

Technical Specification for the Construction of Major Roads at R.Dhuvaafaru

1) INTRODUCTION

a- General

This section specifies the minimum technical requirements of facilities and infrastructure to be designed and constructed within the proposed period by the Contractor.

i- Permanent Work

- (1) Sidewalks
- (2) Service Lines including Cable Junctions
- (3) Road drainage
- (4) Carriageway
- (5) Road lighting
- (6) Road Sign Boards
- (7) Road Markings

b- Standards

The Contractor shall, perform the Works in compliance with all regulations, standard specifications or statutes of the Government of Maldives unless otherwise conform to this specification.

The current British Standard Specifications and Codes of Practice shall apply to and form part of these specifications unless otherwise specified in respect of all materials and works to which they have application.

In various places throughout this specification and the Bills of Quantities reference is made to the Standards, Specifications and By-Laws issued by the British Standards Institution and other similar organizations. These references shall in every case be deemed to include the latest edition or issue of such Standards. Specifications and By Laws including all revisions, amendments and addenda subsequently issued. Where materials are not specified to be to a particular British Standards and a British Standard exists in respect of such materials, and then the materials shall in all respects comply with the relevant and current British Standards. In such cases where British Standards do not exist, the materials used shall be of the best type available and shall generally be to the Employer's satisfaction.

c- Investigations and Surveys

The Contractor shall satisfy himself of the existing site conditions and shall, as a minimum, undertake geotechnical and topographic surveys of the site to gain accurate and complete records of the existing situation.

The geotechnical investigation shall be specified, undertaken and reported in accordance with appropriate international standards. The investigation shall provide sufficient data to inform the design of structures, pavements, underground services and storm water management system. It shall also be sufficiently detailed to identify any existing ground/groundwater pollutants which will require remediation and/or control measures.

The Contractor shall undertake a comprehensive and detailed topographic survey of the concession area, to fully understand the existing conditions for the use of designing and construction. Copies of all investigations and reports shall be provided, free of charge, to employer in hard copy and in electronic format.

d- Environment and Sustainability

The Contractor shall ensure that all planning, design, and construction are undertaken with full regard to and in compliance with GOM laws and regulations on environment, planning and sustainability.

The Contractor shall demonstrate his understanding and awareness of the issues associated with the investment and, as required by the Maldives Environment Protection and Preservation Act, shall prepare all necessary environmental impacts assessments, compliance documentation and environmental management plans.

The Contractor shall comply with all relevant environmental and sustainability legislation including, but not limited to:

- The Environment Protection and Preservation Act (Law 4/93)
- The National Environmental Action Plan (NEAP 2009-2013)
- The Maldives National Strategy for Sustainable Development (NSDS)

e- As-built Drawings

A requirement of this Contract, which shall be met before the issuance of Taking-Over Certificate is the submission of As-Built drawing drawings by the Contractor.

These drawings shall cover all aspects of the works and shall be at the same scale as the drawings included as part of these documents.

They shall be prepared on 'permatrace' or similar material and be drawn in ink on A1 sheets. One (1) copy original and two (2) photocopies shall be made available to the Employer. Electronic copies in 2 sets AutoCAD File in an approved latest version shall be made available on disk.

These drawings shall include but shall not be limited to the following:

- Record drawings showing location of all buried services including invert levels, means of identification, cover, joints, valves, controls, dimensions from readily identifiable points and all other relevant information.
- The contractor shall ensure that the records of all necessary information for these drawings before backfilling.

f- Drawings and Specifications

Drawings ,BOQ and Specifications are intended to complement each other, so that if anything is shown on the Drawings, but not mentioned in the specifications or vice versa, it is to be furnished and built as though specifically set forth in all three. If any discrepancies, errors, ambiguities or omissions occur in the Drawings or BOQ or Specifications, the same shall be referred to the Employer before proceeding with the Works, and the Employer decision on such discrepancies, errors, ambiguities or omissions shall be final.

In addition to the Drawings, BOQ and Specifications attached hereto, the Employer will during the progress of the Works furnish additional Drawings, Specifications, and instructions as may be necessary, in the opinion of the Employer for the Purpose of the proper and adequate execution and maintenance of the Works, and the Contractor shall make his work conform. Such drawings and instructions shall be deemed to be part of the Contract Documents.

g- Transportation to The Site

The Contractor shall provide all necessary transport, handling and storage of all materials, components and the like to their points of installation on site including transport to and from storage. The Contractor shall provide all necessary transport of labour to and from the site.

h- Materials, Goods and Workmanship

Materials, goods and workmanship shall be of the best quality of their respective kinds and, as far as applicable, shall comply in every respect with the requirements of the quoted Standards, Codes of Practice and Specifications or any other National Standard approved by the Employers. Preambles and descriptions of materials, goods and workmanship given in any one section of

the specifications shall apply throughout the whole of these specifications unless otherwise described. The substitution of materials, goods, workmanship and the like from that specified shall only be permitted with the written approval of the Employer.

The Contractor shall submit for the approval of the Employer a list of names and addresses of the manufacturers and trademarks or names of all the various types of materials and goods he proposes to use the Works. This list shall include reference to the specifications Clause or Article to which the materials and goods apply.

All materials used in the Works shall be new and of the appropriate quality all to the Employer's approval.

Materials shall be obtained from approved sources and used in accordance with the manufacturer's printed instructions. In the absence of a specification all materials shall comply with a relevant standard. The Employer shall order the removal of any materials, which he has not approved.

No orders for materials and goods shall be placed until approval has been obtained for the materials and goods from the Employers.

The Contractor shall note that it is his responsibility to include in his price for the cost of the materials and products as specified and no adjustment will be allowed should the alternatives be rejected by the Employer.

All workmanship shall be of the best standard. All goods and materials to be incorporated in the Works must be new, unused, of the most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the contract.

i- Samples

The Contractor shall furnish for approval with reasonable promptness, all samples as directed by the Engineer. The Engineer shall check and approve such samples with reasonable promptness only for conformance with the design concept of the Works and for compliance with the information given in Contract Documents. The work shall be in accordance with the approved samples.

j- Ordering Materials

The Bills of Quantities shall not be used as a basis for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered.

k- Defective Work

Any defective work materials and also deviations from the working details in respect of setting out, correct lines and levels, verticality, sizes thickness of members and/or any other dimensional variation of any kind whatsoever, shall be removed and reconstructed or otherwise rectified without undue delay to the approval of the Employer and the Contractor shall be responsible for all additional costs incurred due to rectification of any defective work or material.

l- Disposition of Existing Utilities

Before commencing any construction work the Contractor shall obtain from the various utilities departments, companies or Employer the location of any existing utilities on the Site. Active utilities on the site shall be carefully protected from damage, relocated or removed as required by the work.

m- Site Cleaning

The Contractor shall tidy up and leave the Site in a clean and sanitary condition at all times during the execution of the Works.

