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## **1.0 GENERAL**

### **1.1 GENERALLY**

Unless otherwise stated or contradicted, materials and workmanship specifications, are to apply reciprocally between trades.

All references to and descriptions containing trade names, materials and procedures shall be deemed to include the phrase "or other equal and approved".

All references to and descriptions containing the words Architect and/or Engineer and/or Project Manger shall be deemed 'Engineer'.

### **1.2 MATERIALS**

Materials are to be of the best quality consistent with the character of the works. Materials are deemed to be specified in the following order or priority unless otherwise indicated:

- a. Complying with Cyprus, British or EEC standards
- b. Complying in general with Cyprus, British or EEC standards
- c. of Cyprus, British or EEC manufacture

Where local practice is such that an alternative material or quality of material to that specified is generally accepted, then the Architect's approval must first be obtained before such alternative will be permitted to be used.

If the contractor allows for such alternative in his rates without the prior approval of the Architect, no extra cost will be allowed if subsequently the alternative is not approved.

Branded materials are to be handled, stored, and used, and processes are to be carried out, strictly in accordance with the manufacturer's instructions and recommendations.

Submit samples of all materials for the approval of the Architect.

Materials rejected by the Architect are to be removed from site within 24 hours of such rejection and the Contractor shall substitute proper and suitable materials to the approval of the Architect. All additional costs in connection therewith shall be borne by the Contractor, and no extension of time will be admitted on this account.

### **1.3 WORKMANSHIP**

Except where otherwise stated or contradicted, workmanship is to comply with British Standard Codes of Practice where applicable.

Workmanship is to be of a high standard throughout, particularly with regard to the accuracy of dimensions, lines, planes, levels and the quality of surface textures.

The Contractor is to do everything necessary to ensure that the standard of finish which is hereby demanded by this contract is achieved.

Construct, exhibit and finally demolish and clear away sample panels of concrete, or brickwork and blockwork, of all finishings and of painting and decorating for approval. The finished work is to correspond to the samples.

Provide such other samples of materials and workmanship as the Architect may require.

Work rejected by the Architect is to be demolished and cleared away within such time as may be specified by the Architect and re-executed to his approval. All additional costs in connection therewith shall be borne by the Contractor.

### **1.4 PIPE SIZES**

Pipes, tubes, bars, cables, conduits, standards and the like have been grouped and described as follows:-

- i. Small (i.e. not exceeding 55 millimetres diameter)
- ii. Large (i.e. over 55 millimetres but not exceeding 110 millimetres diameter)
- iii. Extra Large (i.e. over 110 millimetres diameter)

## **2.0 EARTHWORKS**

### **2.1 SITE PREPARATION**

#### **2.1.1 Clearance**

Generally, clear the site of rubbish, grub up bushes, shrubs, vegetation, etc., clear and cart away leaving the site ready for excavation.

For roadworks an area generally 2 metres beyond the limits of earthworks shall be cleared of all trees, bushes and other vegetation.

No trees or saplings shall be cut down without the prior approval of the Architect.

Where specified trees shall be removed complete with the roots. The holes caused by removing the roots shall be backfilled (if required) with approved material compacted to at least 90% of the maximum dry density achieved in test 13 of BS1377.

#### **2.1.2 Obstructions**

Break out foundations, drain, services, septic tanks and all other obstructions as required by the Architect and remove all material from the site.

#### **2.1.3 Services - Public Utility Services**

Arrange for the disconnection, by the public utility services authorities, of all services at the point of entry to the site.

#### **2.1.4 Drainage**

Any active drainage runs within the site, together with their connections to the public sewers, are to be left in a sound working condition, or diverted as directed.

#### **2.1.5 Records**

Records are to be made of positions and levels of any services or drain runs within the curtilage or on the perimeter of the site, including revised routes for any diverted services.

### **2.2 EXCAVATION**

#### **2.2.1 Excavation General**

The whole of the work shall be carried out in accordance with the current editions of the British Standard BS 6031 "Earthworks" and BS 8004 "Code of Practice for Foundations" unless otherwise stated in the Specification.

Notwithstanding any authorisation, approval or direction given by the Architect in any way, the Contractor shall be responsible for the proper carrying out of the work and for taking all necessary safety precautions and for any loss or damage which may arise from the operation of carrying out the works.

Excavation shall be carried out in all materials and by whatever means are necessary, accurately to the lines and levels of the drawings, and to the depths and dimensions shown on the drawings, or as the Architect may direct. The Contractor shall allow in his rates for working in water and disposal as directed.

Should any dimensions of any excavations, exceed those shown on the drawings or ordered by the Architect, or should the sides fail, the Contractor shall at his own expense fill and tightly pack such extra space with mass concrete or other approved materials as the Architect may direct. Should the Contractor excavate to greater depth than shown on the drawings or as directed by the Architect, he shall at his own expense make good the excess excavation in mass concrete up to the required level.

The methods of excavation shall be at the sole discretion of the Contractor, however, should the method of excavation adopted be such that in the opinion of the Architect the benefit of natural support to be obtained from the surrounding ground is impaired, then the Contractor will be required to backfill the whole of the excavation with mass concrete or other approved material and this together with any other costs arising from this operation shall be entirely at the expense of the Contractor.

Slopes and formation surfaces shall be trimmed true to line and the required profiles and shall be left well consolidated, neat and smooth.

Where the Contractor carried out excavation in stages and where material is filled and rammed around foundations, all foundation walls, beams, columns, slabs, etc., are to be adequately propped and supported while such work is being carried out and the Contractor must include for this in his rates, or price.

If loose soil, bad ground or cavities are met within any part of the foundations the Contractor shall excavate to a solid formation and shall fill up the excavation to a proper level with concrete Grade 15 or suitable fill properly consolidated to the direction of the Architect.

The Contractor shall report to the Architect when excavations are completed and are ready to receive blinding concrete, or foundation concrete if blinding is not required, and shall obtain consent before depositing concrete.

#### **2.2.2 Excavation in Rock and Boulder Rock**

Rock in this context is any material met which is, in the opinion of the Architect, of such size or position that it can only be removed by means of wedges, compressed air or other special plant, or explosives.

Boulder rock in this context is any material met which is, in the opinion of the Architect, of such size, position or composition that it can only be removed by means of special equipment but which does not need breaking up prior to removal.

The use of explosives shall not be permitted without the prior approval in writing of the Architect. Blasting will not be allowed if, in the opinion of the Architect, the rock at foundation level to any building is likely to be disturbed.

In no case blasting will be allowed below 400 mm from the proposed base level of the foundation. Pneumatic or other approved means of excavation will be used for this purpose.

The Contractor shall take all necessary precautions to ensure the complete safety of all site personnel, including any third party, together with all buildings on site, including buildings completed or partly completed by any third party.

When excavating for foundations on or adjacent to sloping rock faces, the Contractor shall execute the work in such a way as to avoid damaging the rock face below and to avoid spillage or casting excavated material down the rock face.

The Contractor shall judge for himself the nature of the ground to be excavated, and shall allow in his rates for all hand and or mechanical excavation and disposal in whatever types of soil and filling are encountered including rock and boulder rock, roots and other natural obstructions occurring anywhere on the site.

#### **2.2.3 Shoring Excavations**

The Contractor shall to the satisfaction of the Architect shore the sides of excavations for structures, trenches and pits to prevent them from slipping or falling. Should any slips, falls or settlement nevertheless occur, they shall be made good by the Contractor, at his own expense, with selected fill or with mass concrete as may be directed by the Architect.

In removing shoring from the sides of excavations, care shall be taken to avoid bringing loads on any concrete until it has hardened sufficiently to carry such loads.

Timber or other materials used for shoring the sides of excavations shall be removed as the work proceeds except when ordered to be left in by the Architect.

The Contractor shall, not later than one week before commencing any excavation, submit to the Architect for inspection, calculations and working drawings for the proposed scheme of strutting and retaining the sides of the excavations and shall not proceed with the appropriate section of the works until receipt of the Architect's written consent.

The receipt of such consent shall not relieve the contractor of any of his duties and responsibilities under the contract.

### **2.3 EXCAVATION OF TRENCHES**

#### **2.3.1 General**

The Contractor shall erect all forms and bracing, and make ready all excavations for trenches necessary to install all drainage, sewer, water and any other conduits, such as electrical cables to the lines and grades shown on the drawings and/or as directed by the Architect.

Trenching shall be opened to the lengths, widths and depths as shown on the Drawings, specified or as the Architect may approve or direct.

Trench widths to be as small as practicable but not less than the external diameter of pipe plus 300 mm or larger dimensions if specified on drawings. Trench sides must be vertical from bottom up to 300 mm above crown of pipe.

Maximum width of trench: for Class B bedding where total depth of trench exceeds transition depth, maximum width to be as follows:

Nom. Pipe bore (mm)	100	150	225	300	400
Max. width (mm)	600	700	800	900	1000

Transition depth: for purposes of determining max. width of trenches, transition depths to be as follows:

Nom. pipe bore (mm)	100	150	225	300	400
Transition depth (m)	6.0	5.4	4.0	2.9	2.5

Trenches for drains or other services, if below the level of the underside of adjacent foundation, shall not be excavated below a line drawn at an angle of 45° to the horizontal from the nearest lower edge of such foundation in stable soil, and 30° in the case of wet clay or silts. If it is essential to construct such trenches within these limits, the trenches shall be filled with mass concrete up to the level of the under side of the adjacent foundations.

Excavation for manholes, septic tanks, percolating pits and similar structures shall be sufficient to allow enough space between their outer surfaces and shoring timbers which may be used to protect the banks.

During excavation, materials suitable for backfilling shall be piled at a sufficient distance from the sides of the trench to avoid overloading and prevent cave-ins. All excavated material not required, or unsuitable for backfilling shall be moved and carted away to an approved dumping area.

### **2.3.2 Excavations Inside The Chamber Of The Ship**

Few excavations will have to be carried out in the Ship's Chamber. These will be the excavations of 10 isolated footings, on which the steel columns will be resting. These excavations are shallow and will have the depth of the footing plus the blinding concrete and additional 20cm, so that after concreting the footing there are 20cm available to finish the floor. The plan dimensions of these excavations shall have the size of the footings. No working space is required since the depth will only be 70cm. This way no formwork is required also.

The excavations shall be carried out by using small hand tools, manually or electrically operated, which will not cause significant vibrations to the area. No use of disks is allowed to avoid any sparks.

The contractor has to submit the method and tools for approval. The Supervision shall be present during the excavation of the first footing to provide the final approval of the method.

## **2.4 GRADING**

Grading shall be done as necessary to prevent surface water or rainwater from flowing into trenches, and any water, which may accumulate therein, shall be removed immediately. Trenches shall be kept dry during the whole period until backfilling is completed and approved.

Particular attention shall be paid to the installation of sheeting and shoring as may be necessary, for the protection of the work and for the safety of personnel, workmen and adjoining property.

If soft or loose material is encountered at the bottom of the excavation, it shall be removed or compacted to the depth ordered by the Architect and refilled when necessary, with selected excavated material compacted in layers, not exceeding 150 mm to a density of 95% of the maximum dry density as determined by Test 13 of BS1377, to produce a firm bearing.

No pipes, conduits or any utility shall be placed, prior to filling and compacting the earthwork to the levels required. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its length, except for the portions of the pipes where it is necessary to excavate for bell holes and for proper sealing of joints. Bell-holes and depressions for joints shall be dug, after the trench bottom has been graded.

Care shall be taken not to excavate below the depth indicated. Where rock is encountered, the rock shall be excavated to the required depth. Uneven surface at the bottom of the trench shall be excavated 150 mm deeper. Such depth shall be backfilled with approved sand at the Contractor's own expense.

The thickness of the compacted bedding under the barrels of the pipes shall be a minimum of 100 mm thick. The material shall be compacted in layers not more than 150 mm thick to give a uniform bed true to

gradient. Wherever possible, suitable machines shall be used for compacting the bedding. Where this is not possible, the material shall be thoroughly tamped. Joint holes shall be formed in the granular bedding and they shall be as short as practicable. On completion there shall, however, be a minimum depth of 50 mm of granular material beneath the joints.

Pipes must be laid in straight lines, true to gradients, each pipe being boned in between sight rails all in accordance with the procedures laid down in BS8301 Building Drainage. Bricks, blocks or battens must not be used to bring the pipe line to gradient. After jointing, the pipe must be capable of withstanding the air or water test for tightness required by BS 8301 "Building Drainage". Pegs used for alignment or to resist pipe driving impact must be withdrawn before side filling commences.

## **2.5 FILLING OF TRENCHES**

Filling around pipes and cables shall commence with carefully placed fine granular material to cover the pipe or cable completely before the normal backfilling is placed.

For UPVC pressure pipes fine granular material 10 mm - 5 mm in size, shall be used for filling around the pipes and for a minimum of 100 mm over the crown of the pipes and consolidating carefully to avoid damaging the pipes.

For A.C. pipes, cable ducts, cables etc, trench fill shall be clean, well graded sand, free from dirt, organic or any objectionable matter, and shall have particle sizes not larger than 5 mm. For clay pipes trench fill shall be either sand as above or natural aggregate up to 10mm for pipe sizes up to 110mm or 20mm for pipes of larger diameter.

Underground pipes shall be laid with not less than 750 mm cover below finished ground level except within 600 mm of the internal face of any external wall, unless otherwise indicated on drawings.

Backfilling material for the first 300 mm over the crown of the pipe shall be thoroughly compacted by hand in layers not exceeding 150mm. Thereafter, backfilling shall be laid and compacted in layers not more than 300 mm thick to the requirements of the filling specifications.

## **2.6 FINISH OF EXCAVATION AND INSPECTION**

No excavation shall be refilled nor any permanent work commenced until the formation has been inspected by the Architect's representative and his permission to proceed given. The bottom 150 mm of all excavations shall be taken out by hand immediately prior to commencement of permanent work. Levelling and ramming to form bottoms to the excavations, excavating out and refilling of any soft or defective portions as required and cleaning out of all water, drift sand, rubbish etc shall be carried out before placing concrete.

## **2.7 REMOVAL OF WATER**

The excavations shall at all times be kept free from stormwater, percolating water and subsoil water by any means necessary. The Contractor shall provide, maintain and clear away on completion any equipment necessary together with temporary drains and the like.

## **2.8 FILLING For roads and parking areas refer to appropriate section).**

### **2.8.1 General**

Foundation trenches, column bases and the like are to be backfilled with selected excavated materials, well rammed and consolidated by hand tamping to the satisfaction of the Architect in layers not exceeding 150 mm thick, (after compaction), and well watered during tamping.

For all other areas, backfilling shall be well consolidated in layers not exceeding 300 mm thick, (after compaction). The density after compaction in all cases shall be at least 95% of the maximum dry density achieved in test 13 of BS1377 at +1% to -2% optimum moisture content.

For landscaped areas, the above figure shall be reduced to 90% of the maximum dry density as defined above. After the final compacting and the trimming of formation has been executed, no carting or other traffic which is liable to disturb the formation shall be allowed. The contractor must take all necessary precautions to protect the prepared formation from the effects of extreme temperatures or inclement weather and all formations must be covered within forty-eight hours to prevent weathering. Final compacting and trimming of the formation must be delayed until the foundation or base construction is ready to be laid.

All fill material shall be placed at a moisture content appropriate to the type of material being used which shall in all cases be to the approval of the Architect.

The Contractor must ensure that all materials used is similar to the approved sample and that when placed in position, it is capable of withstanding the necessary loads to be placed upon it without movement and it is to be capable of compaction by ordinary means.

Surfaces of filling to receive concrete shall be finished smooth with a layer of fine material to provide a true base for the concrete work.

#### **2.8.2 Approved Filling Material - Other than Rock**

Only suitable material shall be used as fill and it shall be to the approval of the Architect.

Naturally occurring soils, sand and gravel used for backfilling of the excavations and for making up levels shall be selected and approved materials obtained either from excavations on the site or from an approved source off the site.

Where the excavated material arising from the excavations is to be used as filling, the Architect reserves the right to decide, according to the quality of the excavated material, the location in which this excavated material is to be deposited in spoil heaps either adjacent to the same location for backfilling or in the main spoil heaps where indicated or directed.

The fill material other than rock fill to be used beneath ground floor slabs shall be free of clay, rock or gravel larger than 100 mm in any dimension, debris, waste, vegetable matter and any other deleterious matter. It shall be well consolidated in layers not exceeding 150 mm thick. The density after compaction shall be at least 95% of the maximum dry density achieved in Test 13 of BS 1377 at +1% to -2% of optimum moisture content.

For landscaped areas, fill material when required shall be as above. For topsoil requirements and treatment refer to appropriate sections of this specification.

Concrete used as fill for making up to correct level areas of over-excavation shall be, where required by the Architect, Grade 15 lean mass concrete.

#### **2.8.3 Rock fill**

Rock fill within the main building area shall only be used in areas previously approved by the Architect.

"Rock fill" shall consist of hard durable inert material of suitable size for deposition and compaction as specified below:

#### **2.8.4 Deposition and Spreading of Rock Fill**

Material used in rock fill shall except for any specified external cover to slopes or near formation level, be of such size that it can be deposited in horizontal layers each not exceeding 450 mm loose depth. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. Material shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes.

Each layer shall consist of reasonably graded material and all surface voids shall be filled with broken fragments before the next layer is placed. The top surface and side slopes of embankment where shown on the drawings shall be thoroughly blinded with approved fine graded material to seal the surface. On side slopes and verges, such material may be top soil as defined.

