**ANNEX B: Civil and Structural Design requirement**

**MINIMUM REQUIREMENTS FOR CIVIL / STRUCTURAL DESIGN**

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**1.0 GENERAL**

This attachment describes the minimum civil and structural requirements to be adopted for the design of new buildings, structures, foundations, and access roads/paved areas.

**2.0 Load Definition**

**2.1 Dead Load**

Dead loads are vertical loads due to the weights of all permanent building components. Typical components are walls, floors, fixed equipment of all kinds, piping, electrical lighting, suspended ceilings, HVAC components and ductwork. These shall include suitable contingencies for material tolerances. The unit weights of materials and components shall be as defined in BS 648 “Schedule of Weights for Building Materials” or information from the product supplier giving installed weights of materials or components.

**2.2 Live Load**

Live loads are all moveable superimposed loads such as furniture, moveable partitions, occupants and moveable equipment, but not including wind, earthquake or equipment dynamic loads. Live loads shall be as specified in BS 6399, Part 1. Loads shall be applied as a combined arrangement for the most severe effect.

**2.3 Wind Load**

The wind pressures shall be calculated in accordance with BS CP3, chapter V, part 2, 1972 “Basic data for Design of Buildings ‐Wind Loads”. Structures shall be designed for a Basic wind speed of 45 m/sec.

The following wind factors shall be used:

1) Topography factor S1 = 1.0

2) Ground Roughness, S2, Building size and Height above ground factor from table 3.

3) Statistical factor S3 = 1.0

The prevailing wind direction is WSW, but for design purposes wind shall be assumed to

come from any direction.

**2.4 Load Combinations**

Members/elements of buildings/structures as well as their supports and fixing points shall be designed for the following load combinations:

|  |  |  |  |
| --- | --- | --- | --- |
| Load Combinations | Dead | Live | Wind |
| D+L | X | X |  |
| D+L+W | X | X | X |
| D+W | X |  | X |

Where "D" is the dead load, "L" is the Live Load, and "W" is the wind load. Where appropriate, load(s) due to earth pressure and/or water pressure should be included in the load combination(s).

**3.0 Structural Design**

**3.1 Reinforced Concrete**

**3.1.1 General**

Design and detailing of structural concrete shall be in accordance with BS 8110 and

BS8007.

Earth retaining structures shall be designed to resist the raking active earth pressure based on the soil parameters given in the Soil Investigation report. For the passive soil pressure neglect the first 300 mm from the finished grade level in the calculations.

All underground structures shall be statically checked for flotation. In the case of pits, basins, manholes and other soil bearing structures the factor of safety against flotation shall be 1.1 for the empty/construction condition.

The thickness of the blinding layer shall be 75mm minimum.

Types of loads and the load combinations shall be considered as per section 2.4. Load factors shall be applied as per BS 8110 or BS 8007 to obtain the most unfavorable conditions.

In pedestals vertical reinforcing shall be enclosed by complete circumferential ties meeting the size and spacing requirements of BS 8110 for tie reinforcement for compression members.

**3.1.2 Material Requirements**

**3.1.2.1 Cement**

Cement for structural reinforced concrete and paving shall be ordinary Portland Cement

(OPC) to BS 12 or equivalent.

**3.1.2.2 Concrete Grades**

Concrete works shall be designed using the following grades:

|  |  |
| --- | --- |
| Grade  N/mm2 | Applications |
| 35 | Structural concrete  (Reinforced) |
| 25 | Duct encasement, backing, unreinforced footings |
| 15 | Blinding |

A trial mix shall be conducted and approved by the Employer/Engineer before commencing any concrete works

**3.1.2.3 Reinforcing Steel**

Reinforcing steel bars shall be uncoated high yield deformed bars of characteristic strength of 460 N/mm² to BS 4449, or equal

Uncoated mild steel plain bars with characteristic strength of 250 N/mm² to BS 4449, or equal

Steel wire fabric shall be of characteristic strength 485 N/mm² in accordance with BS 4483 or equal.

All steel bars shall be bent in accordance with BS 4466:1989.

Mechanical bar couplers, where required, shall be specified as complying with the requirements of BS 8110.

Reinforcement shall be fixed, supported and maintained in position by the adequate use of chairs, spacers and tying wire.

**3.1.2.4 Concrete Cover**

Concrete cover is the concrete thickness to all steel reinforcement including links:

1) For all concrete (with protection) in contact with soil cover shall be 70 mm.

2) For all above grade concrete exposed to weathering cover shall be 50 mm.

3) For above grade concrete protected from weathering cover shall be:

• Beams and columns: 40 mm

• Slabs and walls : 30 mm

4) Cover to bar couplers shall not be less than the minimum specified for reinforcing bars.

Note: Blinding concrete is not to be considered as cover.