The contractor shall clean up the site and dispose all unwanted materials from the site on completion of works to the satisfaction of the Employer.

n- Scaffolding

The Contractor at his own expense shall provide, erect, maintain, dismantle, and clear away at completion proper and adequate scaffolding for the proper execution and completion of works.

o- Protection of Works

The Contractor shall cover up and protect the Works from the weather and from damage by his own or other workmen performing subsequent operations. He shall provide all necessary dustsheets, barriers and guard rails and clear away same at completion.

p- Cutting and Patching

The Contractor shall be responsible for all cutting and patching and making good required for all trades for all work and his prices will be deemed to include for all such cutting and patching and making good.

q- Water for the Works

The Contractor shall make all necessary arrangements and provide all water for the proper execution of the Works, together with all transport, temporary plumbing, storage and distribution, pay all charges and alter, adapt and maintain temporary work as necessary and remove and make good at completion.

Water for execution of works such as Construction works, Concreting, Curing, Pressure testing, Leak testing, cleaning and for other construction activities shall be portable fresh water and shall not contain any harmful impurities which may affect quality of works. Saline water shall not be allowed for above purposes. Cost of water shall be borne by contractor.

r- Electricity for the Works

The Contractor shall make arrangements to provide all necessary lighting and power for the proper execution and security of the Works and its protection, with all meters, temporary wiring and fittings, pay all charges and alter adapt and maintain the temporary work as necessary and remove and make good at completion.

s- Safety of Adjoining Existing Buildings

The Contractor shall take all necessary precautions during the excavation for the Works particularly those excavation which are adjoining existing buildings, Curb Stones, pavements and shall protect such structures from the damage or collapse by means of temporary or permanent shoring, strutting, sheet piling or underpinning or excavation in short lengths and/or other methods as he deems fit also he shall properly support all foundations, trenches, walls, floors, etc affecting the safety of the adjoining existing buildings

The Contractor shall alter, adopt and maintain all such works described above for the whole period of the Contract and shall finally clear away and make good all damages done

The construction and efficiency of the shoring, underpinning, strutting and the like for the purpose for which it is erected shall be the responsibility of the Contractor, should any subsidence or any other damage occur due to the inefficiency of the shoring, underpinning, strutting and the like or any other support provided. The damage shall be made good by the Contractor at his own expense and responsibility.

The shoring, strutting, piling and the like, shall be executed in such a manner as to cause as little inconvenience as possible to adjoining owners or the public and the Contractor shall be responsible for negotiating with the adjoining owners the means to safeguard their property and for the use of any portion of their land for the purpose of executing the excavations and no claims submitted on this ground will be entertained

The Contractor shall be held solely responsible for the safety of the adjoining existing buildings, the sufficiency of all temporary or permanent shoring, underpinning, piling, and the like. The Contractor shall keep the Employer informed as to manner in which he intends to proceed with

the execution of the excavations and obtain his approval. Such approval if given shall not absolve the Contractor of his responsibility under this Clause

The Contractor shall save harmless and indemnify the Employer in respect of all claims, demands, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any such matters in so far as the Contractor is responsible under this Clause.

t- Interference with Access to Properties And Apparatus

Before interfering with access to any property, the Contractor shall make adequate alternative arrangements for the occupiers.

The Contractor shall not obstruct access to any apparatus or utilities of any service or utility.

u- Contractor's Site Area

Throughout the period of the Contract the Contractor shall maintain the area of his operation within the limits of the Site in a clean, tidy and safe condition by arranging materials and the like in an orderly manner. All rubbish, debris, waste materials and the like shall be systematically cleared from the Site as it accumulates.

The Contractor shall take all steps necessary as directed by the Employer to minimise or eliminate dust, noise or any other nuisance, which may occur. Plant emitting dust, smoke, excessive noise or other nuisance shall not be permitted.

v- Safety

The Contractor shall comply with industrial normal safety practices for working in or around the site.

Contractor's workers should be provided with safety equipment in compliance with the acceptable industrial safety.

When working at Site the contractors should comply with Occupational Health and Safety (OH & S) standards to meet OHSAS18001:2007. OH & S refers to the conditions and factors that affect or could affect the health and safety of employees or other workers (including temporary workers and contractors personnel), visitors, or any other person in the workplace. This includes,

- Wearing of Proper Site clothing.
- Wearing of hard hats, gloves at working site.
- Wearing Safety Shoes at working sites.
- Maintaining a "First aid Kit" to attend to minor injuries that may occur during Site works.
- Providing Safety Sign boards near areas where a danger or public related health issue may occur.

- Providing Proper Barricading and Warning lights when an area such as an “excavated area is left open”.
- Wearing of Safety Mask/Gas Protection Mask when working with Hazardous chemicals.
- And any other related safety precautions as per the site condition that may affect the health and safety of the workers or people involved in the workplace.

w- Security

The contractor shall ensure that the site is secure during the period of work and shall be liable for any loss or damage sustained as a result of their failure to comply with this condition. The Contractor shall provide and maintain, night lights, road sign boards, warning tapes etc. Where the works are in close proximity to buildings, walls or other existing structures, the contractor shall take adequate measures to prevent any damage to such structures. In addition before commencing work the Contractor shall submit details in writing to the Engineer’s Representative of his proposed method of carrying out these measures and shall not commence operations until these are approved in writing.

2) CONSTRUCTION OF CARRIAGEWAY

a- Carriageway Structure

Design Concept of pavement structure is assumed based on the visual observations. Final design calculations, detail drawings shall be submitted for approval after the completion of geotechnical investigations and engineering study.

The pavement structure includes:

- **Subgrade**
Compacted sub grade
CBR value shall be not less than 20%
- **Cement stabilized base course**
150mm thick cement stabilized base course (CSB)
CBR value shall be not less than 80%
- **Application of Prime Coat and Construction of Wearing Course**
50mm thick Hot mix Asphalt Surface

b- Shaping and Compaction of Subgrade

- (1) Sub-grade material is to be either existing road material or existing reclamation dredge fill. The sub-base is to be shaped to the cross falls shown on the drawings.
- (2) The material used for the top 150mm of sub base shall conform to 4 day soaked CBR of the soil shall not be less than 20%.
- (3) The construction of the base shall not commence in any section of the works until the drainage works and installation of Service Lines in that section have been completed.
- (4) The base material shall spread not exceeding 225 mm for compaction using 8-10 tonne smooth wheeled roller or any other roller of comparable compactive effort. Where necessary the material may be spread in thicker layers greater than 225 mm with the approval of the Engineer provided a heavier roller is used for the compaction.
- (5) The compaction shall be carried out at or near the optimum moisture content. Bearing capacity should be 400 KPa and CBR value of 60%.
- (6) The moisture content of the material shall be checked daily at the time of compaction as directed by the Engineer. If the material is too wet it shall be dried by aeration and if it is too dry, the material shall be sufficiently wetted prior to compaction.
- (7) Rolling shall commence at the edge and proceed towards the center longitudinally except at super elevated section where the rolling shall commence at the lower edge and proceed towards the higher edge.
- (8) Should soft areas be encountered, the Engineer shall determine with the Contractor the extent of soft material to be removed.
- (9) The base shall be compacted to a density not less than 100% of the maximum dry density as determined by the standard compaction test specified in BS 1377-75 or ASTM D 698-98
- (10) The control of quality of the material and the work shall be carried out as given in quality control document.
- (11) The compacted sub base shall be finished to levels, grades and cross sections shown in the drawings and as directed by the Engineer, subject to the requirements given in quality control sections.

