by URA or MEA and shall follow relevant standards and norms according to BS and IEC.  For the design of the cabling and its installation, the Contractor shall, amongst others, consider the following:   1. Exposure to high temperatures shall be minimized by appropriate shielding; 2. Cables in trenches shall allow access for maintenance and inspection personnel and effective drainage shall be provided; 3. Trenches, ducts, trays, ladders etc. shall offer a usable space of at least 25% as spare; 4. Wherever appropriate, empty conduits shall be provided;   Any equipment installed outdoor or in areas of high dust exposure shall be of at least IPX5 or IP65 respectively unless, due to the mode of installation, a higher protection class is required to prevent from water or sea water ingress. |
| * + 1. Earthing and Lightning Protection System | The Contractor shall supply and install all necessary earthing equipment such as, but not limited to, earth leads, mats and electrodes |
| * + 1. Emergency Power Supply System | The emergency power supply system shall consist of suitably sized a diesel driven genset that is housed in a noise suppressing environment and an uninterruptible power supply (UPS) system.  For the design of the genset module, the Contractor shall take into consideration the power ratings of the site. The fuel supply and storage for the genset system shall be designed accordingly. |
| * + 1. Indoor and Outdoor Installations | The Contractor shall provide indoor and outdoor installations such as, but not limited to, lighting in acc. with national/international standards (and lighting poles), sockets, cabinets and distribution panels to cater for a safe operations of the equipment |
| * + 1. Indoor sockets and lighting | The power supply to indoor sockets and lighting shall be provided via indoor distribution panels with two feeding lines. The indoor lighting shall be fed by the emergency power supply system. For maintenance purposes, the Contractor shall install 400 V AC industrial type sockets suitably rated and protected (IP65). Commercial 230 V AC sockets shall be provided wherever needed in any other part of the Site. Sufficient light intensity shall be provided both inside and outside. Energy saving illuminates (LED) shall be used wherever appropriate and possible. |
| * + 1. Outdoor sockets and lighting | Subject to the design considerations of the Contractor, the supply of the outdoor sockets and lighting shall be provided via either outdoor cabinets or via an indoor distribution panel. Outdoor lighting shall be eligible for emergency power supply.  Outdoor sockets shall be provided in a weatherproof enclosure (min IP65) and shall be located wherever appropriate. Higher water protection classes shall be provided in the event the installation is exposed to direct water/sea water attack.  Outdoor lighting poles shall be sufficient in number and shall offer a sufficient light intensity. Outdoor illuminates used in at the lighting poles shall be LED.  Whenever an outdoor cabinet shall be provided, the Contractor’s design shall consider the sea-waterproof and weatherproof installation. |
| * + 1. Emergency Lighting | Emergency lighting shall be in accordance with national standards shall be provided In order to meet all the safety objectives such as the chance to leave a place safely or to ensure the safety of potentially hazardous workplaces. |
| 6.2 Building Services | The following building services shall be provided to all Site areas as needed:   1. LV distribution; 2. Lighting; 3. Communication, telephone and computer networks (ICT); 4. Fire detection, alarm and suppression systems; 5. Ventilation and air conditioning; 6. Grounding and Lightning protection; 7. Plumbing and sanitary installations; 8. CCTV system; 9. Access control, security and alarm systems   With respect to the electrical installation, the Contractor shall liaise with STELCO to get all necessary approvals and consents to install and operate the equipment and electrically driven components.  All installations shall be tested and commissioned according to the Contractor’s program within the commissioning |
| * + 1. LV Distribution | The Contractor shall supply power via separate LV switchboards for every detached building. Every floor shall be equipped with a LV distribution board to avoid failures to cause other floors to be affected.  Wherever appropriate, the Contractor shall install industrial type sufficiently rated 400V/230 V AC sockets to operate tools and other equipment. Protection classes of the sockets shall be IP65 in outdoor applications and IP44 for indoor applications where no dust ingress is foreseen. In the event dust ingress or water attack is likely, higher protection classes shall be considered.  Indoor distribution boards shall be of protection class IP55 within the process area and of IP31 within dry and dust free rooms. Outdoor distribution boards shall be located sufficiently high to avoid seawater and water attack but shall be nevertheless of IP65.  Further information for requirements are elaborated in Section 6.1 |
| * + 1. Lighting | Indoor lighting services and illumination levels shall be in line with the minimum recommendations as per CIBSE code for the appropriate Site area and operational function.  The illumination level shall not be below the level that is necessary to perform work or other essential activity in any particular location of the Site.  Emergency lighting luminaries shall be of the self-contained type.  Wherever appropriate and feasible, the Contractor shall use energy saving lighting (mainly LED).  Sufficient outdoor lighting of roads, walkways and parking areas shall be provided to ensure the safety and security of the operation of the Site, the safe movement of people and vehicles. The exterior of the buildings shall be provided with lights for safe night operations.  Outdoor lighting installation shall be of IP 65 as long as seawater attack can be prevented. |