Except where shown on the drawings, the maximum dimension of any boulder shall not be larger than 2/3 the thickness of the compacted layer.

#### **2.8.5 Compaction of Rock Fill**

Each layer in rock fill shall be compacted by at least 12 passes of a vibratory roller with a static mass per meter width of roll of at least 1800 kg or a grid roller with a mass per metre width of roll of at least 8000 kg or other approved plant. The number of passes is the number of times that each point on the surface of the layer being compacted has been traversed by the item of compaction plant.

##### **Filling Test Procedures**

Where defined tests for the following shall be carried out in accordance with the procedures specified in the relevant part of BS1377 "Methods of test for soils for Civil Engineering Purposes":

##### Test

1. Liquid limit
2. Plastic limit
3. Plasticity index
4. Particle size analysis
5. Compaction test (Heavy Compaction)

## 6. Moisture content

The results obtained in the compaction test on the fraction passing, the 20 mm sieve shall be adjusted as follows where the fraction is less than 95% of the soil. The maximum dry density shall be adjusted to  $(\% \text{ passing } 20 \text{ mm} \times \text{test maximum} \times 0.01) + (\% \text{ retained on } 20\text{mm} \times \text{specific gravity of particles retained on } 20\text{mm} \times 0.009)$ . The optimum shall be adjusted to  $(\% \text{ passing } 20 \text{ mm} \times \text{test optimum} \times 0.01) + (\% \text{ retained on } 20 \text{ mm} \times \text{moisture content of particles retained on } 20 \text{ mm after immersion in water followed by drainage but not drying})$ .

### Field Dry Density

Field Dry Density tests shall be carried out by the sand replacement (large pouring cylinder) in accordance with BS 1377 or other suitable water replacement method agreed with the Architect.

### Frequency of Testing (for areas other than roads and parking areas)

#### Filling Materials

For every 300 m<sup>2</sup> of each type and layer of material placed, a complete analysis shall be carried out on material recovered from at least one area selected by the Architect. This analysis shall consist of tests 1 to 6 as defined in the previous clause.

#### 2.8.6 Non compacted Fill

Non-compacted fill shall be non-plastic granular material to the approval of the Architect.

#### 2.8.7 Hardcore

Hardcore shall be granular material free from harmful matter well graded, passing a 75 mm BS sieve with not more than 25% less than 5 mm in size and in any one layer, only one of the following:

- Crushed hard rock or quarry waste,

- Crushed concrete,

- Crushed block or tile, free from old render

Immediately prior to the laying of polythene sheet, hardcore shall be blinded with sufficient sand to fill the upper interstices of the fill and leave the surface smooth and compact.

#### 2.8.8 Existing Service Mains Etc.

The Contractor is to ascertain the routes of any existing service mains under the site. Any such main so ascertained or otherwise discovered on site are to be protected, temporarily supported or permanently re-routed as may be required by the Architect.

Care is to be taken in all excavation work to avoid unnecessary disruption of public supplies.



## **3.0 CONCRETE WORK**

### **3.1 GENERAL**

Unless stated otherwise, the provisions, of the BS8110 Part 1, for The Structural Use of normal reinforced concrete, shall be held to be incorporated in this specification and is referred to as BS8110 in subsequent paragraphs.

The work is to be carried out in accordance with drawings, sketches, specifications and instructions which are issued to the Contractor by the Architect at the start and during the course of the Contract. The Contractor shall examine all details before commencing the work and in the case of a discrepancy, he shall refer to the Architect before proceeding. The workmanship throughout the work shall be the best possible and to the satisfaction of the Architect.

### **3.2 AGGREGATES**

#### **3.2.1 General**

Aggregates for concrete shall consist of naturally occurring materials complying with the requirements of BS 882, and shall consist of sound, hard, clean, durable sand gravel or stone, whole or crushed or a combination thereof. They shall be of high crushing strength, and free from adherent coatings such as clay, earth, vegetable and organic matter, alkaline or acid reactions, bituminous or any other deleterious matter or impurities.

Aggregates shall not contain harmful materials such as iron pyrites, coal, mica, shale or similar laminated materials, or flaky or elongated particles in such a form and in sufficient quantity to affect adversely the strength or durability of the concrete, or any materials which will cause expansion in the concrete after hardening has commenced or taken place or in addition to the above for reinforced concrete, any materials which might attack the reinforcement.

Aggregates shall comply with the Mechanical Properties in BS 882 and in addition, the flakiness and elongation indices when determined by the method described in BS812 shall not exceed 40 for 40mm aggregates nor shall it exceed 30 for 20 mm aggregates for concrete up to grade C25. For concrete of higher grade these indices shall be less than 25.

The amount of material passing a 0.075 mm BS sieve shall not exceed 3% by weight of the the natural fine aggregate, 7% by weight of the crushed fine aggregate and by 1% by weight of the coarse aggregate.

The sulphate content as SO<sub>3</sub> (Sulphur Trioxide) of both the fine and coarse aggregates shall not exceed 0.25% of the dry weight of the aggregate.

The chloride content of the fine aggregate shall not exceed 0.10% by weight and of the coarse aggregate shall not exceed 0.05% by weight. However, if the above limit is exceeded, the material shall still be considered acceptable provided that:

a. the total acid soluble Chlorides (as NaCl) in the whole mix shall not exceed 0.32% by weight of cement in the mix, irrespective of the origin of the chlorides.

b. the sulphates in the aggregates shall not more than double that present in the cement and the total acid soluble sulphates (as SO<sub>3</sub>) in the whole mix shall not exceed 4.0% by weight of cement.

Prior to commencing the work, the contractor shall submit to the Architect for his approval, samples of aggregates, details of sources of supply and details of the type of crushing and/or screening machinery he proposes to use. No aggregates are to be used until such approvals have been given by the Architect.

#### **3.2.2 Grading of Aggregates**

The grading of coarse and fine aggregates when tested in accordance with BS 882 are to be within the limits defined in Tables 4 and 5 or to such gradings as the Architect may require or deem necessary having regard to the availability of materials locally. The impact value of the coarse aggregate determined in accordance with BS 812 shall not exceed 25% by weight.

#### **3.2.3 Soundness**

When the coarse aggregate is subjected to five successive cycles of the sodium or magnesium sulphate soundness test, as described in the relevant method of test in ASTM-C88, the weighted loss shall not exceed 12% or 18% respectively.

When the fine aggregate is subjected to five successive cycles of the sodium or magnesium sulphate soundness test, as described in the relevant method of test in ASTM-C88, the weighted loss shall not exceed 10% or 15% respectively.

### **3.2.4 Storage of Aggregates**

Aggregates shall not be stored in contact with the ground and shall be protected against the intrusion of the ground and other foreign matter. There shall be a physical partition between the store-heaps of fine and coarse aggregates and between separate heaped sizes of coarse aggregate which may have been segregated for mix control.

Aggregates which in the opinion of the Architect are not clean or which have become mixed due to the defective storage shall be removed from the site immediately.

## **3.3 CEMENT**

### **3.3.1 General**

No cement shall be used until the supply has been approved by the Architect and the approved source of supply shall not be changed without the written permission of the Architect.

Portland Cement grade 42.5 is to be used and shall be normal setting, of the specific gravity, fineness and chemical composition described in BS 12 and to be capable of satisfying the tests specified therein.

Sulphate resisting cement shall conform to BS4027 and shall be capable of satisfying the tests specified therein.

The tricalcium aluminate content of any cement shall not exceed 10.0%.

The total alkali content, expressed as the soda ( $\text{Na}_2\text{O}$ ) shall not exceed 1.2%.

The sulphuric anhydride ( $\text{SO}_3$ ) content shall not exceed 2.5% when the C3A content is 5% or less. If the C3A content is greater than 5%, then the total  $\text{SO}_3$  content shall not be greater than 3%.

The specific surface (fineness) when determined by the method specified in BS 12 Appendix A shall be at least 225  $\text{m}^2/\text{Kg}$ .

The heat of hydration when determined by the method specified in BS 1370 Appendix H, shall not exceed 70 cals per gram when tested at 7 days nor exceed 80 cals per gram when tested at 28 days.

Certificates of cement tests by the manufacturers shall be submitted to the Architect before the work commences. Where cement is obtained from an indirect supplier, the Architect may, alternatively, require tests on the cement to be carried out, where manufacturer's test certificates are not available.

### **3.3.2 Delivery of cement**

Cement bags shall be clean, sound and of adequate strength to permit handling and clearly marked with the name of the supplier and the type of cement contained therein. Cement shall be delivered in the manufacturers bags unless the written permission of the Architect is obtained for delivery in bulk by means of purpose made bulk delivery containers.

Such permission will only be given in cases where the contractor has available on the site proper bins or silos for the storage of the cement.

### **3.3.3 Storage of Cement**

Each consignment of cement delivered to site shall be kept separately and the contractor shall use the consignments in the order in which they are received. The cement shall be stored in the bags provided by the manufacturer and bags that have been opened shall be removed immediately.

Cement shall be stored under cover on a floor raised at least 150 mm above ground and care shall be taken to protect the cement from damp or other deleterious influences.

Any cement that fails to comply with the above clauses, and which the Architect considers to have deteriorated as a result of dampness or other causes shall be removed from site immediately.

Prolonged storage of cement on site is to be avoided and any cement stored on site for a period greater than 21 days shall be liable to rejection by the Architect and, if so directed, the Contractor shall remove such cement from site at his own expense.

## **3.4 REINFORCEMENT**

### **3.4.1 General**

Steel fabric reinforcement shall comply to the requirement of BS 4483 and shall be delivered to the site in flat mats.

Hot rolled mild steel bars and hot rolled deformed high yield bars shall comply with the requirements of BS 4449.

Where indicated by "R" on drawings and schedules, the reinforcement shall be mild steel bars with a minimum yield stress of 250 N per  $\text{mm}^2$ .

Where indicated by "Y" on drawings and schedules, the reinforcement shall be high - yield steel bars grade B500C according to EN1992. Recent Mill certificates must be provided to assure the quality of the reinforcement before the Contractor brings the reinforcement on site. Tests of the reinforcement after it is brought on site will be carried out according to following paragraphs.

Hard drawn mild steel wire shall comply with the requirements of BS4483.

Tying wire shall either be:

- a. 1.6 mm diameter soft annealed iron wire, or
- b. 1.2 mm diameter stainless steel wire

The source of reinforcement shall be approved by the Architect, and the Contractor shall submit rolling mill test certificates prior to proceeding with the work. If non-British steel is used, the contractor must satisfy the Architect that it complies with the above-mentioned British Standard.

Should the results of any test prove unsatisfactory, then the reinforcement may not be used in the works, and any of that consignment which has been delivered shall be removed from the site or otherwise disposed of as directed by the Architect.

### **3.4.2 Storage of Reinforcement**

Reinforcement of all types shall be stored on site in an approved manner so as to avoid damage on timber sleepers raised at least 300mm above ground.

All reinforcement shall be free from loose scale, rust, oil, grease or any other matter that may impair the bond between the concrete and the reinforcement. If required by the Architect, the reinforcement shall be thoroughly cleaned with wire brushes and immersion in chemicals.

### **3.4.3 Bending of Reinforcement**

The Contractor shall prepare bending schedules for all parts of the work, based on the drawings and sketches provided by the Architect. These shall be submitted to the Architect for approval. All reinforcement shall be bent sufficiently in advance of the concreting programme. Bending of reinforcement shall be in accordance with BS 4466. All reinforcement shall be bent cold. Rebending of high yield reinforcement shall not be permitted.

The Contractor shall provide facilities on site for bar cutting and bending.

The Architect may require tests to be conducted on a random sample of bars selected by the Architect. These tests shall comprise:

- a. Tensile test (in accordance with BS EN 10002-1)
- b. Bend tests (in accordance with BS4449)

For each test 3 specimen lengths (of approximately 2 metres) from each of 8, 10, 12, 16, 20 25 and 32mm diameter reinforcing bars shall be taken.

The Contractor is to allow for the cost and execution of one such set of tests for each consignment. If the test results show that the steel does not comply with the relevant British Standard, the Contractor shall be responsible for carrying out at his own expense further tests as required by the Architect, until it is established that the material proposed is complying with the relevant British Standard.

### **3.4.4 Placing of Reinforcement**

All reinforcement shall be rigidly fixed in position and the concrete cover shown on the drawings shall be carefully maintained. The placing of spacers and chairs shall comply fully with the requirements of Report CS101 of the Concrete Society.

Where concrete cover blocks are used to maintain cover, they shall not exceed 50 mm square in section and shall be securely wired to the reinforcement to ensure that they are not displaced when the concrete is poured. They shall be made of similar mix proportions and strengths as the adjacent concrete.

If it is necessary to provide "chairs" or other subsidiary reinforcement not shown on the drawings to keep the reinforcement in position, the contractor shall not be entitled to additional payment for providing same. The concrete cover to any subsidiary reinforcement shall not be less than that over the reinforcement adjacent to it.

At intersections, the reinforcement bars shall be bound together with tying wire and the loose ends of the wire shall be turned towards the inside of the member.

No splices shall be made in the reinforcement except where described in the drawings or where approved by the Architect.

The Contractor shall provide adequate scaffold boards or similar to ensure that the reinforcement is not displaced by being walked upon during the placing of the concrete or other operations.

### **3.5 WATER**

Water used for mixing concrete and water for spraying aggregates and shutters, for curing and like purposes shall be clean and free from oil, grease, vegetable matter or other organic impurities. Potable water must be used for all these purposes.

The maximum content of dissolved chemical impurities shall not exceed two parts per thousand. When required by the Architect, the quality of mixing water shall be determined in accordance with the requirements of BS3148.

In sampling water for testing, care shall be taken that the containers are clean and that samples are representative. Water from public reticulation systems for human consumption shall be accepted without further test.

Prior to the commencement of concreting and subsequently once every three months, the Contractor shall sample and test the water supply for the presence of sulphate and chloride salts. The amount of dissolved solids in the water shall also be checked on a weekly basis by conductivity methods during the period when concrete work is being carried out, and any significant change in the amount of dissolved solids recorded shall be immediately investigated by further testing for sulphate and chloride salts.

If at any time when tested with universal indicator, the water supply has a pH value outside the limits of 5.5 to 8.5 then the Architect shall be informed and the water shall be tested in accordance with the recommendations of BS 3148 in order to determine the acceptability of the supply for further use. In the interpretation of the test results, the Architect's decision shall be final.

### **3.6 CONCRETE QUALITY**

#### **3.6.1 General**

Mixes for the classes of concrete shown in Table 3.6.1 shall be designed by the Contractor. The class is denoted by the minimum 28 days work cube strength and the maximum size of aggregate.

The mix shall be designed generally in accordance with the requirements of BS 8110.

The cement content in any mix shall not exceed 550 kg per cubic metre of concrete. The quantity of water shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

Complete calculations for the mix proportions and the information and assumptions on which they are based, shall be submitted to the Architect before any preliminary strength cubes are made. The maximum free water to cement ratio shall not be greater than 0.5 by weight of cement.

#### **3.6.2 Design Mix Details**

All concrete in contact with the ground shall be protected with a continuous impervious membrane of 300 microns thick or three coats of bitumen emulsion as approved by the Architect and applied strictly in accordance with the manufacturer's instructions. Where concrete is specified to be made with sulphate resisting cement the mix shall be designed with maximum water/cement ratio of 0.45.

Mass concrete shall be grade C15 with 20-5 mm nominal size coarse graded aggregate.

The design mix details table 3.6.1 gives the minimum cement content for each type of concrete. The exact quantity of cement to give the specified concrete strength shall be determined in accordance with BS8110.

#### **3.6.3 Trial Mixes**

Trial mixes shall be made of three separate batches of concrete for all mixes specified. Cube results attained from these mixes shall be tested in accordance with BS 1881.

No structural concrete shall be placed in the works until the relevant mix has been approved by the Architect.

Any adjustments found to be necessary shall be made in accordance with the provision of BS8110, and are subject to the approval of the Architect.

When the mix has been approved by the Architect, no variations shall be made in the proportions, the original source of the cement and the aggregate, or in the type, size and grading zone of the latter, without the consent of the Architect who may under these circumstances require further tests to be made.

#### **3.6.4 Admixtures**

The use of admixtures and additives to promote workability or any other purpose shall only be allowed with the prior approval in writing of the Architect. Where such approval is given, the additive shall be applied strictly in accordance with the manufacturer's recommendation.

Additives containing calcium chloride shall not be permitted.

### 3.6.5 Mixing Concrete

Unless otherwise agreed by the Architect, concrete shall be mixed in an approved type of mechanical weigh batcher. No hand mixing will be allowed.

The weighing and water-dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerance described in BS1305 and checked against accurate weights and volumes when required by the Architect.

**Design Mix Details Table 3.6.1**

#### Mix Designation

Characteristic strength of concrete	N/mm <sup>2</sup>	20	25	30
Specified works cube strength at 28 days	N/mm <sup>2</sup>	20	25	30
Specified works cube strength at 7 days	N/mm <sup>2</sup>	16	20	24
28 day target mean strength (Standard deviation = 4.0 N/mm <sup>2</sup> )	N/mm <sup>2</sup>	27.0	32.0	37.0
28 day target mean strength without evidence of standard deviation. Margin taken to be 15.0 N/mm <sup>2</sup>	N/mm <sup>2</sup>	35	40	45
Maximum coarse aggregate size mm	20	20	20	
Minimum Cement content	kg/m <sup>3</sup>	320	360	390

#### Notes:

1. For sulphate resisting concrete use sulphate resisting cement (BS4027)
2. For sulphate resisting concrete minimum cement content to be increased by 40 Kg/m<sup>3</sup> for each grade of concrete.
3. The standard deviation of 4 N/mm<sup>2</sup> is the absolute minimum it can be considered under a very high standard of quality control.