- (12) Prior to the construction of the base the contractor shall project the sub grade from damage caused either by the water by traffic or by any other means. Any damage caused shall be rectified prior to the construction of the base. Where the damage may be attributed to the negligence of the contractor the repairs shall be at his own expense.

c- Construction of Cement Stabilised Base

Material to be stabilised

- (1) The material used for stabilization may be a naturally occurring soil, a washed or processed granular material, or any combination of these providing the material is free from organic contamination which would affect the setting of the cement and does not contain such a proportion of sulphates or other chemical that the long-term durability of the stabilized material will be affected.
- (2) The material shall be well-graded with a coefficient of uniformity of not less than 10 and have a grading finer than the following limits:-

Sieve Size	Percent by Weight passing within the Range
	Sub Base
53.0 mm	100
37.5 mm	95 - 100
19.0 mm	45 - 100
9.5 mm	35 - 100
4.75 mm	25 - 100
600 microns	8 - 65
300 microns	5 - 40
75 microns	0 - 10

- (3) If the material is plastic it shall have a liquid limit not greater than 45 per cent and a plastic limit not greater than 20 per cent as determined in accordance with B. S. 1377.
- (4) In the event of the contractor offering a material having a grading curve falling slightly outside the limits stated in the Table, or plasticity properties slightly outside the limits given above, the Engineer may approve its use subject to his being satisfied, as a result of such tests as he may require that it meets all other requirements specified in the Clause. The material may, however, prior to its use in the works be subject to disapproval by the Engineer if, although having acceptable grading or plasticity properties, it is shown during the preliminary trials to be incapable of producing a well closed final surface to the compacted layer.

- (5) Cement for stabilization shall comply with the requirements of Ordinary Portland or other approved cement to B.S. 12.

Mix Design

- (6) Mix design should be worked out to specify the amount of cement to be added to obtain the required strength in terms of 7-day Unconfined Compressive Strength (UCS) and/or durability test under alternate wet-dry conditions. Pulverisation of soil clods, mixing of pulverised soil with the required amount of cement, compaction and curing of the compacted layer are important construction operations. The mix shall be designed for a minimum laboratory 7 days unconfined compressive strength of 3.00MPa for use in base course.

Method of stabilization to be used:

- (7) If the layer to be stabilized does not exceed 6 inches in compacted thickness it may be constructed in one layer within the range 3-6 in after compaction using either mix in- place or stationary plant for the mixing process provided the plant meets the requirements specified in the Clause. If the course to be stabilized exceeds 6 inches in compacted thickness it shall be constructed in two or more layers each within the range 3 in to 6 in in thickness when compacted. When two or more layers are employed the mix-in-place process will only be permitted for the construction of the bottom layer.

Mixing:

- (8) The plant to be used for pulverising and mixing the stabilized material shall be approved by the Engineer on the basis of preliminary trials to establish that the plant is capable of producing the degree of mixing and uniformity of the stabilized material specified in this Clause.
- (9) If stationary plant is used it shall be of the power driven paddle or pan type and maybe of the batch or continuous type. When mix-in-place construction is employed with plastic soils, the mixer shall be of the single-pass type and the degree of pulverization as determined in accordance with B. S. 1924 achieved in one pass shall not be less than 80 per cent. With non-plastic materials both single and multi-pass equipment will be permitted.
- (10) The proportioning of the cement in the stabilized mixture shall be by weight or, if approved by the Engineer, by volume.

- (11) If batch mixers are used the appropriate measured amounts of material and cement shall be delivered into the mixer. Water may be added during mixing to bring the moisture content of the resulting mixture to the optimum moisture content for compaction as determined by the preliminary trials. Special care shall be taken with batch type paddle mixers to ensure that the cement is spread uniformly in the loading skip so that it is fed uniformly along the mixing trough and that with both paddle and pan mixers the cement is proportioned accurately by a separate weighing or proportioning device from that used for the material being stabilized. Mixing shall be continued until the mixture has the uniformity required by this Clause and for not less than one minute unless a shorter minimum period is permitted by the Engineer, after satisfactory preliminary trials.
- (12) If continuous mixing is used the paddles, baffles and rate of feed of material shall be adjusted to give a uniformly mixed material. The spray bar distributing water into the mixer, if it is required, shall be adjusted to give uniformity in moisture content throughout the mix.
- (13) If the mix-in-place process is used the mixers shall be equipped with a device for controlling the depth of processing and the mixing blades shall be maintained or reset periodically so that the correct depth of mixing required is obtained. The cement shall be spread ahead of the mixer by means of a cement spreader of a type to be approved by the Engineer fitted with control gates or other device to ensure a uniform and controllable rate of spread of cement both transversely and longitudinally.
- (14) If multi-pass equipment is being employed, the soil shall first be pulverised to the required depth and degree with successive passes and the moisture content adjusted if it is more than 3 per cent below the value required for compaction. The cement shall then be spread and mixing continued with successive passes until the required depth and uniformity of processing has been obtained.
- (15) With single-pass equipment the forward speed of the machine shall be selected, in relation to the rotor speed, such that the required degree of mixing, pulverisation and depth of processing is obtained.
- (16) The machine shall also be set so that it cuts slightly into the edge of the lane processed previously so as to ensure that all the material forming the layer has been properly processed. If it is necessary to adjust the moisture content of the material to the optimum for compaction, water shall be added during the mixing operation using a water sprayer of such a design that the water is added in a uniform and controlled manner both transversely and longitudinally.
- (17) Where hard non-plastic soil is encountered in situ, the Engineer may approve the use of a scarifier or prepariser ahead of the mixer but with plastic soils no prior scarification will be

permitted unless the soil is subsequently re compacted before processing with the single-pass mixer.

- (18) The output of the mixing plant shall be such that a minimum rate of 20 linear yards per hour measured longitudinally of completed stabilized layer can be maintained in order to permit satisfactory compaction of the material.

Transporting and spreading plant-mixed material:

- (19) The plant used for transporting the mixed material shall have a capacity suited to the output of the mixing plant and the site conditions and shall be approved by the Engineer. All transporting plant shall be capable of discharging cleanly.

Compaction:

- (20) Compaction shall commence as soon as possible after the mixed material has been spread and shall be completed within a period of two hours of mixing or such shorter period as may be necessary in drying weather.
- (21) Compaction shall be carried out initially with a 2-3 ton smooth-wheeled roller followed by an 8-10 ton smooth-wheeled roller, and finished, if necessary with a 2-3 ton smooth-wheeled roller or the compaction can be carried out by such other means such as pneumatic-tyred or vibrating rollers, dropping weight or vibrating plate compactors as are approved as a result of compaction trials. The work of compacting shall be continued in such a manner as to produce throughout the full depth of layer an average dry density corresponding to not more than 5 per cent air content at the moisture content at which the stabilized material is compacted or such other air content as the Engineer shall permit as a result of the preliminary compaction trials.
- (22) Where it is necessary to employ more than one layer of stabilized material, the material for each successive layer shall, subject to the following proviso, be placed and compacted within two hours of the completion of the compaction of the layer beneath. Where it is not possible to achieve this and the two hour limit has to be exceeded, the surface of any layer remaining so exposed shall be subjected to the curing process required by this Clause.
- (23) Special care shall be taken to obtain full compaction in the vicinity of both transverse and longitudinal construction joints and the Contractor shall, if required, provide special small compactors to assist in this work. Any loose uncompacted material left in the vicinity of construction joints shall be removed prior to the placing of fresh stabilized material.
- (24) The approval of the Engineer shall be subject to each layer on completion of compaction being well closed, free from movement under the roller, from compaction planes, ridges,

cracks or loose material and, within the tolerance for surface finish allowed in this Clause, true to the lines and levels shown on the Drawings. All loose, segregated or otherwise defective areas shall be broken out to the full depth of the layer and recompact. If this cannot be carried out within the two hour limit specified, the material broken out shall be removed and replaced with freshly processed and properly compacted material without extra charge.