|  |  |
| * + 1. CIT System | Telephone, communication and computer networks shall be installed wherever needed to allow internal and external communications, operations and high-speed data exchange to meet the operational requirements of the components interlinked. |
| * + 1. Fire Detection, Alarm and Suppression Installations | The Contractor shall be responsible for the design, supply and installation of fire detection, alarm and suppression systems that meet the requirements of the Fire Rescue Service of the Maldivian National Defence Forces (FRS of MNDF) whatever is more stringent. The Contractor shall liaise with FRS on the approval scheme, timeline and all submissions to be provided in the course of the approval of the fire service installations.  Fire service installations shall include, but are not limited to, fire hydrants, fire monitors, sprinkler systems, fire extinguishers, fire detection equipment, fire alarm panels, alarm sirens, fire alarm system etc.  The Contractor shall provide fire services installations for the entire Site wherever needed. Particular considerations shall be applied to the fire detection, alarm and suppression equipment within at the waste transfer desk and its hereto attached civil structures, and wherever flammable materials are handled or stored, such as, but not limited to, waste, waste oil, auxiliary fuel, diesel etc.  Firefighting water shall be of sweet water quality and shall be made available in a sufficient amount for all fire hydrants and fire-fighting and suppression systems.  A stationary sprinkler system shall be installed to protect the structural integrity of the roof over the tipping area in the event of a fire. The design of the sprinkler system shall be in accordance to the requirements of FRS.  The fire service installations shall be supplied by the emergency power supply system.   * The Contractor’s fire safety assessment, fire alarm and fire detection and suppression system shall be forwarded to the Engineer as part of the design documentation. |
| * + 1. Ventilation and Air Conditioning | Air leakage rates shall comply with Building Regulations.  Ventilation rates shall be calculated according to National standards or CIBSE and BRE guidance.  Ventilation to appliances shall be provided where such ventilation is necessary to allow their normal and safe operation.  The design of ventilation systems for the offices and social rooms shall minimize odour nuisance from the rest of the Facility.  Ventilation and air conditioning systems shall be in line with the climatic conditions of the Site to facilitate a healthy working environment for Personnel working in the delivered products.  The Contractor shall liaise with FRS to reconcile the automatic override requirement of the ventilation and air conditioning systems control in the event of a fire incident. |
| * + 1. Grounding and Lightning Protection | All electronic equipment and installations shall be protected against lightning and electrical surge |
| * + 1. Plumbing and Sanitary Installations | The plumbing and sanitary installations for the water supply and waste water shall comply with the National Buildings Code of the Maldives. Fixtures shall be of a water saving design.  The Contractor shall provide a water supply system wherever needed but shall at least meet the following minimum requirements:   1. A potable water supply system shall be installed in the control building and the waste intake building. Potable water shall be supplied by external supply. 2. Subject to the design of the Contractor, flushing water for toilets shall be provided either from collected non contaminated rain water.  * All drains and sinks shall be connected to the sewer system |
| * + 1. CCTV system | The Contractor shall install a CCTV system for monitoring and surveillance of the operations in the following areas:  Process related locations:   1. Control Room 2. Electrical Room 3. Transformer Room 4. Turbine Room 5. Engine Generator Room 6. Air Compressor Room 7. Crane Operator Room 8. Refuse Intake Building 9. Control and Office Room 10. Waste Intake Building 11. Tipping deck 12. Access gates and revolving doors   Cameras shall be of IP65 protection class. Outdoor cameras shall meet the conditions of the corrosive marine environment. |
| * + 1. Access Control System and Security System | An appropriate access control system shall be provided and installed for the entire Site and, subject to the design considerations of the Contractor. The access control system shall include a smart card system for Operator’s staff and, in the event of overhaul and maintenance, for third parties’ personnel.  Access to the Site shall be allowed via the external gate from the public roads.  In the event of any non-authorized access a suitable alarm and security system shall be installed.  The access control system and its lay-out shall be provided as part of the Contractor’s design documentation.  The access control system shall be entitled for uninterrupted power supply. |
| * + 1. Acoustics and sound insulation | BS8233: 1995 shall be used as a guidance document in developing the acoustic design.  The Contractor shall comply with the Noise at Work Regulation  Appropriate acoustic separation performance shall be provided between adjacent spaces.  Noise reduction within circulation areas shall be in accordance with Building Regulation recommendations. |