The weights of cement and each size of aggregate as indicated by the mechanisms employed shall be within a tolerance of  $\pm 2$  percent of the respective weights per batch agreed by the Architect. The weight of the fine and coarse aggregates shall be adjusted to allow for the free water contained in the fine and coarse aggregates which shall be determined by the Contractor by a method approved by the Architect immediately before mixing begins and further as the Architect requires. The materials shall be mixed until they are uniformly distributed and the mass is of uniform consistency and colour but in no case shall the mixing time be less than two minutes after all the materials have been added to the drum. The drums of all mixers shall revolve at the speeds recommended by the manufacturers.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Unless otherwise agreed by the Architect, the first batch of concrete throughout the mixer shall then contain only two thirds of the normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

### 3.6.6 Ready mixed concrete

Ready mixed concrete from an approved central mixing plant may be used provided it complies with the requirements of this specification, with respect to materials, proportions, water/cement ratio, slump and strength, and in addition complies with the requirements of BS5328.

The concrete shall be brought to site in an approved type of agitator truck and during transport it shall be agitated continuously at the rate specified by the manufacturer of the truck as the agitating speed.

### 3.6.7 Pumped concrete

If it is the Contractor's intention to transport concrete by pumping, he is to obtain the Architect's written approval at the commencement of the contract. The foregoing clauses on mix design shall apply equally to concrete that is designed to be "pumped".

### 3.6.8 Quality control of concrete

A slump test shall be carried out in accordance with the requirements of BS 1881 whenever the Architect may require it and in any case not less than the average rate of one test per 25 cubic metres of concrete mixed on site, or one test per load of ready-mixed concrete. The water/cement ratio shall be the minimum necessary for workability.

The slump shall be 75 mm for all grades of concrete, and 100 mm maximum for pumped concrete.

Works test cubes shall be 150 mm cubes, made, cured and tested in accordance with the requirements of BS1881 from samples of concrete taken from the point of deposition. Samples shall be taken for every 25 cubic metres of concrete placed with a minimum of one sample taken every day on which the mix is used. From each sample, 5 cubes shall be made, one for testing seven days after casting and 4 for testing

twenty-eight days after casting. Higher or lower rates of sampling may be implemented at the discretion of the Architect taking into account the nature of the work.

The results of tests shall be analysed in accordance with the procedure laid down in BS8110.

All cubes shall be clearly marked with the date of casting and accurate records shall be supplied to the Architect, stating the dates of taking and testing samples, together with the results of tests and the exact position from which the sample was taken.

If ready-mixed concrete is supplied from more than one plant, then, the number of test cubes stated shall relate to each plant.

If, in the opinion of the Architect, from the evidence of the cube test, the concrete is not likely to be capable of fulfilling its purpose, the Architect shall require 3 cores to be taken from the area represented by the test cubes. The actual location shall be decided by the Architect. These cores shall be taken and tested in accordance with the requirements of BS 1881 and if the average of the three cores when reduced to the corrected equivalent test cube strength at 28 days falls below the specified strength, further cores are to be cut in order to determine the extent of the unsatisfactory concrete. The volume of concrete shown to be below the required strength shall be taken out and replaced. All the above costs shall be at the Contractor's expense.

#### **3.6.9 Cost of testing**

The cost of provision of manufacturer's certificates and acceptance testing, of mix design testing and of routine quality control testing of materials and concrete as required shall be deemed to be included in the Contractor's rates.

### **3.7 FORMWORK**

#### **3.7.1 General**

Formwork shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support.

All formwork shall be designed and so constructed that there shall be no loss of material from the concrete or unacceptable deflection. After hardening, the concrete shall be in the position and of the shape, dimensions and surface finish described in the Contract.

All formwork whether metal or timber shall be securely placed and supported to prevent ragging and bulging. All joints are to be closed to prevent leakage of liquid from the concrete, with special care being taken where vibration of concrete shall take place. Formwork panels shall have true edges to permit accurate alignment at sides and provide a clean line at the construction joints in the concrete.

All propping to formwork shall be positioned so that it does not overstress any part of the completed structure. The props shall be left in position until the new construction is sufficiently strong to support its own weight together with additional incidental loads.

Formwork shall be constructed so that the side forms of members can be removed without disturbing the soffit forms.

Unless otherwise stated on the drawings, the formwork to all slabs and beams shall be constructed with the following upward camber:-

Beams and slabs spanning between supports - 7 mm for every 5 m of span

Cantilever beams and slabs - 12 mm at free end for every 3 m of span

Where internal metal ties are permitted, they or their removable parts shall be extracted without damage to the concrete and the remaining holes filled with latex modified mortar.

#### **3.7.2 Formed surface - Classes of finish**

The classes of finish for formed surface shall be as follows:

##### **3.7.3 Sawn Formwork (Type A)**

This shall be designed formwork or moulds of closely jointed sawn boards or other approved material. Small blemishes due to entrapped air or water shall be allowed but the surface shall be free from voids, honeycombing or other large blemishes.

##### **3.7.4 Wrought formwork for "Fair Face" Finish (Types B, C and D)**

Where concrete is described as having "Fair Face" finish it shall have a "Type E" finish to the surface in accordance with BS8110.

This finish shall be a high quality hard smooth finish resulting from a high quality concrete with forms or moulds having a hard smooth finish. The concrete surface shall be smooth with true clean arrises and only very minor surface blemishes shall be allowed with no staining or discolouration from release agents. Whilst the concrete is still green, fill all surface blemishes with a fresh specially prepared cement and fine aggregate paste. Every effort shall be made to colour match the concrete. After the concrete has been properly cured,

the faces shall be rubbed down where necessary to produce a smooth, even and uniform-textured surface. The Contractor shall ensure that permanently exposed concrete surfaces are protected from rust marks, spillage and stains of all kinds.

#### **3.7.5 Type B**

Formwork type B is to be wrought timber with joints tightly butted and regular in pattern. Where two or more widths are used on one face, they are to be equal and joints between lengths are to be staggered.

#### **3.7.6 Type C**

Formwork type C is to be formwork lined with waterproof oil tempered plywood or approved equivalent material, to give a perfect smooth finish.

#### **3.7.7 Type D**

Formwork type D is to be formwork of wrought tongued, grooved and vee-jointed boarding in 100 mm widths with joints tightly butted and regular in pattern with staggered longitudinal joints, the whole to produce a smooth patterned surface to the approval of the Architect.

#### **3.7.8 G.R.P. Formwork**

Formwork for fair faced waffle floor slabs, should be of G.R.P. standard waffle pans. The required dimensions and grid to be as per detail drawings.

#### **3.7.9 Sand Blast Finish**

The inside surfaces of the forms shall be coated with an approved retarding agent. The agent must be used strictly in accordance with the manufacturer's instructions and must not come into contact with the reinforcement.

Once the formwork has been struck and whilst the concrete is still green, the surface of the concrete must be blasted in an approved manner to expose the aggregate.

#### **3.7.10 Preparation of formwork before concreting**

The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed by the Architect, be coated with an approved material to prevent adhesion of the concrete. Release agents shall be applied in accordance with the manufacturer's instructions and shall not come into contact with the reinforcement. Mould release agents shall not be used on formwork to concrete which shall be visible in the finished works. When concrete surfaces are to receive an applied finish, the Contractor shall ensure that the release agent used shall not effect the finish or bonding to the concrete.

Immediately before concreting, the contractor shall ensure that all wire clippings, dirt, shavings, loose concrete and any other refuse has been removed.

#### **3.7.11 Unformed Beds**

The classes of finish for unformed beds shall be as follows:

##### **1. Tamped Finish**

The concrete shall be uniformly levelled and screeded to produce a plain or ridged surface as described in the contract. No further work shall be applied to the surface unless it is used as the first stage for a floated or trowelled finish.

##### **2. Floated Finish**

After the concrete has hardened sufficiently, the concrete tamped surface shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

##### **3. Trowelled Finish**

When the moisture film has disappeared and the concrete has hardened sufficiently only to prevent laitence from being worked to the surface, a tamped surface shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

#### **3.7.12 Removal of Formwork**

The Architect shall be informed in advance when the contractor intends to strike any formwork.

The time at which the formwork is struck shall be the contractor's responsibility, but the minimum periods between concreting and the removal of forms shall be as follows:

Sides of beams, walls and columns	- 24 hours
Soffits of slabs (Props left in)	- 5 days
Removal of props to slabs	- 10 days
Soffits of beams (Props left in position)	- 10 days
Removal of props to beam soffits	- 21 days

The periods stated above, are based on a constant surface temperature of the concrete of 16°C and the use of Ordinary Portland or Sulphate Resisting Cement. They shall be increased during colder weather or reduced during hot weather as directed by the Architect and may be changed if other types of cement are

used subject to the Architect's agreement.

If props are to be left in place when the soffit forms are removed, these props shall not be disturbed during the striking.

All formwork shall be removed without damage to the concrete. Where it is intended that formwork is to be re-used, it shall be cleaned and made good to the satisfaction of the Architect, prior to it being permitted for re-use.

#### **3.7.13 Ties**

The contractor shall submit to the Architect for approval details of any ties or cast in fixings that he proposes to use in connection with his formwork. Any embedded metal ties shall not have any part of the tie closer to the finished concrete surface than the specified thickness of cover to the reinforcement. Holes left after removal of any ties shall be filled with latex modified mortar.

### **3.8 TRANSPORT AND PLACING OF CONCRETE**

#### **3.8.1 General**

The method of transporting and placing concrete shall be to the approval of the Architect. Concrete shall be so transported and placed that contamination, segregation or loss of constituent materials does not occur.

All formwork and reinforcement contained in it shall be clean and free from standing water immediately before the placing of the concrete.

Concrete shall not be placed in any part of the structure until the Architect's approval has been given.

The contractor must give 24 hours notice to the Architect for pre-pour inspection. Any inspections made by the Architect do not relieve the Contractor from his liability to replace materials which prove to be faulty and do not comply with this Specification.

If concreting is not started within 24 hours of approval being given, approval shall again be obtained from the Architect. Concreting shall then proceed continuously over the area between construction joints. Fresh concrete shall not be placed against in-situ concrete which has been in position for more than 30 minutes, unless a construction joint is formed in accordance with this Specification. Where in-situ concrete has been in place for 4 hours, no further concrete shall be placed against it for a further 20 hours. Concrete when deposited shall have a temperature of not less than 5 °C and not more than 30degrees C except with the approval of the Architect. It shall be compacted in its final position within 30 minutes of discharge from the mixer unless carried in purpose made agitators, operating continuously, when the time shall be within 2 hours of the introduction of water to the mix and within 30 minutes of discharge from the agitator provided the Architect is satisfied that the concrete can be placed at the required workability.

Except where otherwise agreed by the Architect, concrete shall be deposited in horizontal layers to a compacted depth not exceeding 300 mm and each layer shall be well consolidated before the subsequent layer is placed. Concrete shall not be dropped into place from a height exceeding 2 metres. When trunking or chutes are used, they shall be kept clean and used in such a way as to avoid segregation. Concrete shall not be pumped or discharged through aluminium or alloy conduits. Concreting shall be carried out continuously and no concrete shall be placed on concrete which has sufficiently set as to cause the formation of seams or planes or weakness within the section. Where concrete cannot be placed continuously, joints as specified shall be formed, only where shown on the drawings or approved by the Architect.

In case where the Contractor may consider a local increase in workability desirable, such increase may not be obtained by increasing the water content of the mix. It may, if authorised, be obtained by the addition of a mortar consisting of sand and cement in equal proportions mixed to the necessary consistency but not having a water/cement ratio exceeding that in use of the concrete mix or by the addition of an approved plasticiser.

During placing of concrete in reinforced concrete work, a competent steelfixer shall be present.

No concrete shall be placed in flowing water. Underwater concrete shall be placed in position by tremies or by pipeline from the mixer. Full details of the method proposed, shall be submitted in advance to the Architect and his approval obtained before placing begins. Where the concrete is placed by tremie, its size and method of operation shall be in accordance with BS8004 "Code of Practice for Foundations". During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended until the Architect permits them to continue.

#### **3.8.2 Compaction of concrete**

All concrete shall be compacted to produce a dense homogeneous mass. Unless otherwise agreed by the Architect, it shall be compacted with the assistance of mechanical vibrators, and sufficient mechanical



vibrators in serviceable condition shall be on site so that spare equipment is always available in the event of breakdowns.

Mechanical vibrators shall be of the immersion type capable of producing not less than 10,000 cycles per minute or of the external type capable of producing not less than 3,000 cycles per minute.

No vibrator shall be operated by a workman who has had insufficient training in its use.

With immersion vibrators, the tubular part of the tool shall be inserted vertically into the full depth of the concrete to be vibrated at points 600 mm apart and at least 100 mm away from any formwork. The vibrators shall be kept constantly moving whilst in action to prevent segregation. Vibration shall not be applied directly or through the formwork or reinforcement to sections or layers of concrete which have taken their initial set or concrete which has ceased to become plastic under vibration. Vibration shall be stopped after the decrease in volume is no longer apparent or before localised areas of grout or laitence are formed. Should the supply of concrete from the mixer be interrupted, the vibrators shall be lifted clear for the work.

The size of the vibrating probe shall be as recommended by the appropriate Code of Practice.

### **3.8.3 Curing of concrete**

Immediately after compacting and for 7 days thereafter, concrete shall be protected against harmful effects of weather, including rain, rapid temperature changes, frost and from drying out. The methods of protections used shall be subject to the approval of the Architect.

The method of curing used shall prevent loss of moisture from the concrete and shall be in accordance to clause 6.6 of BS8110 Part 1. On concrete surfaces which are to be water-proofed curing membranes shall not be used. Details of all curing shall be fresh well water. Where water is used for curing concrete work buried in the ground, care shall be taken to avoid excessive curing water from running below the foundation or the footing.

All concrete during setting and hardening shall be protected from shock, vibration or damage from any cause. Where damage does occur, all remedial work and consequential delays shall be at the Contractor's expense.

### **3.8.4 Special measures for hot weather working**

The contractor shall take special measures in hot weather to ensure that the temperature of the concrete when deposited does not exceed 30°C and it shall not be placed when the shade temperature exceeds 43°C. Such measures are to be approved by the Architect and shall include some of, or if necessary all of the following:-

a. With respect to aggregates

Aggregate stock-piles sited in shade even if this has to be provided temporarily. Watering of stock piles shall not be permitted.

b. With regard to water

(i) Water for mixing obtained from the coolest possible economic source and may be cooled with ice or other means subject to the Architect's approval.

(ii) Water storage tanks sited in shade, permanent or temporary

(iii) Storage tanks insulated or buried below ground where site conditions permit.

(iv) all distribution pipes, or water trucks, insulated, or painted white.

c. With respect to cement

(i) the cement store shall be sited in the shade

d. With respect to mixing and placing concrete

(i) the mixing plant and all delivery equipment sited in shade wherever possible and organised in such a way that the interval between mixing and placing is the absolute minimum.

(ii) where shade is impossible provide equipment painted white and/or mixer drum insulated.

(iii) immediately before concrete placing, formwork, reinforcement, cable ducts, etc, sprinkled with cool water fit for human consumption.

e. With respect to curing and protection:

(i) proper curing with adequate protection from sunlight maintained continuously for a minimum period of 7 days.

(ii) Exposed surfaces always and, where practicable, shuttering protected from direct sunlight.

(iii) For most curing, the concrete shall be completely covered with absorbent material which shall be maintained in a wet condition by applying water in the form of a fine spray.

(iv) Membrane curing sheets of impermeable material shall be fixed in close contact with the concrete as soon as practicable after casting. If any drying has occurred, the hardened concrete shall be completely saturated with a fine spray before fixing the membrane. The edges and lapped points shall be held down to prevent the circulation of air.

(v) Sprayed curing compounds will not normally be permitted on surfaces which are to receive an applied finish. Where permitted they shall contain a fugitive dye to given visual indication of even and complete application.

### **3.8.5 Watertight concrete for water storage**

Where the concrete is described as watertight on the drawings and details, the contractor is responsible for ensuring that the resulting construction is watertight. In the event of any leakages, the Contractor must carry out, at his cost, any remedial work required by the Architect.

All water retaining structures shall be constructed in accordance with BS8007 "Code of practice for the design of Concrete Structures for retaining aqueous liquids".

All concrete work shall comply with BS8110 "Structural Use of Concrete", BS8102, "Code of Practice for Protection of Structures against water from the ground" and this Specification.

The combined aggregates used in the concrete mix shall have an absorption of not greater than 3% measured in accordance with BS812, "Testing aggregates".

The concrete shall be a designed mix grade C30, or as previously described with the addition of a plasticiser and waterproofing agent in the proportion recommended by the manufacturers, and all to the approval of the Architect.

Where holes are required through watertight construction, they are to be formed by casting in puddle flanged sleeves of a suitable diameter approved by the Architect.

All concrete so described shall be vibrated with internal vibrators and all construction joints and movement joints shall be provided with water stops.