**3.1.2.5 Concrete Protection**

Appropriate Concrete Protection system shall be designed as per the soil / environmental condition to which the structural elements are exposed. Under ground concrete protections system shall be proposed based on the soil report. If the soil condition is very hostile to the concrete structure then the contractor shall propose a system of concrete protection including the use of appropriate concrete admixtures (micro silica, corrosion inhibitors etc.), as required. However the following are the minimum requirement as per QP standards.

Clauses 3.39.1 a),b) and c) of QGPC Standard Specification for Civil Works Volume 1 are replaced by the following.

Concrete in contact with soil in foundations shall be protected using BITUTHENE 3000 HC

membrane system or equivalent.

For surfaces not exceeding 45° to the horizontal, the BITUTHENE is to be laid on top of concrete blinding, the top surface of the membrane is to be protected with a cement screed at least 40 mm thick.

At junctions and joints the membrane is to be overlapped by a minimum of 75mm, exposed edges of concrete are to be chamfered, propriety angel beads are to be provided where necessary.

Where rising blockwork walls are supported by concrete foundations, the membrane and protection board shall be applied on each side of the rising wall up to ground level. Where a floor slab abuts the rising wall the membrane shall be overlapped by the slab polythene damp proof membrane.

Prior to applying the membrane the contractor shall ensure that the concrete or blockwork surfaces are finished smooth and that any irregularity which might cause the membrane to be punctured has been removed and all edges shall be chamfered, proprietary corner fillets shall be installed. The contractor shall adhere strictly to the manufacturers recommendation when applying the protection system.

**3.2 Structural Steel**

**3.2.1 General**

The following provisions shall be applicable to steel structures and buildings, stairways, and other miscellaneous steelwork. The design, details, fabrication and erection of structural steel shall be in accordance with BS 5950. All structural steel shall be Grade 43A to BS 4360:Part 2 or equivalent as a minimum.

Types of loads and the load combinations shall be considered as per section 2.4. Load factors shall be applied as per BS 5950 to obtain the most unfavorable conditions.

**3.2.2 Design Data**

Types of loads and load combinations shall be in accordance with section 2.0. The Allowable deflections for some of the members are given below. For other members reference shall be made to BS 5950.

|  |  |  |  |
| --- | --- | --- | --- |
| Category | Member type | Vertical  Deflection | Horizontal  Deflection |
| Steel members | Purlins  Primary Floor beams with equipment without equipment Cantilever beams | L/200  L/500  L/300  L/400 |  |
| Steel frames | without equipment  With equipment;  ‐ without wind allowance  ‐ with wind allowance |  | H/200  H/300  H/200 |

H is the height of frames, and L is the span of beams

**3.2.3 Connections**

Standard simple beam connections, unless otherwise noted, shall be designed and detailed by the fabricator as shown in Part 3 of “BCSA Structural Steelwork Handbook”.

Where bolts are permitted in structural connections (beam/column connections, moment connections, bracing connections, etc) they shall be black bolts grade 8.8 conforming to BS

3692 in normal tolerance holes with minimum of two M20 bolts. Whenever bolted

connections are used, the reduced strength due to holes shall be computed.

Connections shall be designed taking into account of the effects of any eccentricity on the component parts of the connection, including welds and bolts.

The minimum leg length of any stressed weld shall be minimum 6mm or in accordance with the following table;

|  |  |
| --- | --- |
| Thickest part to be connected (mm) | Leg Size (mm) |
| Up to and including 20  20 to 35 | 6  8 |

Size of fillet welds shall refer to the leg length. The effective length of fillet welds shall be the length excluding the first and last 25mm of the weld.

**3.2.4 Minimum Material Thickness**

Minimum dimensions of load carrying members shall be as follows;

Structural members Expect for the webs of rolled steel sections, steel used for external construction shall not be less than 8mm thick, and in construction not so exposed, not less than 6mm thick.

Gusset plates No thinner than 10mm.

**3.2.5 Load on crane beams**

The design loads for structures handling moving loads shall include an impact allowance in accordance with BS 5950 as specified below;

|  |  |  |
| --- | --- | --- |
| Load Application | Electrical operation | Hand operation |
| Vertical loads: increase static wheel loads by | 25% | 10% |
| Horizontal force acting transverse to the rails taken as percentage of lifted load + weight of crab | 10% | 5% |
| Horizontal force along the rails taken as percentage of lifted load + weight of crab | 5% | 5% |

**4.0 Soil Properties**

Where specified, soil characteristics for all the foundations shall be established through appropriate soil investigation carried out in accordance with BS 5930. The scope shall cover the soil bearing capacity considering the strength and settlement, durability and stability of the foundation soils with regard to water erosion, soil corrosion characteristics, and problems with respect to excavation/construction.