###### **List of Drawings**

|  |  |
| --- | --- |
| * 1. General | The Contractor shall provide the following drawings during the different phases of the project. If the Contractor does not deem the defined formats and scales appropriate he shall suggest alternatives.  Subject to further reasonable request of the Employer’s Representative, the Contractor shall provide additional drawings as needed.  The Contractor and the Employer’s Representative shall agree on the expected level of detail prior to submission of the drawings. |
| * 1. Design of building services | During the detailed design stage, the Contractor shall provide the set of drawings that were agreed for the concept design phase but that reveal the level of detail pertaining to the detailed design. In addition the following drawings shall be submitted for review by the Employer’s Representative. |

| **Format** | **Scale** | **Description** |
| --- | --- | --- |
| A0 | 1:500 | Drainage system layout plan and cross sections incl. indication of slopes, ducts, pipes, outfalls, etc. |
| A1 | 1:25 | Details site utilities (water, sewerage manholes, etc.) |

###### **Interfaces**

|  |  |
| --- | --- |
| * 1. General | This chapter describes how the interfaces with key stakeholders will be managed and the physical limits of the Contractor’s responsibilities. |
| * 1. Hardware Interfaces | In preparing the design, the Contractor shall take into account the interfaces with existing or to-be-built infrastructure as set forth below.  The Contractor shall accomplish all necessary construction works and shall supply the necessary Materials for laying any cables, pipes, preparing ducts, culverts, conduits, roads and carriageways etc. up to the transfer points and construct any temporary or permanent building to accommodate any hereto related equipment. |
| * + 1. Power Supply | The supply/feed-in interface to STELCO, the state owned electricity company, shall be the input terminal of the metering system (from the Contractor’s view) that shall be provided and installed by STELCO. All equipment prior to the meter shall be provided by the Contractor.  The exact physical location of the transfer point is subject to further arrangements between the Contractor and STELCO.  Power during the construction phase shall be provided by the Contractor.  Contact person at STELCO is Ahmed Saif, Project Coordination Director, [ahmed.saif@stelco.com.mv](mailto:ahmed.saif@stelco.com.mv). |
| * + 1. Water Supply | The transfer point shall be the output flange of the water meter installed by Male Water and Sewerage Company, MWSC, at the premises boundary.  During the construction period it shall be subject to the considerations of the Contractor how to supply the required amount of water. |
| * + 1. Waste Water Discharge | Wastewater shall be collected and treated during the construction phase.  The Contractor shall be permitted to discharge wastewater into the existing sewer line through permits and services received from the utility offices on location. |
| * 1. Interfaces to Third Parties | The Contractor shall consult with the following third parties and stakeholders to obtain the necessary clarifications to accomplish the obligations during the Design-Build. |
| * + 1. Environmental Protection Agency (EPA) and Utility Regulating Authority (URA) | All questions related to environmental permits and clearances shall be forwarded to and shall be settled with EPA and URA. |
| * + 1. Ministry of National Planning and Infrastructure (MNPI) | All aspects to be considered during the application of the building and construction permit shall be discussed and agreements be achieved with MNPI. |
| * + 1. Fire Rescue Services (FRS) | FRS, a department of the Maldivian National Defence Forces, is responsible for all firefighting activities in the Maldives.  The Contractor shall confer with FRS all firefighting relating questions and aspects during the Design-Build phase.  Queries related to firefighting aspects shall be forwarded to Colonel Abdulla Zuhury, [a.zuhury@mndf.gov.mv](mailto:a.zuhury@mndf.gov.mv). |