All concrete kickers shall be cast monolithic with the structure and shall be 150 mm high. The contractor shall forward to the Architect a layout of the positions of all joints in the watertight concrete construction for approval prior to commencement of work on site.

PVC or rubber water stops to the approval of the Architect shall be incorporated at all joints, and as shown on the drawings.

Particular attention is required to ensure the concrete is compacted around the water stops to avoid honeycombing and damage or displacement of the water stops.

Internal water stops shall be held firmly in position during casting by means of split stop ends or other approved methods. External water stops shall be securely anchored so that movement does not take place during casting. Details of all water stops to be used in the works shall be submitted to the Architect for approval. Any leakage of the joints shall be made good to the Architect's satisfaction and the cost of such work shall be at the Contractor's expense.

### **3.8.6 Oversite Blinding Concrete**

Oversite blinding concrete shall be laid with its top surface free of projecting aggregate, irregularities or ridges and shall be satisfactorily smooth so that polythene sheeting or bituminous membrane can be laid on the surface of the blinding without risk of puncturing or tearing.

### **3.8.7 Tolerances**

The following tolerances must not be exceeded. Any work which falls outside the specified limits shall be liable to be condemned and to be demolished and reconstructed at the Contractor's expense. Any consequential costs arising from delays etc shall also be borne by the contractor.

- (i) Member section - dimensions in each direction  $\pm 5$  mm.
- (ii) Position of members - centre lines in each direction  $\pm 5$  mm.
- (iii) Vertical misalignment of members in each direction in storey height  $\pm 5$  mm.
- (iv) Horizontal misalignment of members (Lozenging)  $\pm 5$  mm.

Note: - These tolerances shall not be cumulative and the maximum vertical misplacement of any horizontal surface shall not exceed  $\pm 10$  mm.

## **3.9 EXPANSION JOINTS**

The expansion joints in concrete structures shall be formed by means of a closed cell filler board cast between the two adjoining edges of concrete.

All joints in the filler board shall be taped to prevent concrete seepage.

The Contractor must ensure that the expansion jointing is not bridged at any point by concrete or other solid matter so that the joint is made ineffective.

At exposed faces, of expansion joints, the filler shall be cut back on completion of the structure and the joint sealed with a closed cell extruded polyethylene foam and a sealant suitable for use in warm countries. The sealant shall conform to BS4254 or BS5212 and shall be non-slumping.

The sealant shall be applied in accordance with the manufacturer's printed instructions. Colour to be approved by the Architect.

For water retaining structures, PVC or rubber water stops shall, in addition, be used at the expansion joints, as shown on the drawings. Generally, expansion joints will be 30 mm wide.

### **3.10 CONSTRUCTION JOINTS**

The positions of construction joints are to be as indicated on the drawings unless otherwise agreed by the Architect and shall be so arranged as to minimise the possibility of occurrence of shrinkage cracks.

Surfaces of existing concrete are to have the aggregate exposed with a light power tool over all contact areas except within 25 mm of permanently exposed faces. This operation is not to be carried out until the concrete has been in position for more than 24 hours.

All loose materials shall be removed.

The face shall be thoroughly saturated with water so that the construction joint is in a saturated, but surface-dry condition. The use of grout or mortar on the joint shall not be permitted.

### **3.11 PROTECTIVE MEMBRANE**

All concrete in contact with the ground shall be protected by a continuous impervious membrane, double folded and taped at the joints and sufficiently robust to avoid being damaged by the placing and compaction of backfill material. The membrane shall consist of a 300 microns thick polythene sheeting or three coats of bitumen emulsion as approved by the Architect.

The membrane shall be applied strictly in accordance with the manufacturer's instructions, and to the approval of the Architect.

### **3.12 CAST-IN FIXINGS AND SUNDRY ITEMS**

The Contractor shall be responsible for accurately casting in the concrete work or fixing to the formwork any fixings, ties, dowels, slots, holding down bolts etc., required for securing blockwork, precast concrete work, steelwork or electrical and mechanical services for other trades and suppliers.

Provision shall be made for forming holes, chases, ducts, rebates, the building in of pipes, conduits and other fixings as shown on the drawings. Holding down bolts and washer plates shall be firmly set in the formwork in taper boxes, polystyrene blocks or other approved sleeves as shown on the drawings. After concreting, but before the concrete has set, the bolts shall be ruled and loosened so that they are free to move in the finished work.

### **3.13 PRECAST CONCRETE**

#### **3.13.1 Manufacture of precast reinforced members**

The Architect's approval to the method of manufacture shall be obtained before work is started. When the method has been approved, no changes shall be made without the consent of the Architect.

The Contractor shall inform the Architect in advance of the date of commencement of manufacture and casting of each type of member. A copy of all 28-day cube test results relating to the work shall be sent to the Architect as soon as they become available. Where the Architect requires tests to be carried out, no members to which the tests relate shall be despatched to the site until the tests have been satisfactorily completed.

All members shall be indelibly marked to show the Member Mark as described in the Contract, the production line on which they were manufactured, the date on which the concrete was cast and, if they are of symmetrical section, the face which will be uppermost when the member is in its correct position in the works. The markings shall be so located that they are not exposed to view when the member is in its permanent position.

#### **3.13.2 General requirements for precast concrete work**

The materials and workmanship, handling and erection for precast concrete units generally shall comply in all respect with this Specification and the following additional requirements:-

##### **(a) Execution of Works**

All reinforced concrete units shall be manufactured on site or at a factory approved by the Architect which has the necessary facilities for ensuring compliance with all provisions for this Specification. The Architect shall have the right to visit the works where the units are manufactured at all times during manufacture and

shall be given the necessary facilities to inspect the work and satisfy himself that work complies with this Specification and to carry out such tests as may, in his opinion, be necessary. The Architect does not engage in any liability to supervise the work, but reserves the right to make such periodical visits to the place of manufacture as he may deem to be necessary, if any.

Any inspections made by the Architect do not relieve the contractor from his liability to replace material which proves to be faulty and does not comply with this Specification.

(b) Test Cubes

One set of three standard test cubes shall be made each day or as instructed by the Architect. The test cubes shall be marked with the date of casting, quality of mix, and unit from which cubes are taken, and shall be tested as instructed by the Architect.

(c) Testing

The Contractor shall provide suitable facilities for testing by direct Loading, if required, such units as may be selected by the Architect. The test consists of loading the units and noting its deflection until it breaks or until its resistance is demonstrated to be within the design limits. The Architect reserves the right to select certain precast units which shall be broken up to enable the reinforcement to be examined.

All units broken for testing purposes will be paid for at contract rates unless found defective in which case no payment will be made whatsoever. No member to which the tests relate shall be despatched to site until the tests have been satisfactorily completed.

(d) Finish to concrete

The faces of all units which are required to form a joint with in-situ construction shall be left well roughened to ensure that an adequate key will be obtained. Exposed faces shall comply with the particular specification issued and with approved samples which shall be submitted prior to starting bulk manufacture.

(e) Fittings

Fittings, bolts and timber plugs are to be cast in the units where indicated on the drawings. All bolts cast in are to be supplied complete with 1 No. standard nut/washer.

(f) Construction Joints

Each precast unit shall be constructed in one operation. No construction joints are to be formed unless ordered in writing by the Architect.

(g) Reinforcement

The contractor shall be responsible for ensuring that the reinforcement as detailed and scheduled accurately fits the units with the concrete cover specified on the working drawings. Before commencing general cutting and bending of the reinforcement, the contractor shall assemble a prototype cage of reinforcement for each type of unit in order to ascertain any adjustments which may be necessary due to possible creep in bending or for any other reason. In the event of the contractor requiring amendments to the working details and/or bar bending schedules in order to effect such adjustments or assist his casting programme, he shall immediately inform the Architect who shall determine the extent to which such revisions are permissible.

(h) Lifting and movement of units

Approval must be obtained from the Architect, before casting commences, for proposed positions of lifting holes and/or points of attachment of lifting slings.

The units shall not be lifted from their bed and shall not be loaded and transported to the site until the concrete has attained a sufficient strength to enable this to take place without danger of any cracking or other damage to the concrete. The contractor shall be responsible for all damage to units caused by premature lifting from the moulds, unsuitable provision for lifting operations, or premature transit, and all units thus damaged shall be replaced at the expense of the contractor. The Architect reserves the right to prohibit lifting or transport of units which are, in his opinion, insufficiently matured, but the consent of the Architect to the transportation of units does not relieve the contractor from his liability to make good any damage so caused.

(i) Transport of units

The units shall be suitably packed and transported to the site by approved means so designed that the units are completely protected against damage and unduly high adverse stresses during transit.

(j) Delivery of units

Adequate lifting facilities for unloading at site shall be provided in order to ensure that the units are not damaged during this operation. All units delivered to site shall be subject to inspection by the Architect before being hoisted into position in the contract works and any defective units shall be rejected.

(k) Hoisting of units

Hoisting shall be carried out with suitable appliances so designed as to avoid damage to the units.

**3.15 DEFECTIVE WORK**

Any construction work which fails to comply with the requirements of this specification in all respects shall be liable to be rejected and demolished and reconstructed at the Contractor's expense. Any consequential costs arising shall also be borne by the Contractor.

## **4.0 STRUCTURAL STEELWORK**

### **4.1 GENERAL**

The design fabrication and erection of all structural steelwork shall comply with the requirements of EN 1993 and the connecting requirements with all the Euronorms EN1990 to 1999 and their relevant modifications. For matters not covered by the Euronorms, BS5950 Parts 1 & 2 : 1985. These codes shall be deemed to be part of this specification.

The Architect shall not provide further drawings and details other than those provided in the Tender Drawings.

The contractor shall carry out and be responsible for the designing and detailing of the connections and joints between structural members where these are not otherwise shown on the Tender Drawings. Information on the loadings for which the connections are to be designed shall be provided by the Architect.

### **4.2 FABRICATION (SHOP) DRAWINGS**

The contractor's fabrication drawings together with calculations for the connections shall be submitted to the Architect for approval at least six weeks before fabrication is to be carried out. These drawings shall be based on the Tender drawings and on any further written design or other information provided by the Architect, and precise measurements that the Contractor has to carry out on site. The Architect shall verify the correct interpretation of the design and the requirements but shall not be responsible for the accuracy of the drawings prepared by the contractor.

Fabrication of the steelwork shall not commence until the drawings have been amended to take account of any comments which may be made by the Architect.

Notwithstanding any approval of the fabrication drawings which may be given by the Architect, the Contractor shall remain responsible for the correctness of the fabrication details and the adequacy of his designing for the joints and connections.

On completion of the steelwork erection, the contractor shall supply to the Architect, one copy negative of each of his fabrication drawings.

### **4.3 MATERIALS**

#### **4.3.1 Steel Sections**

Steel plates, sections, bars and hollow sections for structural steelwork purposes shall comply with BS 4360 and shall be to the grade specified on the drawings.

#### **4.3.2 Manufacturer's Certificates, Samples and Testing**

The contractor, when requested by the Architect, shall provide certificates from the manufacturer to confirm that the chemical composition and the mechanical properties of the steel are in accordance with the appropriate British Standards. If required by the Architect, facilities shall be provided for the Architect's inspection, at the place of manufacture of the items being produced for the works, for the selection of the Architect of samples for testing in accordance with EN 1993 and the relevant Euronorms & BS 4360 and for the witnessing of tests for evaluating mechanical properties of the steel.

#### **4.3.3 Dimensions and Dimensional Tolerances of hot rolled sections**

Structural steel hollow sections, and equal and unequal angles, shall comply with the dimensions and dimensional tolerances given in EN 1993 and BS4848 : Parts 2 & 4.

#### **4.3.4 Surface defects**

The correction of surface defects in rolled steel sections shall be limited to that covered by the EN1993 and the relevant Euronorms & BS 4360 unless otherwise approved by the Architect.

#### **4.3.5 Dimensional tolerances of plates bars and flats**

The dimensional tolerances of plates, flat bars and wide flats shall be in accordance with EN1993 & BS4360 except that the tolerance on thickness shall be wholly over the thickness shown on the drawings unless otherwise specified.

#### **4.3.6 Steel for Welding**

Steel to be used in built-up welded assemblies or at welded connections shall have maximum carbon equivalent value appropriate to the grade of steel in accordance with the Euronorms & BS4360 where this may be required for the avoidance of Hydrogen cracking in welds unless the contractor's proposed welding procedures are such as to make this requirement unnecessary.

#### **4.3.7 Ultrasonic testing for plates and flats**

Steel plates and flats which may, as a result of welding be subject to lamellae tearing shall be quality graded by ultrasonic testing using equipment as described in section 2 of British Standard draft for development DD2L and unless otherwise specified or agreed, be of quality grade A01 as defined in that document.

#### **4.3.8 Fasteners - General**

Zinc coated fasteners shall be used internally and externally or where built into walls. Fasteners shall be selected for the type, grade and class required.

#### **4.3.9 Friction grip bolts**

Where specified, as HSFB bolts shall be high strength friction grip bolts, with appropriate nuts and washers for the grade of bolt specified, shall comply with the requirements of BS4395: parts 1 and 2, and are to be hot dip galvanised to BS 729. Load indication washers shall be used in all cases.

#### **4.3.10 Black bolts and screws and nuts**

Black bolts, screws and nuts, where specified, shall comply with BS4190 for bolts of Grade 4.6 and bolts of Grade 8.8 shall comply with the relevant Euronorms. The grade of bolts shall follow the requirements specified on the Tender drawings:-

#### **4.3.11 Washers**

Washers for use with black bolts shall comply with BS4320. Plain washers shall be made of steel. Taper or other specially shaped washers shall be made of steel or, subject to the Architect's approval, malleable cast iron.

#### **4.3.12 Mechanical properties of bolts nuts and washers**

The contractor shall provide satisfactory evidence that the mechanical properties of all bolts, nuts and washers comply with the requirements of the appropriate European or British Standard.

### **4.4 FABRICATION**

#### **4.4.1 General**

The Architect shall have access at all reasonable times to all places where work is being carried out, and shall be provided by the Contractor with all necessary facilities for inspection during fabrication and off-site assembly.

All materials, before and after fabrication, shall be straight unless required to be curvilinear in form, and shall be free from twists and other defects. Any necessary straightening or shaping shall be carried out by methods that neither weaken nor circumstantially deface the material.

At all stages of fabrication, structural steel shall be positively identified by grade, either by colour marking or by other approved marking system.

#### **4.4.2 Cutting**

Where the ends of members are to bear in compression, the ends shall be cold sawn and then machined so that the loads are evenly transmitted over the entire area of the section. In all other cases, cutting may be by shearing, cropping or sawing.

Notches or other shaping to the ends of members shall be formed by cold or hot sawing. Machine flame cutting may be used only where approved, in writing by the Architect. Manual flame cutting shall not be allowed under any circumstances.

Edges shall be free from any defects which would adversely affect the serviceability of the member. All burrs and similar defects shall be carefully removed. The edges of flame cut plates shall, unless otherwise agreed by the Architect be machined to remove notches, the heat affected zone or both.

#### **4.4.3 Clearances**

Care shall be taken to ensure that the clearances specified are worked to. The erection clearance at ends of beams without web cleats shall not be more than 3 mm at each end, but where, for practical reasons, this clearance has to be increased, the seatings shall be suitably designed.

#### **4.4.4 Holes for fasteners**

Holes for fasteners shall not be formed by flame cutting. Holes for the assembly of built-up sections shall normally be drilled after the members have been assembled and tightly clamped together.

Where this is not practicable, holes shall be drilled or, subject to the Architect's approval, may be punched to a diameter at least 2 mm less than the required size and reamed after assembly to the full diameter.

All burrs shall be removed from holes before assembly except that, where holes are drilled in one operation through parts which would not otherwise be separated after drilling, the parts need not be separated to remove the burrs provided that the holes are for black bolts only.

Finished holes for black bolts shall not be more than 2 mm in diameter larger than the diameter of the bolt passing through them for bolt diameters up to 24 mm and not more than 3 mm larger than the diameter of the bolt for diameters over 24 mm unless otherwise specified by the Architect or required by the design.

Where friction grip bolts are used and the number of plies in the grip does not exceed three, the size of the hole shall be as above. If the number of plies exceeds three, the holes in the two outer plies shall be as above and the diameter of the hole in the inner plies shall not be more than 3 mm larger than that of the bolt.

Slots, where specified or permitted, shall be formed using a proper slotting machine. Alternatively, holes may be drilled and the metal between removed by filing or other approved method provided that the surface between the circular end is even and straight. Provision shall be made to prevent the ingress of moisture to the interior of sealed hollow members where these are holed for bolts. Holes for fitted bolts, pins or rivets shall be in accordance with clauses 3.4 & 3.5 of BS5950 Part 2.

#### **4.4.5 Machining of butts**

Butt joints of compression members dependent on contact for the transmission of compressive stresses, shall be accurately prepared to butt, so that the permitted stress in bearing is not exceeded nor eccentricity of loading created which would induce secondary bending in the members.

#### **4.4.6 Moment Connections**

Where beam end moment connections are formed by the use of fabricated Tee sections or end plates to beam flanges, the bearing faces of the Tee section table plates or the end plates shall be machined so that after fabrication they shall provide a tight bearing contact on the surface of the element to which they shall be attached.

The Contractor shall ensure that when the Tee sections are attached to the top and bottom flanges of the beams they shall be accurately aligned to bear tightly against the element to which they shall be attached.