Curing:

(25) The surface of any layer of stabilized material, unless it is to be covered within two hours by another layer of the material or other pavement course, and any exposed edges shall be cured as soon as compaction is completed for a period of at least 7 days.

(26) Construction traffic or other vehicles shall not use any stabilized layer until it has been cured for a period of at least 7 days.

Joints:

(27) The Contractor shall so organize his work that longitudinal joints against hardened stabilized material are avoided as far as possible. Wherever possible, in any day's work the area constructed shall extend the full width of the carriageway. At the end of each day's work on completion of compaction, the transverse edge of the layer shall if stabilized be feathered out and shall be cut back vertically to the full depth of construction\ of the layer before work starts again. Alternatively the work may be terminated against an approved stop end. When the joint has been cut back or formed it shall be adequately protected from drying out. On resumption of work the vertical face of the joint shall be brushed to remove loose material and freshly mixed stabilized material shall be butted tightly against the previous work. Joints in the layers, where more than one layer is required, shall be staggered a distance of 5-10 ft.

d- Application of Prime Coat

- (1) Apply prime coat of bitumen emulsion complying BS 594 Part 2 Clause 5.5.
- (2) This work shall consist of an application of a prime coat on the base course prior to laying asphalt so as to provide a proper bond between the layers and also to serve as a protective measure for the base course.

- (3) Materials used shall meet the requirements of following unless otherwise directed. Binder shall be medium curing cutback bitumen (20 – 45 percent) or MC 30, MC 70, MC 250 or MC 800 which conforms to conform to ASTM D 2027-76.
- (4) Medium curing cutback bitumen used for road construction and maintenance shall be prepared at site by fluxing 60 -70 penetration bitumen with Kerosene oil. The percentage of kerosene added shall be as specified or as directed by the Engineer depending on the purpose for which the binder is to be used. The cutback bitumen prepared shall be designated by the percentage quantity by volume of kerosene present in the binder (e.g. 10 percent cutback bitumen shall contain 10 percent by volume of Kerosene and 90 percent by volume of bitumen). In the alternative medium curing cutback bitumen shall conform to ASTM D 2027-76 where they are designated as MC 30, MC 70, MC 250, MC 800, MC 3000. The residue from distillation of these grades when heated to 360°C shall not be less than 50%, 55%, 67%, 75% & 80% respectively
- (5) The prime coat shall generally in dry weather and when the ambient temperature is not below 15°C. It shall not be applied when rain is imminent.
- (6) Prior to the application of prime coats the surfaces shall be well brushed to remove all dust, loose particles and other objectionable material, with a power broom or any other means approved by the Engineer. In the case of aggregate bases, such cleaning shall continue until the entire surface shows a pattern of exposed, large particles free from dust as far as application of the binder, unless otherwise directed by the Engineer.
- (7) The prime coat shall be applied by means of a mechanical sprayer or a hand sprayers or any other means approves by the Engineer, at a temperature within the range given here.
- (8) Spraying Temperature for Binders

Binder Type	Temperatures Degrees C
MC 30 or 45 percent Cutback Bitumen	40 – 50
MC 70 or 35 percent Cutback Bitumen	55 – 70
MC 250 percent Cutback Bitumen	80 – 90
MC 800 or percent Cutback Bitumen	105 – 115
Emulsions	Ambient Temperature

- (9) The rate of application of binder shall be as specified or as directed and shall generally range between 0.5 and 1.5 liters per square meter (1.0 and 3.0 gallon/square). However, this rate shall be such that the surface becomes dry with a matt finish within 4 hours when emulsions are used or within 24 hours when cutbacks are used. Emulsions shall be diluted with water where so directed by the Engineer.
- (10) Traffic shall not be permitted on the primed surface for a period of 3 hours or longer until the binder has penetrated and dried up and in the opinion of the Engineer will not be picked up by the traffic. However, where the Engineer deems it impracticable to detour traffic, the contractor shall spread a sufficient quantity of blotting material in order to prevent the prime coat from being picked up prior to allowing the traffic to pass. Any areas which are in excess of deficient in priming material shall be corrected by the addition of blotting material or binder, as appropriate.

e- Construction of Wearing Course

- (1) Materials used for the hot rolled asphalt are to comply with: BS 594: part 1:1992 “Hot Rolled Asphalt for roads and other Paved Areas”. Part 1: Specification for Constituent Materials and Asphalt Mixtures and standards.
- (2) Laying of the Asphalt is to comply with: BS 594: Part 2: 1992 “Hot Rolled Asphalt Road and other Paved Areas” Part 2: Specifications for the Transport, Laying and compaction of Rolled Asphalt.
- (3) The binder shall be 60 – 70 penetration grade bitumen.
- (4) The coarse aggregate of nominal sizes (20-14mm), (14-6mm) and the fine aggregate (0-6mm) shall conform to the following:
 - The aggregate Impact Value(AIV) determined shall not be greater than 30%.
 - The flakiness index determined shall not be greater than 35%.
 - For coarse aggregate used for asphalt concrete surfacings treatment shall have a Los Angeles abrasion Value not greater than 40%.
 - Fine aggregate (aggregate substantially passing the 4.75mm sieve) used for road bases and surfacing shall either be crusher fines or river sand. Where crusher fines are used they shall be derived from rock meeting the requirements of coarse aggregate for road bases and surfacing.

- (5) When the coarse and fine aggregate are combined, along with filler where required, the combined aggregate grading and the binder content shall be as given below for the wearing course.

Sieve Size	Specification Limits	
mm	Lower	Upper
28.0	100	100
20.0	85	100
10.0	66	94
5.0	46	74
2.36	35	58
1.18	26	48
0.600	18	38
0.300	11	28
0.150	7	20
0.075	3	12
Percentage binder content by weight of the mix: 4-6%		

- (6) The contractor should get approval from the Engineer for the type, source and composition of the Aggregate and binders.
- (7) Asphalt mixtures are to be sampled and tested in accordance with BS 598: part 100, Part 101: 1987 and Part 102: 1989.
- (8) The mix characteristics as determined by the Marshall Mix Designs procedure shall be as given in Table below for wearing courses for medium traffic.

No.	Description	
1.	Marshall stability in KN	Not less than 3.33
2.	Marshall flow (0.25 mm)	8 to 18
3.	Air voids in mix percent	3 to 5
4.	Voids in mineral aggregate percent	Not less than 14

- (9) The contractor shall submit to the Engineer in writing at least two weeks before the start of the work, the job mix formula proposed to be used by him for the work which shall give the following details:
- (i) A single percentage of aggregate passing each specified test sieve.
 - (ii) A single percentage of binder content by total weight of total mix.
 - (iii) A single temperature at which the mix is emptied from the mixer.