**5.0 Roads and Paved Areas**

Precast concrete paving blocks, 80mm thick, shall be used or roads and car parking areas. Kerbs shall be provided at the boundaries of all concrete paved areas and at raised islands where these are shown on the drawings.

**6.0 Underground Utilities**

All reinforced concrete underground foundations, manholes, and chambers shall be protected externally on horizontal and vertical surfaces, as per Section 3.1.2.5 of this document.

All underground utilities, pipes, structures, culverts and covers shall be designed to accommodate imposed loading from service loading, and construction traffic.

**7.0 Foundations, Footings and Floor Slabs**

Floor slabs shall be laid flat with no crossfalls. The top level of slab shall not deviate more than ±3mm in 2m when measured in any direction. All floor joints shall be sealed with an approved two‐part polysulphide sealant or equivalent sealant.

Floor slabs shall be laid on one layer of 1200 gauge polythene sheet lapped minimum 300 mm at each edge on top of 50mm concrete blinding on compacted free draining imported granular material.

In stability analysis calculations the foundation shall be designed to have a minimum factor of safety of 2.0 against overturning and 1.5 against sliding. The weight of soil overburden may be taken into account when calculating factor of safety. The minimum factor of safety against floatation shall be 1.1. In determining the factor of safety against floatation allowance shall be made for removal of soil overburden and possible loss of skin friction from the sides.

**8.0 Concrete Blockwork**

Blockwork shall be designed to BS 5628. External walls shall be cavity type comprising

100mm solid concrete externally, a 50mm insulated cavity and 150mm hollow concrete

block internal skin.

Walls dividing storage areas from office areas, walls surrounding electrical rooms shall be minimum 200mm hollow concrete block. Other internal blockwork walls shall be minimum

150mm hollow concrete block.

Blockwork walls shall be tied to structural columns and beams using a proprietary stainless steel system that complies with the requirements of BS 5628. Cavity wall ties shall also be stainless steel.

Where joints are required, stainless steel plaster stops shall be used either side of each joint for all external wall joints. Internal wall joints in office areas shall be finished flush with plaster on stainless steel expanded metal. Wall joints formed using plaster stops shall be filled using an approved two‐part polysulphide sealant.

All blockwork up to the ground level shall be of solid blocks and of sulphate resistant cement and shall have a minimum compressive strength of 15N/mm2.

**9.0 Detailed Engineering Documents**

1) Detail of design and calculations shall be shown on sketches showing structural arrangements, loads, member sizes, etc. Computer printout of input data files shall be supplemented with analysis model plots, illustrating node/element numbers, support type (fixed, pinned, spring), member property/size, member orientation, member length, and member loading. Computer model plots shall not be altered by hand.

2) For Structural analysis, a structural analysis software such as STAAD or similar software shall be used and the input file, shall be submitted for design approval.

3) All calculations shall be in SI units. The calculation report and the drawings shall be in English.

**10.0 Earthworks**

**10.1 Fill**

The controlled earth filling shall be done using ‘selected fill’ material imported from an approved area.

Any fill shall be spread in layers of maximum 250 mm compacted thickness and with a minimum density equal to 95% of the maximum dry density (MDD) as determined by BS

1377 Test 13.

The first layer of fill shall be limited to 200 mm loose thickness. After placement but prior to compaction the area shall be scarified to a depth of 300 mm (100 mm into the natural soil) to break up any weathered crust and mixed with the new fill.

**10.2 Excavation**

The contractor shall obtain the relevant excavation permits as required to commence work. Materials to be excavated are not specifically classified and the work shall include excavation of all types of soil and rock, whether water bearing or not.

Excavated materials suitable for fill shall be transported to and replaced in fill areas within the limits of workspace. . The gradation limit shall be within the gradation limits specified below.

Excavated material unsuitable for fill shall be disposed off in spoil approved areas. Unsuitable material for fill includes organic clay or silt, wood or other material subject to decomposition, dune sand or desert fill not conforming to the gradation curve or to maximum allowed salt content, materials obtained during site clearance, e.g. concrete, steel, etc.,

The contractor shall liaise with the Employer with respect to the work near utility services and shall establish safety procedures and clearance requirements at the start of the excavation work.

Finished excavation slopes in the permanent works shall be free from debris and loose material.

The contractor shall pay special care to ensure no damage occurs to the any existing pipes/ducts or culverts during the excavation. Should The contractor in the course of excavation or subsequently, uncover any previously uncovered services, He shall notify the Employer in writing, description, dimensions and level above datum and other appropriate details on an appropriate drawing.

The contractor shall be responsible for all damage, which may arise from the entry of water into the excavations and shall provide all necessary labour and equipment to bale, de‐water, or drain as required keeping the excavations clear of water arising from whatever source.