#### **4.4.7 Slab bases and caps**

Slab bases and slab caps, except when cut from material with true surfaces, shall be accurately machined over the bearing surfaces and shall be in effective contact with the end of the stanchion. A bearing face which is to be grounded direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes of not less than 40mm diameter shall be provided in stanchion bases for the escape of air. The grouting shall be a polymer cement based no shrinking and high flow mortar and of the Architect's approval.

#### **4.4.8 Marking**

Each piece of steelwork shall be distinctly marked before delivery, in accordance with a marking diagram, and shall bear such other marks as shall facilitate erection.

#### **4.4.9 Bolting**

The parts to be jointed shall be firmly drawn together. Where necessary, washers shall be tapered or otherwise suitably shaped to give the bolt heads and nuts a satisfactory bearing. Washers shall be provided under each bolt head and nut unless otherwise agreed.

The length of each bolt and the length of thread shall be such that after tightening at least 6 mm of thread projects through the nut and at least one full thread remains clear between the nut and unthreaded shank.

All matching holes shall register with each other so that the bolt can be inserted freely through the assembled members in a direction normal to the faces in contact. Drifting to align the holes shall not distort the metal or enlarge the holes.

Friction grip bolts complying with BS4359 shall be used in accordance with BS4604. On installation, galvanised high strength friction grip bolts shall be lubricated with beeswax to prevent galling in the threads. Load indicating washers shall be used in accordance with the manufacturer's recommendations and the gap tightening shall be such that the bolt shank tension shall not be less than the minimum required for the particular size and grade of bolt.

##### **4.4.9.1 Bedding down**

After assembly all bolts in the joint shall be tightened with the bedding torque as given below, using a calibrated tightening device such as a break back spanner or a torque controlled impact wrench. The Contractors attention is drawn to the fact that during tightening of any one joint the first bolts tightened may relax and may be necessary to re-tightened each bolt more than once until the bedding down torque is achieved.



Bolt designation	Bedding Torque Nmm
M16	74
M20	144
M22	195
M24	248
M27	316
M30	429
M36	752

#### 4.4.9.2 Inspection

Before final tightening the Architect shall be informed so that he may check that the bolts have been correctly bedded down.

A tolerance of +/- 15% on the specified bedding down torque will be permitted to allow for slight variations in the calibration of the devices used for tightening and checking.

### 4.5 WELDING

#### 4.5.1 General

Welding shall be in accordance with the relevant Euronorms and/or BS5135. Welding procedures shall be in accordance with the relevant Euronorms and/or BS 4870 : Part 1 and BS 4871 : Part 1 and BS4872:Part 1 as appropriate.

#### 4.5.2 Electrodes

Low hydrogen basic coated electrodes to BS 639 shall be used in the following cases:

- i) For the welding of steel to BS 4360 grades 50B and 50C
- ii) For butt welds in steel to grades 43C and 43D
- iii) For the root run of butt welds in steel to grades 43B in tension flanges > 26mm thick.

#### 4.5.3 Welders and welding procedures

The contractor shall submit in writing, for the Architect's approval, details of his proposed welding procedure for each type of welded connection providing information in respect of the relevant items (A) to (H) of clause 3 of BS 5135 and particulars of the preparation of the fusion faces. Approval testing of each welding procedure shall be carried out in accordance with BS 4870 : Part 1 unless acceptable authentic documentation, relating to experience gained with the welding of similar connections, is available.

Approved testing of welders working to each welding procedure shall be carried out unless not more than six months has elapsed since the welder was last tested on the approved or similar procedure and has continued to produce satisfactory welds as verified by non-destructive testing.

Unless shown otherwise on the drawings, all butt welds shall be complete penetration welds made between prepared fusion faces.

In the fabrication of built-up assemblies, all butt welds in each component shall be completed, whenever possible, before the final assembly.

Where butt welds are specified as being ground flush, there shall be no loss of the parent metal as a result of the grinding.

Weld spatter shall be removed from the surface of the steelwork and pre-welding protective coating, if any, by grinding, chipping or other approved method.

Stud shear connectors, where specified, shall be welded in accordance with the manufacturer's instructions.

#### 4.5.4 Testing

Full strength butt welds and other critical welds, as noted on the drawings, **shall be 100 percent examined** by radiography, ultrasonic, magnetic or other non-destructive method suitable for the type of weld and its location. All other welds shall be visually examined, with the aid of optical instruments, if necessary, and at least 10 percent of the weld shall be examined using a suitable non-destructive method. Tests shall be carried out by a specialized laboratory and test reports shall be submitted before the approval of the steel work and the implementation of other materials that will cover the welded joints.

#### 4.5.5 Quality of Welds

Weld metal shall be properly fused to the parent metal without serious undercutting or overlap at the toe of the weld and shall be free from any type of crack.

Welded joints shall be rejected if any of these defects are present and if the examination of the welds reveals lack of penetration, lack of inter-run fusion, slab inclusions, work holes or porosity such that would impair the strength of the weld and the service performance of the structural member.

#### **4.5.6 Weld Repairs**

Defective weld metal including any damaged parent metal shall be removed and the weld remade using a method approved by the Architect. The repaired weld shall then be examined by an agreed non-destructive method.

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are provided.

Fitted stiffening angles or plates to flanges or sections or brackets shall be accurately shaped to fit the profile of the member to be stiffened.

Unless protection against corrosion is provided by other means, the interior of any hollow member, whether a structural hollow section or a fabricated member, shall be sealed so as to prevent the ingress of moisture.

#### **4.6 ERECTION**

The contractor shall prepare a scheme of erection for submission to the Architect for approval as soon as possible after placing the contract.

The scheme shall include drawings, calculations and descriptions to enable the Architect to assess the suitability and sufficiency of the proposals.

All structural steel shall be transported, stored and handled so that it is not subjected to excessive stress or damage. Special attention shall be given to the handling of steel at low temperatures in order to avoid brittle fracture.

All plant and equipment to be used for erection shall have adequate capacity and be suitable for the contractor's erection procedure.

Where steelwork has been painted or received any other protective coating prior to delivery to the site, the maximum precautions shall be taken to avoid damage to the paint of the protective coating during loading, transporting, unloading, stacking and erection. Slings, ropes and chains shall be rubber sheathed or similar precautions taken during the handling of the steelwork.

Steelwork stored on site shall be raised from the ground on timber bulks or otherwise protected to avoid mechanical damage to, and chemical contamination of the protective coating.

Before commencing erection of the steelwork, the contractor shall check the setting out and levels of the concrete supporting structure, fixing bolts and other bearings for the steelwork. He shall also examine the area and conditions under which the steelwork is to be installed.

If discrepancies or inaccuracies in site works are found which affect the steel frame erection and its correct position in relation to the concrete work, these shall be drawn to the attention of the Architect.

Once the contractor has accepted the supporting structures and ancillary works, he shall accept full responsibility for the accuracy and setting out of the steel work and fitting of all members.

The positioning, levelling and plumbing of the steelwork and the placing of every part of the structure shall be within the specified tolerances and to the satisfaction of the Architect.

Each part of the structure shall be aligned as soon as possible after it has been erected. Members shall not be permanently connected until a sufficient part of the structure has been erected to ensure that they will not be displaced during the erection or alignment of the remainder of the structure. The erection of the steelwork shall be carried out in accordance with the recommendations of BS5531, Code of Practice for safety in erecting structural frames. During erection of the structure, the steelwork shall be securely bolted or otherwise fastened so as to make adequate provision for all erection loads and conditions including loads due to erection equipment and its operation.

Any temporary supports such as bracing, guys and props shall remain in position until such time as the structure is sufficiently far advanced for the temporary supports to be no longer required.

Connections for temporary supports and measures to facilitate handling and erection shall be provided in a manner which does not weaken the permanent structure or impairs its serviceability.

The Architect shall have access at all reasonable times and shall be provided with all necessary facilities for the inspection of the structure during all stages of erection.

#### **4.7 TOLERANCES**

##### **4.7.1 Straightness**

Unless otherwise specified, all steel members, before erection, shall not deviate from straightness by more than the values derived from the relevant Euronorms and/or British standards.

Hollow sections, angles and built-up members shall not deviate from straightness by more than 1/500th on the overall length.

#### **4.7.2 Length**

Unless otherwise specified, the length of a member shall not deviate from its intended length by more than the following:

- (i) For compression members faced at both ends for bearing  $\pm 1$  mm.
- (ii) For other members  $\pm 2$  mm.

For members such as trusses or lattice girders, these tolerances apply to the member as a whole. The length of component parts shall be such that the member can be properly assembled to the required accuracy.

#### **4.7.3 Setting Out and Erection Tolerances**

The setting out, plumbing and levelling of steelwork shall be carried out in a manner so as to be within the following maximum deviations:

(i)  $\pm 3$  mm for the centre of a support from its true position in relation to either centre line but not more than is necessary for the connection of any beam truss or lattice girder to the bearing on the support.

(ii)  $\pm 1.5$  mm from the specified levels as shown on the drawings.

(iii)  $\pm 6$  mm for the overall length and width of the structure.

### **4.8 INSPECTION PRIOR TO GROUTING**

The grouting up to the holding down bolts and base plates for the structures, or any part thereof, shall not be carried out until the Architect has approved the setting out and erection. The Architect shall be given 24 hours notice of the time when the structures or part thereof are ready for his inspection.

### **4.9 PROTECTIVE COATINGS AGAINST CORROSION**

#### **4.9.1 General**

Steelwork shall be protected against corrosion by the application of metal paint or other specified coatings as shown on the drawings and specified below. The preparation and the application of the protective coatings shall be carried out generally in accordance with the recommendations of BS5493, Code of Practice for the protection of iron and steel structures against corrosion.

The protection system for all structural steelwork, including steelwork internal to buildings, shall be suitable for a polluted coastal atmosphere as defined in BS 5493 and shall be suitable for the meteorological conditions prevailing at the Site.

The protection system shall have a typical time to first maintenance of 10 to 20 years after application of the final coat, i.e. a 'long' life as defined in Table 3 of BS 5493.

If the Contractor wishes to offer an alternative protection system he shall submit with his Tender the technical information necessary to specify the system he proposes. The design of this alternative shall conform with the recommendations of BS 5493, and shall be suitable for a polluted coastal atmosphere as defined in BS5493 for both internal and external steelwork.

#### **4.9.2 Paint**

The formulation of paint shall comply with B.S.5493.

All paints forming any one painting system shall be obtained from one manufacturer and the source of supply shall not be changed. Paint shall be supplied in sealed containers and shall be used in strict order of delivery.

#### **4.9.3 Metal Coatings**

Sprayed metal coatings shall comply with the requirements of BS 2569: Part 1. Aluminium coatings shall be material G1C and zinc coatings shall be material Zn3.

Hot dip galvanised coatings shall comply with the requirements of BS 729: Part 1. The nominal thickness of coating shall be 0.1mm, i.e the minimum coating weight shall be 610g/m<sup>2</sup>.

#### **4.9.4 Blast Cleaning**

The surface of structural steelwork shall be blast cleaned to at least second quality finish in accordance with BS7079 or quality SA 2.5 to Swedish SIS 05 59 00, maximum surface profile 100 microns.

Oil grease and dirt shall be removed from the surface of the steel before blast cleaning is commenced. Where galvanising or sprayed metal coating is specified, the cleaning and preparations of the surface shall be carried out using one of the methods described in Clauses 3.2 to 3.12 of CP3012, Code of Practice for cleaning and preparation of metal surfaces, or other approved method.

Any laminations and surface defects exposed must be chipped off, ground and re-blasted before priming. The substrate shall be wire brushed and vacuum cleaned to remove all abrasive dust and debris.

#### **4.9.5 Blast primer**

Within two hours of blast cleaning and before any deterioration of the blast cleaned surface apply to the whole of the clean dry surface, including edges and angles, one full coat of a two pack chemical-resistant epoxy primer to reference KP1A of BS5493 such as EPIGRIP L425 HS Zinc Phosphate Primer, or equal approved, to achieve a minimum dry film thickness of 75 microns.

#### **4.9.6 Undercoat**

After the minimum specified overcoating time and within four days, apply by brush, roller or airless spray one full coat overall, ensuring complete coverage of angles and edges, of a two pack chemical-resistant epoxy undercoat to reference KUIB of BS5493 such as EPIGRIP L653 HI-Build, or equal approved, to achieve a minimum dry film thickness of 150 microns.

#### **4.9.7 Finish**

Apply a two pack chemical-resistant epoxy finish such as EPIGRIP M347 sheen finish or equal and approved to achieve a minimum dry film thickness of 50 microns and applied at site within 4 weeks of undercoating. Allow to dry and apply a polyurethane resin based coating such as RESISTEX M 137 special finish or equal and approved to achieve a minimum dry film thickness (d.f.t.) of 35 microns.

#### **4.9.8 Repairs to Damaged Surfaces**

Areas of paint that have been damaged shall be repaired strictly in accordance with the manufacturer's recommendations or if no recommendations are made they shall be cleaned to bare metal, or to metal coating where this has been applied, and the edges of the undamaged paint bevelled with sandpaper.

Where metal coating has been damaged, the affected area shall be rubbed down to remove excessive roughness, cleaned and made good by the application of a coat of approved zinc rich primer. The full specified painting system shall then be applied in such a manner that the new paint overlaps the existing paint by at least 50mm.

#### **4.9.9 Workmanship**

Paints or coatings shall be applied by brush, airless spray or other method approved by the Architect.

Each painter shall be skilled and experienced in the method he is using and the supervisor shall be skilled in each method under his control.

Paint shall not be applied to any surface until that surface has been prepared and cleared to receive the following coat and damage to previous coatings has been made good.

Paint shall not be applied to a previous paint coat until that coat has dried and cured sufficiently to receive it. Any maximum time limit between coatings specified by the manufacturer shall be strictly adhered to.

If this time is exceeded, the surface shall be prepared by a method recommended by the manufacturer to provide an adequate key for the following coat.

The thickness of each coat and the overall thickness of protection shall not be less than the thickness specified. Stripe coats shall be applied to edges or other areas where the application may result in thinly applied coatings, if necessary, to ensure that the full specified coating thickness is achieved.

The environmental conditions shall be such as not to affect the application or the characteristics of the paint. The manufacturer's recommendations shall be strictly followed. In particular, coatings shall not be applied to surfaces where the relative humidity of the atmosphere is such that:

(i) Condensation is present on the surface

(ii) It will affect the application and/or drying of the paint

When a rising relative humidity reaches a value that produces either of the conditions (i) or (ii) above, the application of coatings shall be suspended and during the time that the relative humidity remains at or exceeds that value, work shall not be started or resumed.

Work shall be suspended when sea-spray, dust or other pollutants are contaminating the surface and the surface shall be properly cleaned and prepared before work resumes. Coatings shall be protected during drying and curing from the deposition of moisture, dirt, dust and atmosphere pollutants.

#### **4.9.10 Treatment of Welded Connections**

The whole surface of the steel shall be blast-cleaned and primed where a weld-through blast primer is used. For other primers and for metal sprayed steelwork, the coating shall be kept back from the weld by 25 mm or greater width as necessary to suit the depth of the weld.

Each coat of a multi-coat system shall be stepped back by 30 mm or other dimension recommended by a coating manufacturer to enable effective making good of the protective system following completion of the weld.

#### **4.9.11 Treatment of bolted connections**

The facing surface of the steelwork at friction grip bolted connections shall be masked during the application of paint coatings. The masking shall remain as temporary protection and be removed immediately before assembly. Where galvanising is specified, the facing surface shall be roughened to improve the slip coefficient before the masking is applied.

The masking adhesive shall be such as not to cause contamination and all traces of the adhesive shall be removed before assembling the connection.

All surfaces for bolted connections are to be prepared and painted after assembly or erection to the full protection specification. The paint shall have a suitable overlap on existing painted surface which shall be prepared to provide an adequate key.

Crevices at joints and gaps at load indicating washer shall be sealed with high built paint or mastic, compatible with the coating system.

#### **4.9.12 Defects**

Protective coatings which on completion are found to be defective as a result of inferior preparation, quality of materials and/or standard of workmanship or which show signs of early degradation by blistering, peeling, flaking, cracking or lack of adhesion, shall be applied to the complete structural member unless remedial work on a patch basis is permitted by the Architect.

Where tests on completion indicate that the full dry film thickness of the protective system has not been achieved, additional coatings may be applied, subject to the Architect's approval to achieve the specified thickness provided that all measures are taken to ensure inter-coat adhesion and an additional finishing coat, if required, shall form part of the painting specification.

#### **4.10 PROTECTION DURING SHIPMENT AND TRANSPORT**

The fabricated steelwork shall resist, without permanent damage, all stresses induced by handling, storage and transport.

The positions of lifting and supporting points, method of lifting and the type of equipment and transport to be used shall be specified by the Contractor.

It shall be the Contractor's responsibility to ensure that all the fabricated steelwork shall not be subjected to excessive stress or damage during transport and shipment.

During transport and shipment of the units, the following additional factors shall require consideration:

- (i) Distortion of the transporting vehicle
- (ii) Centrifugal force due to cornering
- (iii) Oscillation, to prevent the members flexing vertically or horizontally sufficiently to cause damage
- (iv) The possibility of damage due to chafing.

#### **4.11 TRIAL ASSEMBLY**

Before commencing shipment of the steelwork, the contractor shall check the assembly of the manufactured components, in accordance to the approved fabrication drawings.