(iv) A single temperature at which the mix is to be delivered on the road.

In addition the contractor shall give the sources, locations of all material and the details of the mix design based on requirements given in above table.

All mixes furnished shall confirm to the job mix formula approved by the Engineer within the ranges of tolerance given below.

Aggregate passing 9.5 mm and large sieve	± 6%
Aggregate passing sieve between 9.5 mm and 75 um	± 4%
Aggregate passing 75 um sieve	± 2%
Binder content percent	± 0.3%
Temperature of mixture when emptied from mixer	± 10%
Temperature of mixer when delivered on road	± 10 C

(10) If a change in the materials or source of materials is proposed, a new job mix formula shall be submitted and approved before the mix containing the new material is delivered to site.

(11) The mix if not within the specified limits given above shall be rejected.

(12) When unsatisfactory results or changed conditions make it necessary, the contractor, if required, shall submit a new job mix formula to the Engineer for approval.

Preparation of Existing Surface

(13) When asphaltic concrete surfacing are laid over newly constructed bases, prior to construction, the surface shall be cleaned of extraneous matter and applied with a prime coat

Limitations due to Weather, Equipment, etc.

(14) The bituminous mix shall not be laid during rainy weather or when the surface on which it is laid is damp or wet.

(15) No work shall be carried out when there is insufficient equipment for hauling, spreading or finishing or insufficient labour to ensure progress at a rate compatible with the output of the mixing plant.

Mixing Plant and Preparation of Mix

(16) An approved mixing plant of the batch type or of the continuous type shall be used for the preparation of the mix, which shall have the capacity sufficient to supply the paver continuously.

- (17) The mixer shall be capable of accurately batching the aggregates, filler and binder and mixing same thoroughly so that the mixed material on discharge from the mixer is uniform in composition and that all aggregate particles are completely coated.
- (18) Batch type plants, shall be equipped with suitable means for accurately weighing of each bin size aggregate and the filler. The scales of such the weighing mechanisms shall be calibrated at the frequencies as determined by the Engineer using standard weights. The contractor shall always have at hand sufficient 25kg weights for such calibration.
- (19) In continuous type plants the gate openings of the aggregate shall be calibrated by an approved process of weighing test samples. The bitumen feed line shall have a by-pass arrangement in order that the meter could be calibrated. These calibrations shall be carried out at frequencies determined by the Engineer.
- (20) The mixing plant shall be capable of heating the aggregate and the binder to the appropriate temperatures. When wet aggregate is used, the plant shall have an added capacity to dry the aggregate before heating.
- (21) The binder and mineral aggregate shall be heated separately to temperatures between 130 & 160°C, and 150 & 175°C respectively. The materials shall be mixed at temperatures within absolute limits of 145 and 170°C, even allowing for tolerances.
- (22) The plants shall, be equipped with a dust collector so constructed as to waste or return uniformly to the elevator all or any part of the material collected.
- (23) The mixing plant shall be capable of loading the mix into transport vehicles in such a manner that segregation does not occur.
- (24) In addition the plant shall be provided with the following:
- Covered or protected ladders or stairways with secure hand rails in adequate number which shall be placed at all points required for accessibility to all plant operations.
 - Pulleys, belts and drive mechanisms and other moving parts should be covered.
 - A clear and unobstructed passage at all the times in and around that tipper loading space which shall be kept free from drippings from the mixing platform.
 - Insulated flexible pipe connections to carry bitumen.

Transport of Mix

- (25) The mix shall be transported from the mixing plant to the point of use in suitable tipping trucks.

- (26)The mix shall be transported from the mixing plant to the point of use in suitable tipping trucks.
- (27)The trucks shall be good mechanical condition at all times. They shall have clean and smooth metal beds, that have been sprayed with soapy water or lime solution or any other detergent solution approved by the Engineer, to prevent the mix from adhering to the beds. The amount of sprayed fluid shall however be kept to a practical minimum. All precautions shall be taken to avoid segregation of mixed materials and to ensure that they do not become contaminated with dust or foreign matter.
- (28)Any truck causing excessive segregation of bituminous material by its spring suspension or other contributing factors, or that shows oil leaks in detrimental amounts of that causes undue delays, shall upon direction of the Engineer be removed from the works until such conditions are corrected.
- (29)When directed by the engineer, each load shall be covered with a properly fastened canvas or other suitable material of such size as to protect the mix from the weather. In order that the mix shall be delivered to the site within the specified temperature range, during cold weather or during long hauls, a properly fastened insulating cover shall be used when necessary.
- (30)Load and transporting shall be coordinated such that spreading, compacting and finishing shall be completed during daylight hours unless adequate illumination, as approved by the Engineer, is provided by the Contractor.
- (31)The mix shall be delivered at the site at a temperature within the absolute minimum limit of 115°C.

Laying of the mix

- (32)The mix shall be laid immediately after transporting by means of approved mechanical self-powered pavers. They shall be capable of spreading, finishing and providing initial compaction to the mix so that, the surfacing can be finished to the required lines, grades, levels, dimensions and cross sections intended, either over the entire width or over such other partial widths as may be practicable.
- (33)The pavers shall be equipped with receiving hoppers and spreading screws of the reversing type of place the mix evenly in front of adjustable steering devices and shall have reverse as well as forward travelling speeds. They shall also be furnished with vibrating screed

(leveling) unit equipped with suitable burners or heaters and tamping bars or vibration attachments.

(34)The pavers shall be able to confine the edges to confine the edges of the pavement to true lines without the use of stationery side forms. The equipment shall include bending or joint leveling devices for smoothening and adjusting longitudinal joints between lanes. The assembly shall be adjustable to give the cross sectional shape prescribed and shall be as designed and operated as to place the required thickness and weight per square meters of material.

(35)A fully trained and experienced operator shall be in direct charge of the paver at all times. The pavers shall be operated so as to avoid dragging of the material.

(36)The bituminous mix, after spreading, finishing and initial compaction by the paver, shall have a smooth surface free of irregularities caused by dragging, tearing or gauging.

(37)During construction, if it is seen that the paver in operation leaves on the surfacing tracks or intended areas or other objectionable irregularities or segregation of mix, that cannot be satisfactory corrected by normal operations, the use of such a paver shall be discontinued forthwith and another satisfactory paver shall be provided by the contractor.

(38)In narrow widths and in restricted area where the plant cannot operate, the mix may be manually laid, in which case, care shall be taken to avoid segregation. Manually laid strips shall be rolled at the same time as the paver laid work and allowance shall be made for extra compaction of these strips. Any defects in laid surface shall immediately be rectified before rolling commences and there shall be no unnecessary scattering back by hand of material on paver laid work.

Compaction

(39)Immediately after the mix has been spread and struck off, the surface shall be checked and any irregularities adjusted. Rolling shall commence as soon as the material will support the roller without undue displacement or cracking. The mix shall then be thoroughly and uniformly compacted by rolling, according to the sequence of rolling as given below:-

- Transverse joints
- Longitudinal joints, where applicable
- Outside edge
- Initial or breakdown rolling
- Second or intermediate rolling
- Finish or final rolling

- (40) Normally the first rolling joints and edges and the initial or breakdown rolling, shall all be done with static weight (Tandem or three wheel) or vibratory steel wheeled tandem rollers and the second or intermediate rolling with pneumatic tyred rollers.
- (41) Use of any other rollers for the above purposes shall be with the prior approval of the Engineer. During initial or breakdown rolling, the direction of travel of the roller shall be such that the powered or driving wheel passes over the uncompacted mix first, before the driven wheel. The second intermediate rolling shall follow the initial or breakdown rolling as close as possible while the bituminous mix is still plastic and at a temperature that will result in maximum density. The final rolling shall be accomplished with static weight tandems or vibratory tandems (without vibration) while material is still warm enough for removal of roller marks.
- (42) In general the type of roller or roller combination to be used shall be nominated by the contractor for the approval of the Engineer prior to the commencement of work and the rollers shall satisfy the requirements given in compacting equipment section.
- (43) The speed of the rollers shall not exceed the limits given in Table below and shall be at all times be slow enough to avoid displacement of the hot mix.

Type of Roller	Spread in Km/hr		
	Breakdown	Intermediate	Finish
Steel Wheeled Rollers	3	5	5
Pneumatic Tyred Rollers	5	5	8
Vibratory Rollers	5	5	-

- (44) During stages of initial, intermediate and final rolling, rolling shall commence at the low side of the spread and progress towards the higher side parallel to the center line of the pavement.
- (45) When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by either removing or by adding fresh material. The rolling shall be continued till the entire surface had been compacted adequately and the roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one half of the proceeding pass. The roller wheels shall be kept damp if required to avoid the material sticking to the wheels and being picked up. However, the quantity of water used for this purpose shall be the minimum required.
- (46) When using a vibratory roller for the compaction of a surfacing the vibration shall be turned off before the roller stops when reversing direction, and turned on after it starts in the new direction.

- (47) Vibratory rollers shall not be used for surfacing of thickness less than 50mm, unless otherwise approved by the Engineer. The breakdown and the intermediate rolling shall be carried out at temperatures or less than 105 degree C 135 degree C respectively.
- (48) The final rolling shall be completed before the temperature of the mix falls below 85 degree C.
- (49) When the bituminous mix is spread in areas that are inaccessible to rollers such as places as kerbs and manhole etc, compaction shall be obtained by hand tampers, mechanical tampers, or small vibrating plate compactors.
- (50) The density of all samples taken from the compacted surface course shall not be less than 98 % of the Marshall Density at the point appropriate to the locations.
- (51) All rollers shall be self propelled, capable of being reversed without backlash and equipped with power steering, dual controls allowing operation from higher the right or left side. They shall have water tanks with sprinkler systems to ensure even wetting of rolls or tyres.
- (52) The rolling surface of the wheels of a steel wheel roller shall be checked for wear. If grooves or pits have worn into the rolling surface, the roller shall not be used on the job.
- (53) Each roller should have a calibration chart showing the relationship between depth of ballast and weight and giving the tare weight of the roller. Each roller shall be in a good condition and shall be operated by a competent and experienced driver.

Joints

- (54) Both longitudinal and transverse joints in successive course shall be staggered so as not to be one above the other. As far as practicable, longitudinal joints shall be arranged so that the joints in the top course shall be at the location of the line dividing the traffic lanes, and the transverse joints shall be staggered at a minimum of 250mm and be straight.
- (55) Longitudinal and transverse joints shall be made in a careful manner so that well bonded and sealed joints are provided for the full depth of the course no mixture shall be placed against previously rolled material unless the edge is trimmed to line and applied with a very thin coating of binder just before additional mix is placed against the previously rolled material.
- (56) Spreading shall be as nearly continuous as possible and rollers shall pass over the unprotected end of freshly laid mix only when authorized by the Engineer. In all such cases

provision shall be made for a properly bonded and sealed joint with the new surface for the full depth of the courses as specified above. Before placing mix against them, all contact surfaces of kerbs, gutters, manholes etc. shall be given a thin uniform coating of hot bitumen and the joints between these structures and the surface mix shall be effectively sealed by the subsequent spreading, finishing and compaction operations

Others

(57) Sections of the newly finished work shall be protected from traffic of any kind until the mix had sufficiently hardened. Also traffic shall normally, not be permitted over newly laid surfaces at least for six hours after lying.

(58) In the event any binder course is constructed initially the surface so formed shall be maintained in its finished condition until the surface course is placed thereon, and any damage caused shall be made good by the contractor if it shall be corrected at contractor's own expense.

3) CONCRETE WORKS INCLUDING LAYING OF PIPELINES

a- Excavation

- (1) Trench excavation work shall be carried out in a safe and proper manner with appropriate precautions being taken to safeguard workmen and existing structures and utilities against all hazards. Notwithstanding these provisions, if damage to existing utilities results from the contractor's operations, such damage shall be repaired without delay by the contractor or some other agency approved by the engineer, and the cost of such repairs shall be borne by the contractor.
- (2) Trenches shall be excavated to the lines and levels shown on the drawing or as directed by the engineer.
- (3) Trenches shall be excavated to a width, which will provide adequate working spaces and sidewall clearances for proper pipe installation, jointing and embedment.
- (4) All trench excavation shall be open cut from the surface unless authorized by the engineer and shall be excavated so as that pipes can be laid straight at uniform grade without dips or humps between terminal elevations.

- (5) Mechanical equipment shall not be used in locations where its operation would cause damages to trees, buildings, culverts or other existing property, utilities or structures above or below ground. In all such locations hand-excavating methods shall be used.
- (6) Where necessary contractor shall use hand tools to excavate test pits prior to excavation to determine the exact location of existing utilities. Test pits shall be refilled by hand as soon as practicable after the necessary information has been obtained. No extra payment will be made for the excavation of test pits.
- (7) The trench shall be excavated to the necessary depth to meet the requirement for preparation of trench bottom for pipe laying. Any part of the trench below grade shall be backfilled to grade with thoroughly compacted materials approved by the engineer. When an unsuitable sub grade condition is encountered and in the opinion of the engineer, it cannot support the pipe, an additional depth as directed by the engineer shall be excavated and refilled to pipe foundation grade with approved suitable material to achieve a satisfactory trench bottom.
- (8) All excavated materials shall be piled in a manner that will not endanger the work or obstruct sidewalks or drive ways. Gutters shall be kept clear or other satisfactory provisions made for street and other drainage. Location will be as given in the drawing or as directed by engineer.
- (9) The Contractor should take all measures to warn the traffic and people using the stretch of the road where the pipes are being laid. Acceptable road signs and night- lights should be maintained during the work period.
- (10) The contractor should keep the de-watering pumps operated and the pumped water should be diverted to suitable point as directed by the engineer.
- (11) Where soil is not suitable for laying pipes, the selected fill material should be placed 400 mm deeper than the specified inverted level and the bedding should be placed in 100 mm thick layers under the pipe. Each layer should be compacted to the satisfaction of the engineer. The thickness of layers for compaction above the pipe should not be more than 150 mm. The engineer will decide if the excavated material is suitable for backfill and in which case the contractor should sieve the excavated material.
- (12) Trenches shall be excavated to the minimum width necessary to suit the outside diameter of the pipe plus the clearance either side to the trench walls. For smaller diameter pipes this will be less than the minimum width necessary for the work of installing pipes in the

trench, particularly in deep excavations. A minimum trench width of 600 mm shall be used and the maximum width under normal conditions should be as follows:

Pipe Size	Min Trench Width	Max Trench Width
Less than 150 mm (inclusive) nominal diameter	450 mm	750 mm
300 mm nominal diameter	500 mm	800 mm
400 mm nominal diameter	600 mm	900 mm

(13) However for deeper depth, and/or larger diameter of pipe, and where required excavation width, will be more than above specified, so that to have sufficient working space while laying. Excavation width should be more than above specified where Valves, hydrants and other specials and fittings to be laid or installed and sufficient working space should be provided or made where required.