Any necessary straightening or shaping shall be carried out by methods that neither weaken nor deface the structural material.

It shall be the contractor's responsibility to ensure that all the fabricated structural steel delivered to site shall meet the design requirements and approved fabrication drawings.

#### **4.12 PAYMENT FOR TESTING**

The contractor shall include in his rates for the cost of providing and using equipment for the non-destructive testing of welds (radiographic, ultrasonic, dye penetrant and magnetic particle), during fabrication and on site as required by the radiographic films and other test results and reports available to the Architect.

## **5.0 BLOCKWORK AND BRICKWORK**

### **5.1 MATERIAL**

Cement and water shall be as specified in "Concrete Work".

Sand for mortar shall be clean sharp coarse grain which is naturally occurring. The sand shall be free from salts and other foreign matter and shall conform with BS1199 and 1200 and be well graded from 5 mm down.

Lime shall be non or semi-hydraulic lime complying with BS 890 and shall be prepared and stored in accordance with appropriate requirements of BS5628 Part 3. A plastisizer other than lime can only be used with the prior approval of the Architect.

### **5.2 CLAY BRICKS**

Where reference is made in this specification to brickwork, it implies walling constructed with perforated building bricks.

Clay bricks are to be perforated building bricks, hard, sound, well burnt, square, to CYS19, as manufactured by the Limassol Brick and Tile Factory to approved samples and shall be of dimensions 300x200x100 mm.

### **5.3 PRECAST CONCRETE BLOCKS**

The precast concrete blocks shall be manufactured in accordance with BS6073 Part 1 and shall be obtained from an approved manufacturer.

The blocks shall be as set out in the following table:-

<u>Co-ordinating Size (mm)</u>	<u>Work Size (mm)</u>
400 x 200 x 100	390 x 190 x 90
400 x 200 x 200	390 x 190 x 190
200 x 200 x 200	190 x 190 x 190

#### **5.3.1 Co-ordinating size:**

A size of the space, bounded by co-ordinating planes, allocated to a component, including all allowance for joints and tolerances.

#### **5.3.2 Work Size**

A size of a building component specified for its manufacture to which it actually should conform within specified permissible deviations. The sizes of the blocks will be controlled by the use of GO/NOT Go Gauge box in accordance with BS 6073 to ensure the appropriate work sizes.

The special blocks for reveals and sills are also included in the work sizes mentioned above.

### **5.4 SPECIAL BLOCKS**

For Special blocks and purpose made designs, the Contractor shall follow the Architect's drawings with regard to layout, bonding and coursing, co-ordinated dimensions and general assembly of masonry unit, used in walling.

Blocks used below ground level shall be manufactured with sulphate resisting cement.

Precast concrete blocks shall be made in approved block making machines in the thicknesses required. The materials for all blocks shall be mixed upon a clean mixing platform or in an approved mechanical mixer and shall be gauged with sufficient water to enable the materials to bind together under pressure and thereafter placed in the block making machine in layers not exceeding 75 mm, each layer being thoroughly tamped or, if approved, machine vibrated.

On removal from the machine all blocks shall be protected from the direct rays of the sun in an approved manner and kept wet for ten days after which they may be stacked clear of the ground in the open without protection.

Each batch of blocks shall be marked in a distinguishing manner.

Each day's production of blocks shall be tacked separately and marked in a distinguishing manner with the date stated in both English and Greek. All blocks are to be at least one month old before incorporation into the works. Blocks shall be left with good sharp clean edges.

The contractor shall regularly clean his equipment to ensure proper profile of all blocks.

Work sizes of all blocks shall be in accordance with BS6073.

Blocks selected to be tested are to be marked with paint to identify the batch from which they have been taken.

All blocks of special sizes required to form proper bonding at angles, intersections around openings and in panels, etc., which cannot be made in the contractor's machine may be made in approved wooden moulds. Every block must be clearly and permanently marked to indicate whether "load-bearing" or "non-load bearing".

All solid load bearing blockwork shall be a solid block and not hollow block filled with concrete unless actually described as such.

All non-load-bearing blockwork shall be of hollow concrete blocks or clay blocks as indicated on drawings.

## 5.5 TESTING OF CONCRETE BLOCKS

Testing of blocks shall be in accordance with BS 6073 and the contractor shall submit the results of testing to the Architect at regular, but not less than fortnightly, intervals.

Prior to manufacture, the contractor shall prepare two samples of each block for the Architect's approval and the approved samples shall be clearly marked and retained until completion of the contract.

## 5.6 MORTARS

The cement for mortar, where specifically allowed, shall comply with BS 12 for the above ground works and BS4027 for below ground works.

Fine aggregate shall comply with BS1199 and 1200.

The water for mortars shall be as specified under "concrete work".

Mortar for load-bearing walls shall be a mix measured by volume of one part cement to one half part lime to four parts fine aggregate (1:1/2:4).

Mortar for non-load bearing walls, whether built of concrete or clay blocks, shall be a mix measured by volume of one part of cement to one part lime to six parts fine aggregate (1:1:6).

Mortar for reinforced blockwork shall be one part cement to one half part lime to four parts fine aggregate with mortar fill of one part cement to three parts fine aggregate unless otherwise indicated on the drawings.

Cavity walls below ground level shall have all voids filled with sulphate resisting mortar (1:3). Sulphate resisting concrete shall be used if indicated on the drawings.

### 5.6.1 Mixing of Mortar

The ingredients for the mortars shall be mixed in an approved mechanical batch mixer which shall supply all working points. Other arrangements may only be used with the written approval of the Architect.

Coarse-stuff when authorised shall be mixed thoroughly with the correct proportion of cement immediately before the mortar is required. Water will then be added to bring the mix to a workable consistency.

The minimum quantity of water shall be added to achieve workability but other additives may be introduced as approved by the Architect.

Mortars shall be carried in suitable containers and kept free of foreign matter. The consistency must be maintained. No mortar which has been allowed to set prior to use shall be mixed or used in the works.

### 5.6.2 Testing of Mortar

Preliminary tests and work sample tests, shall be made on the mortar as and when instructed by the Architect during the progress of the work.

Six mortar specimens shall be made for each mix of mortars specified using approved materials. The specimens shall be 75 mm cubes and be clearly marked for identification. Three cubes shall be tested at 7 days and the remaining three at 28 days after preparation. The cubes shall be protected during storage and kept in moist conditions. The testing shall be carried out by a recognised and approved laboratory.

The preliminary test cubes shall exceed the value of the specified cube strength as listed in table 5.6.1 with a maximum individual cube variation of not more than 10% of the average strengths.

**Mortar Mix Table 5.6.1**

Mortar Mix	Mean compressive strength
Cement:Lime:Sand	at 28 days(N/mm <sup>2</sup> )
(by volume)	

1:1/4:4	6.5
1:1:6	3.6

### **5.6.3 Mortar Plasticisers**

The written approval of the Architect must be obtained for the use of plasticisers. The plasticisers shall be obtained from an approved manufacturer and shall be used strictly in accordance with the manufacturer's printed instructions.

### **5.7 WALL TIES**

On the vertical joints, the blockwork or brickwork shall be fixed to concrete elements by the use of stainless steel wall ties at 400 mm centres. These shall be built into the block joints and fire shot to the reinforced concrete elements.

In the cavities, the blockwork or brickwork shall be fixed to loadbearing walls by the use of stainless steel wall ties to BS1243, spaced vertically at 400 mm centres and horizontally at 800mm staggered.

### **5.8 BRITISH STANDARDS AND CODES OF PRACTICE**

The following British Standards are relevant to this Specification and the latest edition shall apply.

BS 12	: Portland cement (ordinary and rapid hardening)
BS890	: Building Limes
BS1199 and 1200	: Building sands from natural sources
BS1243	: Metal ties for cavity wall construction
BS6073	: Precast concrete masonry units
BS4027	: Sulphate resisting cement
BS5628: Part 1 : 1978	: Structural use of masonry
BS5628: Part 3	: Brick and Block masonry

### **5.9 LAYING BLOCKWORK OR BRICKWORK**

All blocks shall be carefully unloaded and stacked on level standings. They must be adequately protected from the weather, contamination and also physical damage. No damaged blocks shall be used. All facing blocks must be unchipped and have perfectly square arrises with unmarked faces. Care must be taken to distribute the load from stacked bricks to the design capabilities of the supporting structure.

The blockwork is designated to be well bonded with even course heights and the contractor shall set out his blockwork as shown on the drawings to be constructed in even regular courses with no cut blocks and to the satisfaction of the Architect.

Facing blockwork shall be kept clean at all times and exhibit uniform texture. Where necessary, the contractor shall protect facing blockwork from damage.

All blockwork or brickwork shall be set out and built to the lines, levels, lengths and heights shown. In specified thickness a tolerance of  $\pm 7$  mm shall be allowed in any storey height or 6 metres of length. All blockwork/brickwork shall be laid in stretcher bond solidly bedded jointed and flushed up in mortar. Where wall faces are to be plastered or rendered, the joints shall be raked out to form a key. No cut half blocks are to be used to form bond.

All blocks are to be thoroughly wetted 24 hours before laying and be protected from the sun until laid. All walls are to be carried evenly course by course. During block laying, an open joint not less than 10 mm wide shall be left between the ends of all concrete lintels whether precast or cast in-site, and the blocks adjacent to those ends. These open joints shall be left as long as possible during construction and not filled in until plastering or other work renders such filling necessary. All such joints shall be properly filled in before completion of the work.

In reinforced blockwork, the maximum height of unfilled void shall not exceed 600 mm.

All wall faces to receive in-situ finishings or cement and sand backings shall be hacked and the joints raked out as necessary to produce an adequate key.

All external and internal wall faces where specified as fair face shall be built with blocks having unblemished surfaces, with good clean arrises to all exposed edges and shall be pointed with a bucket handle joint as the work proceeds, unless otherwise indicated on the drawings.

Blockwork or brickwork shall be raised in a uniform manner so that no portion is more than 1 metre above another at any one time. All perpend, quoins, etc, shall be kept strictly true and square. The whole shall be properly bonded and level on the courses and at each floor.

All cutting of blocks shall be kept to a minimum. High strength blocks shall only be cut with a carborundum wheel or disc.

As the work proceeds, mortar joints on the external face of the walls shall be raked for the subsequent application of the renderings, plasters and tyrolean finish to the satisfaction of the Architect.



Movement joints shall be formed at the places and in the manner indicated on the drawings.  
In periods of inclement weather when the stability of the blockwork or brickwork is in doubt, no further work must be done on a wall and suitable precautions should be taken, to protect the work.

#### **5.10 NON-LOAD BEARING WALLS**

Hollow concrete blocks and clay bricks, shall be used for non-load bearing walling as indicated on the drawings.

Only blocks with a minimum compressive strength of  $7\text{N/mm}^2$  shall be used for non-load bearing walls.

Non-load bearing walls shall not be constructed at the same time as the load-bearing walls but built at least two weeks after the concrete slab formwork is struck. Toothing into load-bearing walls shall not be permitted.

On the vertical joints, the blockwork or brickwork shall be fixed to concrete elements by the use of stainless steel wall ties at 600mm spacing, passing through the joint filler, shot fired to the concrete element and bedded in the blockwork mortar joint.

On the vertical joints, the blockwork or brickwork shall be fixed to load bearing walls by the use of stainless steel wall ties to BS 1243, passing through the joint filler and spaced vertically at 400 mm centres.

Non-load bearing walls shall not be constructed full height, until the concrete slab or beams over have been cast. The wall shall subsequently be built up to within 10 mm of the concrete soffit and the remaining joint isolated by a 10 mm thick Flexcell or equal and approved compressible material.

Metal lathing to BS 1369 Part 1, of 300 mm width, or fibre glass mesh of exterior grade and  $115\text{gr/m}^2$  weight, of 300mm width to be used when non-load bearing blockwork / brickwork is jointed with a concrete member.

This lathing to be nailed to both faces of the member by stainless steel nails before plaster is applied and without damaging the blocks.

A glass fiber wall plaster reinforcement of 300mm minimum width may be used at joints of blockwork or brickwork to concrete elements with the prior approval of the Architect. Such glass fiber shall be of minimum weight of  $115\text{ gr/m}^2$  raw net and mesh width of 10x10mm.

#### **5.11 CAVITY WALLS**

Where both skins of cavity walls are built in blockwork or brickwork, the skins shall be tied together with stainless steel wall ties to BS 1243, spaced at the rate of one every 800 mm horizontally and 400 mm vertically, staggered and every 400 mm vertically at ends, jambs and quoins.

Where cavities of cavity walls are formed between blockwork or brickwork and concrete, the blockwork skin shall be tied at every other course to the concrete by means of stainless steel wall ties to BS 1243, spaced every 800 mm horizontally.

The cavities of hollow blocks and cavities of cavity walls shall be kept clear of mortar and other droppings.

Where required, cavity wall insulation shall be 50 mm thick extruded polystyrene slabs of minimum density of  $32\text{ Kg/m}^3$  and of an approved manufacturer.

On external cavity walls exterior skin shall progress first together with the polystyrene slab attached to it with ties and then followed by the interior skin.

##### **5.11.1 Protection of Cavities**

The Contractor shall submit to the Architect for his approval a method for protecting the cavities of hollow blocks and cavities of cavity walls against concrete falling into these cavities while casting floor and roof slab.

#### **5.12 LOAD-BEARING MASONRY**

Load bearing walls shall be constructed in accordance with BS5628:Part 1.

Only blocks with a minimum compressive strength of  $10.5\text{ N/mm}^2$  shall be used for load-bearing walls.

Where a horizontal or vertical joint is not solidly filled or where it was found that the Contractor used blocks other than the blocks specified, the whole panel of wall will be considered suspect and will have to be removed and rebuilt at the Contractor's expense.

##### **5.12.1 Table of Tolerances for Load Bearing masonry**

<u>Item</u>	<u>Distance Over</u>	<u>Permitted Tolerance</u>
1. Variation from the plumb	Up to 4 m	9 mm
In the lines and surfaces of In any storey walls, piers and in arrises	or 6 m max	18 mm

2.	Variation from the level from grades indicated on the drawings	In 3 m In any bay or in 6 m or more	6 mm
	In the levels of bed joints to receive cast concrete slabs, beams or lintels	In 12 m or more	18 mm
3.	Variation of the linear building lines from established position in plan	In 6 m	12 mm
4.	Variation in the size of wall openings flatness	Any	9 mm
5.	Flatness The maximum deviation from a 1.5 m straight edge placed in any position on a normally plain surface shall not exceed 9 mm	1.5 m	9 mm

### **5.13 LINTELS AND CAPPING BEAM**

The concrete in filling for use in the lintels shall be grade C30 with maximum aggregate size 14-5mm. The 150 mm cubes shall, when tested, produce a minimum crushing strength of 30 N/mm<sup>2</sup> in 28 days.

When the total height of the blockwork or brickwork is greater than 3 metres, a continuous capping beam will be provided at door or window level, connecting all the walls. This beam to be of the same thickness as the wall reinforced as per detail drawings, or as instructed by the Architect.

### **5.14 SAMPLES**

Samples of all blocks are to be submitted to the Architect for his approval. Samples of each type of block will be taken at random from the first consignment of each type for comparison with the initial sample. The approval of the Architect must be obtained before the consignment is used. The samples will be retained by the Architect.

All subsequent deliveries shall be at least equal in standard to the sample taken from the first consignment. Inferior material shall be rejected and shall be removed from the site forthwith at the Contractor's expense.

### **5.15 SAMPLE PANELS**

As directed by the Architect, sample panels approximately 1 metre square in size of blockwork shall be constructed to illustrate the standard and the type of finish required. The approved panels are to be protected from physical damage and shall be used as the standard of appearance which shall be acceptable. Any work not conforming to these standard panels shall be taken down, the materials removed and the work rebuilt at the Contractor's expense and to the Architect's satisfaction.

### **5.16 PROTECTION OF FINISHED WALL**

The Contractor shall ensure that the finished walling is not damaged by subsequent operations.

The Contractor is to protect newly or partially built walling against it being dried out too rapidly by the sun's heat or from any other adverse climatic effects and is to follow the Architect's instructions in this matter. The Contractor shall in all cases cover all newly erected walling with hessian or other material approved by the Architect and shall keep the same wet for at least three days.

The Contractor shall prop and stabilise all walls prior to erection of floors and/or roofs and shall not remove any props without the prior agreement of the Architect.

### **5.17 REINFORCEMENT**

Horizontal reinforcement for blockwork and brickwork walls shall consist of welded wall fabric (wires to BS4483) or galvanised expanded metal wall reinforcement to BS 1369 Part 1 and shall be provided in every four courses, at top of door openings and top and bottom of window openings. The fabric shall consist of two wires 5 mm in diameter with spacing to suit the thickness of wall to give cover to the wires of 25 mm

minimum and cross wires of 3 mm diameter spaced at 300 mm centres.

At corners and junction of walls, horizontal reinforcement shall be lapped to the full width of the wall.

At corners and junctions, the cavities of concrete blocks shall be filled with Concrete C30 aggregate size 14-5mm around a 10 mm diameter reinforcing bar.

Jambs of door and window openings and either side of vertical joints in walls where constructed with concrete blocks, shall have similar vertical reinforcement placed not more than 400 mm from the sides of openings or joints.

#### **5.18 COMPRESSIBLE JOINT FILLERS**

Flexcell joint filler obtainable from Expandite Ltd or similar approved, shall be used where specified on drawings or requested by the Architect.