(14) Stepped trenches may be excavated to provide adequate working space over the pipeline, whilst still permitting pipes to be laid in minimum width trenches.

(15) Trenches shall be carefully excavated to the width specified in the design and any soft spots removed from the bottom. All voids, whether due to the removal of soft spots or over-excavation shall be refilled along with any natural material on which the pipes will be bedded.

b- De-watering

- (1) The contractor shall provide and maintain adequate de-watering equipment to remove and dispose of all surface and ground water entering excavations, trenches or other parts of the work as approved by the Government Authorities and copies of such approvals shall be submitted to Employer. The trench shall be kept dry during sub-grade preparation and continually thereafter until the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, floatation, or other cause will result.
- (2) Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damages to the adjacent property.

- (3) Dewatering shall be carried out with liaising to relevant Government authority and as per the government regulations. A copy of approval letter / certificate shall be submitted to Employer.

c- Backfilling of Trenches

- (1) Backfilling shall be undertaken as soon as practicable after the specified operations preceding it, have been completed. Backfilling should not be commenced until the works to be covered have been completed to the extent required by the Employer.
- (2) Compacted backfilling will be required for the full depth of the trenches. The backfill shall consist of uniform, readily compatible materials and shall not contain materials deemed unsuitable as directed by the engineer. At least up to 300mm above the top of the pipe only selected soil or fill materials shall be deposited in 150mm layers and thoroughly compacted using an appropriate mechanical compactor. Particular care shall be taken to avoid damages to the pipe. The remainder of the refilling may consist of course materials, which shall be spread in layers of not more than 250mm and compacted as above.
- (3) Where the excavations have been supported and the supports shall be removed these shall be withdrawn progressively as backfilling proceeds in such a manner so as to minimize the danger of collapse. All voids behind the supports shall be filled and compacted.
- (4) Backfilling shall commence as soon as the work of constructing the pipeline has been completed, but not before the work has achieved sufficient strength to withstand all loads imposed by backfilling. All excavation and backfilling shall be co-ordinate with construction of the pipeline so as to expedite completion with minimum disruption. Backfilling of a trench shall be carried out after inspection of the trench by the Engineer (Employer)
- (5) For pipes bedded on the trench bottom, or on a sand or granular bed, selected backfill material free from vegetable matter, building rubbish, stones, etc. shall be placed in unconsolidated layers of 150 mm thickness, and then uniformly compacted.
- (6) Backfill used above the selected backfill layer shall be to the approval of the Employer, or others responsible for the upkeep of roads, and will usually be the excavated material.
- (7) Contractor should arrange local sand in case of insufficient sand in the excavated area. Well compacted back filling should reach at least 95% of Maximum Dry Density.

- (8) Backfilling around manholes and inspection chambers shall be undertaken in such a manner that will avoid damage or uneven loading.

d- Disposition Of Excavated Materials

- (1) Subject to any specific requirements of the Contract, the disposition of excavated material shall be at the Contractor's discretion but shall be so arranged as to suit the overall requirements for the construction of the Works.
- (2) The Contractor shall ensure that no excavated material which is suitable for or is required for re-use in the Works is disposed of outside of the site.
- (3) Temporary spoil tips may be used to store excavated material as required, and shall be arranged by the Contractor.
- (4) Excavated material which is surplus to requirements or is unsuitable for re-use in the Works shall be disposed off-site either to locations to be found by the Contractor (Contractor's tip) or to locations designated by the Engineer (Engineer's tip). Materials ordered to be disposed of to the Contractor's tip shall become the Contractor's property and he shall be entirely responsible for its disposal. Material ordered to be disposed of to the Engineer's tip shall remain the property of the Employer.

CONSTRUCTION OF PIPE LINES

e- Bedding

The bedding for pipes shall be constructed by spreading and properly compacting suitable granular bedding materials over the full width of the trench. For normal bedding the trench bottom shall be given a final trim and shape so that the pipe will be uniformly bedded on the required grade. Any stones or flints likely to damage the pipe or its coating shall be picked out of the pipe bed, and any hole so formed shall be filled with soft material and trimmed to the correct level.

f- Pipe Laying

- (1) All pipe laying shall be carried out according to the standard code of practice.
- (2) Pipes shall be laid directly on the selected bedding materials properly compacted to the satisfaction of the Employer.
- (3) Pipes shall be accurately laid and in perfectly straight lines and true gradients in accordance with the plans and sections shown on the drawings or as otherwise directed by the Employer.
- (4) Pipes shall be embedded properly by placing embedment materials and shall be protected from lateral displacement during embedment operations.
- (5) Bricks or other hard materials shall not be placed under the pipes for temporary support except where a concrete bed is to be provided.
- (6) After backfilling 300 mm above crown of the pipe, Contractor shall lay acceptable warning tape above all pipes.
- (7) Wherever pipe laying is stopped, the open end of the pipe shall be closed with an end board closely fitting the end of the pipe, to keep sand and earth out of the pipe. The end board shall have several small holes near the centre to permit water to enter the pipe and prevent flotation in the event of flooding of the trench.
- (8) Whenever pipes are laid directly on the trench bottom or on sand or granular bed, depressions shall be formed in the bedding at the pipe joints to ensure that the pipe is uniformly supported throughout the length of its barrel.
- (9) While laying pipes, no tensile stress shall be applied to pipes previously laid.

g- Pipe Installation

- (1) Pipes and fittings shall be carefully examined for cracks and other defects immediately before installation.
- (2) The interior of all pipes and fittings shall be thoroughly cleaned of foreign matters before being installed and shall be kept clean until the work has been accepted.

- (3) Precautions shall be taken to prevent foreign materials from entering the pipe during installation.
- (4) Water shall not be permitted to accumulate in any part of the trench during installation and testing.
- (5) The Contractor shall strictly follow manufacturer's instructions in laying and jointing pipes and fittings.

h- Handling

- (1) The Contractor shall exercise care in handling pipes so as to avoid damage, particularly to pipe ends. The loading and unloading of loose pipes shall be carried out by hand, avoiding the use of skids. Metal slings, hooks and chains shall not come into direct contact with the pipes, and they shall not be dropped onto hard surfaces or dragged along rough ground.
- (2) When pipes have fixed sockets at one end, the socket ends shall be placed at alternate ends of the stack with the sockets protruding so that the pipes are evenly supported along their entire length.
- (3) UPVC pipes and fittings shall be stored under cover out of direct sunlight.

CONCRETE WORKS

i- Cement

Cement shall be Ordinary Portland Cement confirming to B.S. 12 for all works. Other kinds of cements shall not be used unless otherwise approved by the Employer in writing.

j- Aggregate

- (1) Course aggregates shall be clean well graded imported granite chips ranging in average size from 5mm to 20mm.
- (2) Coarse aggregate for concrete shall be uncrushed gravel, crushed gravel or crushed stone from an approved source and complying with the requirements of BS 882 and graded to fall within the grading zones of Table 1.
- (3) Fine aggregate shall be manufactured sand or imported river sand.
- (4) Fine aggregate for concrete shall comply with the requirements for Fine Aggregate for BS 882. It shall be graded to fall within grading zones 1, 2 or 3 of Table 2 of BS 882 but the percentage by weight passing the No. 100 sieve shall not exceed 5 per cent, unless with the special permission of the Engineer.
- (5) Fine aggregate shall not contain more than a total of 3 percent of loam, clay, fine dust and other impurities, nor shall it contain more than 3 percent of mica. The total amount of mica, loam, clay silt, fine dust and other impurities shall not exceed 5 percent . Sand containing salt or coal dust shall not be permitted.

k- Water

Water shall not contain injurious amounts of impurities which may adversely affect concrete and reinforcement. Portable fresh water shall be used for all concrete works and curing. Saline Water Shall not be allowed for any Construction Work or Curing Purpose.

l- Specified Design Strength.

The specified design strength of concrete shall be not less than 35N/mm² unless otherwise specified.

m- Water Cement Ratio.

Water-Cement Ratio of all concrete shall be 0.4 to 0.5 by weight and concrete mix design must be approved by the project consultant.

n- Mix and Mix Ratio

All mixes shall be by concrete mixer.

Fine and coarse aggregate shall be measured by volume unless otherwise specified. The mix ratio for all concrete shall be as instructed by Employer

o- Quality Inspection of Concrete

The contractor shall conduct tests on concrete to ensure its quality. In this respect contractor is required to make three test cubes of standard sizes and make arrangements for testing the strength in 7 days and 28 days and approve the results from Employer.

p- Consolidation

The concrete shall be properly vibrated immediately after placing by means of a mechanical vibrator designed for continuous operation to ensure proper consolidation.

q- Concrete curing

After concrete has been placed the concrete surface shall be kept moist by spraying with water and shall be protected from the direct sunlight and rapid drying. The curing period shall not be less than 7 days.

r- Construction of Form works

- (1) Form work shall be sufficiently rigid and tight to prevent loss of mortar from the concrete and to maintain the correct position, shape and dimensions of the finished work. It shall be so constructed as to be removable from the cast concrete without shock or damage.
- (2) The form shall be capable of producing a consistent quality of surface as required and a neat finish shall be obtained.
- (3) Where holes are required to accommodate, fixing devices or other built-in items, precautions shall be taken to prevent loss of mortar matrix.
- (4) The interior of all forms shall be thoroughly cleaned out before any concrete is placed. The faces of the forms in contact with the concrete shall be cleaned and treated with a suitable agent where applicable.
- (5) Formwork shall be removed without shock to, or disturbance of the concrete.

4) MATERIAL SPECIFICATIONS

Street Lights Columns

- 1- Street Light column should be designed to withstand wind speed of 35 m/s, topography, ground roughness and statistical factor of 1.0.
- 2- Columns should be manufactured in compliance to British Standard BS EN 40.
- 3- Material used for lighting columns should be compliance to BS EN 10025 S275 / JIS G3101 SS400.
- 4- Lighting columns should be longitudinally seam welded conforming to BS 5135 by automatic continuous metal inert gas (mig) process.
- 5- Columns should be anti-corroded by hot dip galvanization complying with galvanizing standard BS EN ISO 1461.
- 6- Columns should have a minimum height of 6m with a service door.

LED Street Light Lantern

- 1- Luminaire Specification:
 Power: Minimum of 170W
 Fitting Material: Non-corrosive die-cast Aluminium
 Optical Cover: 95% Transparent Tempered Glass
 IP Rating: IP66
 Voltage: 220 – 240Vac 50/60Hz
- 2- LED Module Specifications
 Color Temperature: 3000K Warm White
 Color Rendering Index: >70
 Luminous Flux: 23600 Minimum

Electrical Cables:

1. All cables used should be a cable approved by Maldives Energy Authority.

Pipes for Service Line

1. Material: uPVC, The material used shall conform to ISO 1452-1
2. Dimensional tolerances: It shall conform to BSEN 1452
3. Wall thickness: It shall conform to BS EN 1452
4. Class: PN 10
5. Impact Resistance: It shall conform to BS EN 1452
6. Length: Minimum 5.8 Meters

Bitumen 60/70

Analysis	Unit	Limit	Test Method
Density @ 25°C	Kg/m ³	1010-1060	ASTM D70 or D3289
Penetration @ 25°C	Mm/10	60-70	ASTM D5
Softening Point	°C	49-56	ASTM D36
Ductility @ 25°C	cm	100min	ASTM D113
Loss on Heating	Wt%	0.2max	ASTM D6
Drop in Penetration after Heating	%	20max	ASTM D5
Flash point	°C	232min	ASTM D92
Solubility in Trichloroethylene	Wt%	99.0min	ASTM D2042
Spot Test	--	Negative	A.A.S.H.O.T.102
Viscosity @ 60°C	P	2000+/-400	ASTM D2171
Viscosity @ 135°C	cSt	300min	ASTM D2170
Test on Residue from Thin Film Oven Test (ASTM D1754)			
Retained Penetration (T.F.O.T), %	%	54min	ASTM D5
Ductility, (25°C), 5cm/min, cm after TFOT	cm	50	ASTM D113
Viscosity @ 60°C	p	10000max	ASTM D2171

Prime Coat MC30

Properties	Min	Max	Test Method
Kinematic 1 Viscosity at 60°C, EST	30	60	ASTM D2170
Flash Point (Tag Open Cup), °C	38	-	ASTM D1310
Distillate Test 2:			
Distillate percent by volume of total 360°C			
To 190°C	-	15	ASTM D402
To 225°C	20	60	ASTM D402
To 260°C	50	90	ASTM D402
To 316°C	80	90	ASTM D402
Residue from distillation to 360°C			
Test Residue from Distillation penetration at			
25°C, 100G, 5Sec	50	-	ASTM D402
Ductility 3 at 25°C, CM	120	250	ASTM D402/ ASTM D2024
Solubility in Trichloroethylene, Percent Mass	100	-	ASTM D402/ ASTM D2024
Water, Percent Volume	-	0.2	ASTM D95

Interlocking Rectangular Blocks

1. Dimensions: 200mm X 100mm X 65mm thickness
2. Dimensional Tolerances:
Length $\pm 1.5\text{mm}$
Width $\pm 1.5\text{mm}$
Thickness $\pm 1\text{mm}$
3. Compressive Strength: At time of delivery to the work site, the average compressive strength of the test samples shall not be less than 30 MPa with no individual unit less than 25 MPa.
4. Water Absorption: The average absorption of the test samples shall not be greater than 5% with no individual unit greater than 7%.
5. Abrasion Resistance: When tested in accordance with Test Method C418, specimens shall not have a greater volume loss than 15cm³ per 50cm². The average thickness loss shall not exceed 3mm.
6. Color: Standard Grey Color