The joint filler shall be cut to exact widths and shall have all edges neatly trimmed, and recessed as required from all external faces.

Fixing of filler shall be strictly in accordance with the manufacturer's instructions.

#### **5.19 DAMP-PROOF COURSES**

Damp-proof courses for walls shall be bitumen damp-proof course with hessian base to BS6398 type A or as otherwise directed by the Architect.

Damp-proof course for ground bearing slabs shall be polythene sheet 300 microns thick laid under the slab, double folded and taped at joints and jointed to the bitumen coated ground beams and protected against damage during the placing of the reinforcement and placing of concrete.

## **6.0 MASONRY**

### **6.1 MATERIALS**

#### **6.1.1 Stone**

All stone to be the best of its respective kind from a quarry approved by the Architect. Samples of the selected stone shall be obtained and submitted for approval to the Architect which will then represent the range of variations which will be acceptable.

#### **6.1.2 Mortar**

Cement, lime, sand and water shall be as specified in "Concrete Work" and "Blockwork - Brickwork".

Fire aggregate shall be composed of crushed stone of the stone type selected. The proportions of the mix will be determined by the type of stone used, its porosity, hardness etc. and weather conditions and shall be agreed on site. Jointing and pointing shall be carried out with the same mortar and at the same time as the work proceeds. Excess mortar shall be wiped off with a clean rag.

#### **6.1.3 Fixings (where applicable)**

Tying-back and loadbearing fixings and wall ties shall be of austenitic stainless steel to BS5390: 1976 (1984) and BS1243: 1978 respectively.

#### **6.1.4 Adhesives**

Adhesives for stonework facing work shall be "Laticrete 4237" and "Laticrete 3701" grout admixture or similar and approved, applied strictly in accordance with the manufacturer's instructions.

### **6.2 WORKMANSHIP**

#### **6.2.1 General**

All masonry construction shall comply with BS5390: 1976 Code of Practice for stone masonry.

#### **6.2.2 Hoists and lifting equipment**

Hoists and lifting equipment shall be placed on the scaffold by the contractor as required. The contractor is to ensure that all appropriate safety precautions are observed in the use of this equipment, and that all masonry is protected from lifting operations for the duration of the work.

#### **6.2.3 Temporary Protection**

The contractor shall supply, erect and maintain all necessary protective sheeting, foam, stud and rigid sheeting as required to protect the work and working areas during building work and during inclement weather. No ferrous materials are to be used which may result in staining of masonry faces.

#### **6.2.4 Footings**

The stones for footings of any of rubble walls shall be laid as headers and shall be of adequate spread.

#### **6.2.5 Damp-proof courses**

The stonework shall be carefully flushed up with mortar to an even bed to take damp-proof courses where shown on the drawings and the bed on top of the damp proof course shall be free from pebbles or large particles and be of a adequate thickness to accommodate unevenness in the stone. The damp-proof course shall be the full thickness of the wall and left unpointed externally.

#### **6.2.6 Random rubble**

Random rubble stones shall be properly laid and bonded together with mortar to the approval of the Architect.

#### **6.2.7 Faced (ashlar) work**

Stones shall be laid level, plumb, square and true with uniform joints 3 mm thick. The stones shall be dampened as necessary set in full bed of mortar and all vertical joints filled. No hollow beds will be allowed. The beds and joints must be square with the face and arranged at right angles to the pressure exerted up on them. The stones shall be to the sizes and bonded as shown on the drawings. No angle mitred joints will be allowed in any part of the work.

#### **6.2.8 Labours**

Perform all necessary labours such as mortices for dowels, cramps and chases for fixing stonework. All holes and chases executed on site shall be executed by the stone mason.

#### **6.2.9 Protection**

All stonework shall be protected as it is unloaded and stored on site with stacks, straw or other approved material. No damaged stone shall be fixed.

#### **6.2.10 Hoisting**

Hoisting shall be by approved means and care shall be taken not to damage the stone.

**6.2.11 Joggles**

Cement joggle joints shall be formed in side faces of adjacent stones, where required, and to concise of V-shaped sinkings grouted solid with mortar as specified.

**6.2.12 Thresholds**

Thresholds to all doors to be to the sizes indicated on the drawings, stooled both ends, weathered, throated, splayed, rebated and grooved for water bar and mortice for dowels of door frames and rubbed on all exposed faces. Any thresholds under 2m long shall be in one piece.

**6.2.13 Window Cills**

Window cills to be to the sizes indicated on the drawings to BS5642: Part 1: 1978 and shall be grooved for water bar and rubbed on all exposed surfaces.

**6.2.14 Lintels**

Lintels over each window to be to the sizes indicated on the drawings and to BS5977.

**6.2.15 Copings**

Copings to be to the sizes shown on the drawings to BS5642 splayed as shown.

## **7.0 ROOFING**

### **7.1 ROOF SCREEDS (ORDINARY)**

Cement aggregates and water shall be as described in the concrete Specification.

Sand shall be natural sand clean and sharp, carefully sieved and free from earth or clay matter and organic material.

The roof screeds shall be concrete grade C20. The water/cement ratio shall be 0.5.

Roof screeds shall be finished smooth to falls as shown on the drawings. The screeds are to be laid in bays, square where possible, of maximum 9 square metres area. Each bay is to be formed between stop boards of the correct height and cut on each side to indicate the slope required on the roofing. The screed is then to be trowelled with a wood float to true and accurate falls or crossfalls up to the stop boards. A 10 mm wide gap is to be left between each screed bay for the full depth of the screed.

The gaps between the screed bays are to be filled as follows:-

1. Brush or blow out joints to remove dirt, dust, etc and prime the sides of the joints using a piece of sponge or similar dipped in a mixture of equal volumes of bitumen emulsion and water or solvent primer. Allow to dry.
2. Fill up joints slightly proud of the surface using a bitumen mastic.

### **7.2 ROOF SCREEDS (LIGHTWEIGHT)**

Where specified, lightweight roof screeds shall be "Foamcem" lightweight screed of density 400 kg/m<sup>3</sup> minimum, laid to falls as indicated on the drawings. Minimum thickness to be 50 mm at rainwater outlets, all applied strictly in accordance with the manufacturer's specification.

### **7.3 WATERPROOF MEMBRANE TO ROOFS**

Unless otherwise specified, the waterproof membrane to roofs shall be 4mm thick APP modified bitumen, reinforced with non woven spunbond polyester fabric. It shall be heavy duty with a minimum polyester content of 200 g/m<sup>2</sup> and it shall be obtained from an approved manufacturer.

The concrete surfaces shall be dry, regular and free from sharp protrusions, cracks and hollows and they shall be swept free from dust. The membrane shall be laid on properly prepared and primed surfaces strictly in accordance with the manufacturer's specifications. The sheeting shall be carefully dressed into rainwater outlets, overfillets, corners and expansion joints strictly in accordance with the manufacturer's instructions and to the Architect's approval. Side laps shall be 100mm and end laps 150mm wide.

All exposed parts of the membrane shall be protected with two coats of a synthetic resin based coating reinforced with mineral fibres and fillers applied strictly in accordance with the manufacturer's instructions.

### **7.4 ASPHALT WORK**

#### **7.4.1 Materials**

##### **Mastic asphalt**

Mastic asphalt is to comply with BS 6925 for roofing

##### **Sheathing felt**

Sheathing felt is to comply with BS 747 type 4 (A) (1) (bitumen)

##### **Chippings**

Chippings are to be white marble unless otherwise stated

#### **7.4.2 Workmanship**

##### **Asphalt**

Asphalt is to be laid by specialist firm in accordance with CP 144 part 4 for mastic asphalt roofing. Re-melting on site is to be carried out as described in the relevant standards.

Thickness stated is exclusive of keys, grooves and open joints in blockwork and the like.

Chippings are to be evenly distributed and bedded in bitumen.

### **7.5 ROOF INSULATION BOARD**

Roof insulation board 50 mm total thickness unless otherwise specified on the drawings shall be closed cell extruded polystyrene rigid foam board as per BS3837 grade SHD, type A and shall have a minimum density of 32 Kg/M<sup>3</sup> from an approved manufacturer. It shall be laid butt jointed in accordance with the manufacturer's instructions. The insulation boarding shall be protected from wind, uplift, and ultra-violet degradation prior to the laying of the layer of natural gravel, pre-cast concrete paving slabs or any other specified material.

## **7.6 NATURAL GRAVEL LAYER (WHERE APPLICABLE)**

Selected natural gravel shall be 20 mm approximately in size and shall be hard strong durable and smooth pieces with no sharp edges. The stones are to be well washed before laying and to the entire satisfaction of the Architect. The selected gravel shall be placed to form a layer of 100 mm thick on top of the insulation layer.

## **7.7 FLASHINGS TO PERIMETER OF BUILDINGS**

Aluminium flashings are to be in 0.7 mm super purity aluminium to comply with BS1470. The aluminium flashings shall be used as shown on the drawings and dressed down over the upper edge of the bituminous sheeting.

## **7.8 ROOF TO BE WELL GRADED AND -WEATHERPROOF**

Grading/ inclinations shall be done on roofs (on hall roof and Toilets roof) as necessary to prevent stagnation of water. On completion, roofs shall be left sound, weather and watertight and in a neat clean condition before handing over and to a standard which will be to the complete satisfaction of the Architect.

## **7.9 TESTING**

The roofs shall be tested on completion with a minimum of 50 mm water ponding over a minimum period of 24 hours to the entire satisfaction of the Architect.

## **7.10 GUARANTEE**

The Contractor is to obtain a written guarantee of conformity of the materials to be used and submit it for approval before work commences and he is to produce a certificate of origin of the materials. The Contractor shall furnish a 10-year guarantee for completed roofs.

## **7.11 CLAY ROOF TILING**

### **7.11.1 Materials**

All clay roofing tiles, valley tiles, ridges etc shall be of the type shown on the drawings and to be in accordance with samples approved by the Architect.

### **7.11.2 Mortar**

Mortar shall be 1:3 cement:sand

### **7.11.3 Workmanship**

The whole of the roofs indicated on the drawings shall be covered with the tiles specified. Each course shall be laid to the required laps in accordance with the manufacturers printed instructions bedded where required with sand and cement mortar as specified.

At ridges, the half round ridge tiles shall be carefully bedded on to the top course and fully bedded at joints and pointed in cement mortar with a neat flush joint. Care shall be taken to keep the ridge tiles and the top courses clean. Open ends shall be filled with pieces of cut tile bedded and pointed in cement mortar with ends of ridge and cut tiles kept clean.

The hips shall be covered with half round tiles as described, the tails bedded in cement mortar and pointed with a neat joint cut back 6 mm. All visible edges and tiling shall be left clean. The hip tiles shall bond and course with the general tiling.

At abutments carry out all necessary cutting and fitting. No tile shall be cut so that it is reduced in width at any part to less than a full tile in length.

## **8.0 CARPENTRY, JOINERY AND IRONMONGERY**

### **8.1 MATERIALS**

#### **8.1.1 Generally**

The timber shall be clean, straight, sound, of matured growth, thoroughly seasoned, reasonably free from discoloured sapwood, splits, ring shakes, soft pitch, checks, knots of any description in surfaces for staining or polishing and in glazing bars, knots exceeding 2 cm mean diameter on one half the width of the surface, decayed or dead knots unless cut out and plugged, loose knots or knot holes unless cut out and plugged, pitch pockets, decay and insect attack including pinwork holes, excess of wane and other defects and to be sawn die square.

#### **8.1.2 Softwood**

The softwood unless otherwise stated shall comply with EN1995, EN 338, BS 1186 Part 1. Exposed surfaces of timber shall comply with Appendix 8, Clause 1.

Softwood shall be long leaf Pine or European Redwood, Swedish, Romanian or Russian Whitewood or other equal and approved.

#### **8.1.3 Hardwood**

The hardwood for joinery, unless otherwise stated, shall be as indicated on the drawings and shall comply with BS 1186, Part 1 and shall be clean, straight, sound of matured growth, free from discoloured sap wood, shakes, splits, pitchwood, large, loose or dead knots, wane and other defects as before described.

Adjacent members of the construction shall be matched as near as possible, for uniformity of colour, grain, texture and slope of grain.

#### **8.1.4 Temporary Timberwork**

Temporary timberwork may be executed in any timber chosen by the Contractor except rainforest timber who shall remain responsible for the safety and sufficiency of such temporary work. In all cases, the timber for temporary work shall be free from decay or insect attack except that dead pinwork holes may be permitted. The Contractor shall be responsible for clearing away all temporary timber work upon completion.

#### **8.1.5 Moisture Content of Timber**

Softwood shall comply with BS 1186, Part 1 from a source approved by the Architect and shall have a moisture content limit of 12%.

The hardwood shall have a moisture content limit of 10% and shall have been kiln dried.

The whole of the timber for joinery work shall be properly stacked and protected from rain, ground moisture and the sun.

#### **8.1.6 Plywood Blockboard Laminboard and Chipboard**

Plywood, blockboard, laminboard and chipboard shall be obtained from an approved manufacturer to the correct thickness specified. The Contractor will not be permitted to make up the required thickness by gluing together sheets of thinner plywood.

Plywood shall comply with EN1995 and its relevant Euronorms and/ BS 6566 and other boards shall comply with BS5669, BS1142, ISO 1096 to ISO 1098, ISO 2074 and ISO 2426 to ISO 2430.

Veneer shall be of the specified species of timber but where none is specified, it may be of any appropriate species of timber at the Contractor's option. Adhesives shall be to BS 1203 WBP Grade.

Plywood, unless otherwise stated, shall be WBP and equal to samples approved by the Architect.

Chipboard shall be resin bonded with 1 mm veneer.

#### **8.1.7 Plugging to Walls**

Plugging to walls shall be carried out by the following means:

- An approved patent fibre plug fixed in accordance with the manufacturer's instructions.
- An approved plastic filling used in accordance with the manufacturer's instructions
- or
- Hardwood plugs cut on the twist, impregnated with preservative.

#### **8.1.8 Plastic Laminates**

Plastic laminates shall be 1 mm thick high pressure melamine-faced decorative laminate, furniture finish, to be used in conjunction with balancing veneers as specified in the manufacturer's printed instructions.

Laminates and balancing veneers are to be bonded with an adhesive heat-resistant solvent-based contact adhesive.

Laminates, balancing veneers and adhesives are to be applied according to the manufacturer's printed instructions.



### **8.1.9 Nailing and Fixing**

The Contractor shall include nailing and screwing where required, unless otherwise described with suitable nails or pins to the Architect's approval. Nails shall comply with BS 1202. Screws shall comply with BS1210. Other fixing accessories shall comply with BS 1494 as applicable.

### **8.1.10 Timber Preservative**

Water borne preservative shall be copper/chrome/arsenic composition to BS4072 Part 1. Water Repellent organic solvent preservative shall be class F/N solution to BS5707, Part 1. Creosote shall be to BS144.

Application of Water Borne Preservatives by pressure shall be carried out in accordance with the procedures of BS4072 Part 2 to the pressures and periods given for performance category A in table 2 of BS5589.

Application of Organic Solvent Preservative by the Double Vacuum pressure shall be in compliance with the principles of BS5707 Part 3 to the pressures and periods given for performance category A in table 2 of BS5589.

Application of Organic Solvent Preservative by the immersion process shall be done by fully immersing timber in the preservative in compliance with BS5707 Part 3 for periods specified in the relevant Worksection.

Application of Creosote Preservative by pressure treatment shall be in accordance with BS144 to give a minimum net retention not less than that shown in the relevant Table for the timber to be used.

Treatment shall be carried out by specialist firms after all cutting and shaping is completed and care shall be taken to avoid damage to surface of treated timber in subsequent handling. If treated timber is unavoidably cut or damaged, a liberal application of preservative is to be made to the cut or damaged surfaces.

All treated timber is to be dry before incorporation into the works.

### **8.1.11 Glues**

Glues shall be of prime quality, appropriate to their intended use, and shall be used in accordance with the manufacturer's instructions.

### **8.1.12 Ironmongery**

Ironmongery shall be obtained by the Contractor from an approved supplier, and shall be of the type of finish described in the schedules and Bills of Quantities.

Material and finish shall be of the highest quality packed and delivered to site in sets as specified.

Master Key requirements shall be as shown on the Ironmongery Schedules.

Cylinders to doors shall be of an approved type and shall have the same finish as the door furniture.

### **8.1.12 OSB**

OSB (Oriented Strand Board) is an engineered wood-based panel consisting of strands of wood which are bonded together with a synthetic resin; the strands are pressed together in layers. In the outer layers strands are generally oriented longitudinally in line with the panel length, whereas in the middle layers strands generally lie in a cross wise direction.

The wood species used in OSB manufacture must include both softwoods (spruce, pine) and some hardwood. Wood strands have to be cut tangentially from debarked logs which are held longitudinally against rotating knives. The ribbon of strands produced must be about 75 mm wide and this breaks up on handling to produce individual strands which are typically 100 mm along the grain and from 5 to 50 mm across the grain. After drying, strands have to be sprayed with a synthetic resin binder. The resin types include Phenol formaldehyde (PF), melamine fortified Urea Formaldehyde (MUF) or isocyanate (PMDI), all of which are moisture resistant binders.

Density, mass and sheet size

Panel density (and thus panel mass) varies depending upon the product, being affected by the timber species and the manufacturing process. Typical densities are 600-680kg/m.

Contractor shall demonstrate compliance with the legal requirements by showing that their OSB complies with the harmonised standard EN 13986 "Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking". It calls up EN 300 "Oriented Strand Boards (OSB) - Definitions, classification and specifications", which will have to be used when specifying OSB.

Four grades of OSB are defined in EN 300 in terms of their mechanical performance and relative resistance to moisture. These are:

OSB/1 - General purpose boards and boards for interior fitments (including furniture) for use in dry conditions.

OSB/2 - Load-bearing boards for use in dry conditions.

OSB/3 - Load-bearing boards for use in humid conditions

OSB/4 - Heavy-duty load-bearing boards for use in humid conditions.

### Mechanical properties

The threshold value requirements for specified mechanical properties of the 4 OSB grades in EN 300 can be summarised as indicated in the following tables. The values are 95 percentiles (5 percentile values in the case of swelling in thickness) and are characterised by a moisture content in the material corresponding to a relative humidity of 65% and a temperature of 20° C. This implies that these specified mechanical properties have to be controlled according to statistical principles and that 95% of the test values on individual samples have to exceed (or remain below in the case of swelling in thickness) the respective threshold value requirement in EN 300.

			Requirement		
	Test	Unit	Thickness range (mm, nominal)		
Property	method		6 to 10	> 10 and < 18	18 to 25
Bending strength - major axis	EN 310	N/mm <sup>3</sup>	20	18	16
Bending strength - minor axis	EN 310	N/mm <sup>3</sup>	10	9	8
Modulus of elasticity in bending - major axis	EN 310	N/mm <sup>3</sup>	2500	2500	2500
Modulus of elasticity in bending - minor axis	EN 310	N/mm <sup>3</sup>	1200	1200	1200
Internal bond	EN 319	N/mm <sup>3</sup>	0.30	0.28	0.26
Swelling in thickness - 24 h	EN 317	%	25	25	25

### Threshold value requirements for OSB/2

#### Physical properties

##### a) Climate

Like other wood-based panel products, OSB is hygroscopic and its dimensions change in response to a change in humidity. A 1% change in moisture content increases or decreases the length, width and thickness of the different grades of OSB by the amounts set out in the table below:

As a guide OSB can be expected to attain the following

Type of panel	Specification	Dimensional change at 1% change in panel moisture content		
		Length %	Width %	Thickness %
OSB	EN 300, OSB/2	0.03	0.04	0.7
	EN 300, OSB/3	0.02	0.03	0.5
	EN 300, OSB/4	0.02	0.03	0.5

moisture content levels under the following specified conditions.

Relative humidity at 20°C	Approximate equilibrium moisture content
30%	5%
65%	10%
85%	15%

OSB must be conditioned to bring it into equilibrium with its environment before it is fixed. This is usually achieved by loose stacking of the panels in the room where they will be used prior to fixing them. The time required for the panels to achieve equilibrium moisture content will vary depending upon the temperature and relative humidity in the building. The likely equilibrium moisture content levels of OSB in various conditions are as follows:

In a building with continuous central heating: 5-7%

In a building with intermittent central heating: 8-10%

In an unheated building: up to 15%

When components are factory produced for installation on site, it is essential that the site conditions are suitable to receive the components with wet trades completed and the building dried out.

OSB with enhanced moisture resistance (OSB/3; OSB/4) is not waterproof; the term "moisture resistant" applies to the adhesive binder which (within limits defined by EN 300) will not break down in the presence of moisture. Physical wetting of all grades of OSB should be avoided.

#### b) Biological attack

Typically OSB will not be attacked by wood-boring insects common in temperate climates. It can be used in hazard classes 1, 2 and 3 as defined in EN 335-1 "Durability of wood and wood-based products" Part 1: Definition of hazard classes of biological attack". For these three hazard classes, the respective moisture content of OSB and the organisms that may attack OSB under the specified conditions are given in EN 335-3 "Durability of wood and wood-based products" Part 3: Application to wood-based panels".

#### c) Water vapour permeability

The value of the water vapour resistance factor ( $\mu$ ) for OSB having a density of 650 kg/m<sup>3</sup>, can be taken as 30 using the "wet cup" method and 50 when the "dry cup" procedure is employed (EN 12524).

#### d) Thermal conductivity

The thermal conductivity ( $\lambda$ ) of OSB is 0.13 W/m.K for a mean density of 650 kg/m<sup>3</sup>.

#### e) Reaction to Fire

Under the new Euroclass system for the reaction to fire of materials, untreated OSB with a density >600 kg/m<sup>3</sup> and a thickness >10 mm will typically achieve a Euroclass D rating except when used as a laminate floor covering, or a Euroclass DFL rating when it constitutes a laminate floor covering and tested as a separately marketed product whether or not it is subsequently fixed to a flooring substrate.

Dimensional change for a 1% change in panel moisture content (ENV 12872) Storage and handling

Careful storage and handling is important to maintain panels in their correct condition for use; thus, OSB must be protected from rain and accidental soaking. During transport, it is particularly important to keep

edges well covered. Panels should be stored flat in an enclosed, dry building. When handling boards, the edges and corners should be protected against damage. OSB can be cut by a hand or power saw and machined (routed, spindled, planed and bored) with common woodworking machinery. Tungsten carbide cutting edges are recommended for use with powered tools.

#### a) Mechanical joints and fixings

Wherever possible, fittings that depend upon face fixing should be selected; fittings that depend upon the expansion of a component inserted into the board edge should be avoided.

Conventional woodworking fixings and techniques can be applied to OSB which provides good holding power for screw fixings into the board faces; generally, edge fixing is not recommended.

Parallel core screws should be used because they have greater holding power than conventional wood screws. A high ratio of overall diameter to core diameter is desirable.

Drill pilot holes for all screw fixings. Typically, the holes should be 85 to 90% of the screw core diameter. Fixings into the board face should not be within 8 mm of edges and 25 mm of the corners.

Nails and staples can be used for lightly loaded fixings or to hold glued joints while the adhesive sets.

#### b) Adhesive-bonded joints

A wide variety of jointing methods can be used, provided the following simple guidelines are observed:

The joint parts should be accurately machined.

Use sharp cutters to avoid tearing or burnishing the surfaces to be bonded.

Use a high solids content adhesive with low flowing properties such as polyvinyl acetate or urea formaldehyde.

Locate mating pieces accurately and hold them under pressure while the adhesive sets.

The width of grooves machined in OSB should be limited to about one-third of the thickness of the board.

The depth of groove is typically about one-half of the board thickness.

Allow adhesive-bonded joints to condition for several days before sanding and finishing; this avoids the appearance of sunken joints and is essential with high-gloss finishes.

A tongue and groove joint is very efficient, provided the fit of the joints is not too tight to cause a split along the edge.

When attaching lippings, the tongue should be machined on the solid wood piece

## **8.2 WORKMANSHIP**

### **8.2.1 Storage**

All timber shall be stored in suitable well ventilated and watertight stores with elevated floor to the satisfaction of the Architect.

### **8.2.2 Tolerances**

Sawn timber is to hold fully the specified santlings when fixed in the work, except only for the tolerances specified in BS 4978.

### **8.2.3 Workmanship and Construction - General**

Workmanship shall comply with BS1186 Part II. All joinery shall be wrought unless otherwise stated. All finished sizes shall conform exactly to the Architect's detailed drawings, except working tolerances as laid in BS1186 Part II shall apply.

All work which is machine cut shall be cleaned where a painted finish is required. Joinery shall be so finished as to allow the use of decorative material without showing saw marks or imperfections in the manufacture.

No work is to be glued or wedged until required, unless otherwise directed. No piecing, lengthening or unnecessary jointing will be permitted.

All joints shall comply with the requirements of BS1186 Part II, and double tenons are to be used on members exceeding 50 mm thick.

No internal joinery other than painted softwood shall be installed in the building until it is watertight, all wet trades complete and the drying out process well advanced to the satisfaction of the Architect.

All screws in hardwood joinery shall be in brass except as otherwise specified.

Joinery described as countersunk, screwed and pelleted shall include for letting in heads of screws not less than 16 mm and pelleting over in an approved manner with similar selected timber with grain set to match and glued in with appropriate adhesive.

The Contractor shall be responsible for seeing that all joinery is set plumb and true and according to dimensions and details and is not damaged by subsequent trades, that all necessary fixings are incorporated in the carcass and for providing and securing all necessary anchors, bolts, screws, nails etc.

All lippings are to be tongued on.

All arises are to be slightly rounded.

The Contractor shall allow for all necessary plugging to concrete, blockwork, all cramps or dowels and for all fixings, bolts, screws, nails, etc, for firmly securing all joinery. All carpenter's work shall be framed together in workmanlike manner to comply with BS 5268.

#### **8.2.4 Frames and Fixing**

Generally all frames and sub-frames to doors, access panels and screens shall be screw-fixed through the jambs and heads at equal maximum centres of 670 mm. Timber sub-frames shall be pre-drilled in concrete. The frames shall be countersunk to accept pellets and screw fixed into sub-frames.

Where frames shall be jointed with mortice and tenon joints and pinned with hardwood dowels and glued with an appropriate wood-working adhesive, frames shall be offered up to structural openings complete prior to fixing.

Hardwood door frames and linings shall be to BS 1567 to the sizes and dimensions shown on the drawings.

The backs of all joinery and joinery which is built in shall be treated with preservative and primed.

Timber to be finished with clear finishes and sealers shall be selected and kept well cleaned.

#### **8.2.5 Doors Windows and Access Panels**

Doors and access panels shall comply with the requirements of CP151, BS459, BS1567, BS5277, BS5278 and BS5369.

Fire resisting doors shall also conform to the following:

BS4787: Part 1 - Internal and external wood doorsets, door leaves and frames

BS 476: Part 20 - Method for determination for the fire resistance of elements of construction.

Flush doors shall have a hardwood framed core as shown on the drawings faced on both sides with 4 mm quality plywood and with hardwood lipping on all edges.

Where flush doors are to have rebated or rounded stiles, the lippings at edges must be increased sufficiently to allow for these labours. Cutting rebates or forming rebates on standard size lippings will not be permitted, and flyscreen louvred doors shall be as shown on the drawings.

Doors left for painting shall be filled, stopped and rubbed down to give a superior finish.

Adhesives shall comply with BS1203 or BS1204 as applicable and shall be of type MR for internal work and type WBP for external work.

All boring, rebating or other labours to accommodate architectural ironmongery, unless otherwise agreed with the Architect, shall be carried out in the joinery works.

The hardwood veneered doors, etc, shall be sealed before leaving the joinery works.

Glazing beads shall be cut out of the solid and matched with the finishing veneer. Fixed beads shall be pinned and glued in position with pins counterpunched holes stopped and coloured to match finish. The loose glazing beads shall be fixed after painting.

#### **8.2.6 Ironmongery**

All lock furniture, surface fitting plates and the like are to be fitted and removed prior to painting or polishing of joinery. Final fitting shall take place on completion. All Ironmongery shall be carefully wrapped and protected until completion.

All moving parts shall be oiled, adjusted and left in perfect working order on completion and all keys shall be labelled and delivered in accordance with the Architect's instructions.

## **9.0 METALWORK**

### **9.1 MATERIALS**

#### **9.1.1 General**

All materials shall be free from scale, rust, damage or defects. All welding, brazing or hot forging shall be carried out by approved process.

#### **9.1.2 Mild Steel**

Unless otherwise specified, mild steel shall comply with BS4360, Grade 1.

Unless otherwise specified, all mild steel is to be primed before delivery with an approved primer.

#### **9.1.3 Steel Sections**

Hot rolled sections shall comply with BS449 and BS4360.

Cold rolled sections shall comply with BS2994.

#### **9.1.4 Galvanising**

Galvanising shall be in accordance with BS729 Part I and BS5493 and applied by the hot dip process at the rate of 610 grams per square metre on all dipped surfaces. Galvanising shall be carried out by complete immersion after fabrication in a bath and all excess zinc shall be carefully removed. The finish shall be clear and uniform. Galvafrond shall be used where site galvanising becomes necessary.

#### **9.1.5 Finishes**

Prior to finishing all steelwork shall be thoroughly clean and dry and free from loose scale, rust, oil or other surface adhesions.

#### **9.1.6 Stainless Steel**

Stainless steel shall be 18:10:3 chromium:nickel:molybdenum steel type 316 to BS3100. It shall comply with the requirements of BS970, BS1449 and BS6323 and the finishes shall be agreed with the Architect.

#### **9.1.7 Aluminium**

Aluminium items shall be constructed of extruded anodized aluminium sections at least equal to those shown on the drawings, and of thickness not less than 1.8 mm with joints accurately machined to ensure perfect fit and mechanically jointed. The thickness of anodising shall be guaranteed to be 25 microns by the manufacturer and shall be manufactured to approved samples. Aluminium shall conform to BS1470 to BS1475 and BS1490.

#### **9.1.8 Defects**

Damaged materials and manufactured items shall not be installed in the works and any materials or manufactured items damaged after installation shall be removed and replaced at the Contractor's expense and to the entire satisfaction of the Architect.

## **9.2 FABRICATION**

#### **9.2.1 General**

Unless otherwise specified in these descriptions, fabrication of metalwork shall conform to the following:

All work shall be finished straight, smooth and free from all defects and imperfections and shall be to the size shown on the drawings.

All steel items shall be thoroughly wire brushed, cleaned and given one coat primer, before delivery to the site.

All parts which are inaccessible after assembly of erection shall receive two coats of primer before assembly takes place.

All metalwork shall be rigidly fixed in place as shown on the drawings using proper size of bolts, hold fast anchor bolts and locks.

#### **9.2.2 Steel Cutting**

Cutting of steel parts shall be done using backsaws. No oxygen burning shall be allowed. All cut parts and sections shall be ground even and filed smooth with rounded edges.

#### **9.2.3 Steel Welding**

All welding materials, plant equipment procedures and types and types of welds shall conform to BS5135 Specification for Arc welding of Carbon and Carbon Manganese steels.

Welding of steelwork shall be carried out by skilled operators using either gas or electrically, operated plant. Welds are to be continuous fillet welds unless otherwise stated. The welded surfaces shall be prepared, ground and filed to a smooth finish.

1. Where practical, all welding shall be carried out prior to the galvanising process.

2. All mesh fixing angles shall be stitchwelded in accordance with the dimensions indicated on the drawings.

3. Welds shall be finely ground down, filed or spun to a smooth finish prior to the work being released for finishing.

### **9.3 ALUMINIUM DOORS AND WINDOWS**

All frame and sash members to aluminium windows, doors etc, shall be assembled in a secure and workmanlike manner and shall be delivered to the site ready for erection. Junctions of sills and jambs, stiles and rails shall be made with permanently watertight joints.

All necessary reinforcement for integral hardware shall be supplied with it.

Where two or more windows or doors are to be installed in a single wall or partition opening, provision shall be made to assemble the abutting frame members into a satisfactory vertical mullion.

Aluminium doors and windows shall be furnished complete with all necessary neoprene weatherstrips and all ironmongery required which shall be finished to match the door or window. Ironmongery shall be provided as detailed on the drawings, and samples shall be submitted to the Architect for approval.

A neoprene strip packing shall separate aluminium elements from steel, concrete or wood structure.

Aluminium elements shall be arranged to receive glazing with the proper type and thickness required and the frames shall be designed to receive caulking.

Surfaces of non-ferrous frames and anchors in contact with concrete, mortar, wood etc, shall be covered with a thick coat of an approved protective bitumastic paint.

Steel bolts and screws when in contact with aluminium shall be of stainless steel.

Sills and thresholds shall generally be of the same materials and finish as the windows and doors and shall be extruded to the sections shown on the drawings.

Aluminium doors and windows shall conform with BS4873 and shall be obtained from an approved manufacturer. Contractor shall ensure that copies of certificates of tests are obtained from the manufacturer for approval by the Architect before orders are placed.

Samples of sections and doors and windows mock-ups to be submitted to the Architect for approval.

### **9.4 FLYSCREENS**

Flyscreens to doors, where specified, shall be framed and braced with rails, stiles and braces and filled in with aluminium fine wire mesh of 0.7 mm, beaded on.

Flyscreens to windows, where specified, shall be framed with rails and stiles and filled in with aluminium wire/mesh of 0.42 mm beaded on.

### **9.5 RAILINGS**

Railings and balustrades shall be constructed and assembled complete in accordance with the Architect's detailed drawings.

### **9.6 WORKMANSHIP**

#### **9.6.1 Steel elements**

Steel frames shall be fixed in the positions shown on the drawings. They shall extend 40mm below the finished floor level and project from finished wall face as shown on the drawings.

Steel doors shall be fixed in true vertical position, with a clearance between leaf and frame as shown on the drawings.

Holes for metal fixings are to be drilled clean, and burns removed. Countersinking is to be concentric and bored to correct depth. Bolts shall be fitted with washers under the nuts where such bear on a tapered surface. The threaded position of each bolt shall project at least 2 threads beyond the nut.

Welding of steelwork shall be carried out by skilled operators using either gas or electrically operated plan. Welds are to be continuous fillet welds unless otherwise stated. The welded surfaces shall be prepared, ground and filed to a smooth finish.

#### **9.6.2 Aluminium Elements**

All aluminium work shall be first class workmanship accurately set in position, true and plump, and securely anchored to the structure.

Drilling, cutting and fitting shall be properly and carefully carried out, and the aluminium elements cleaned of all metal fillings.

Aluminium door frames shall be used with a dry wall construction to suit the specific requirements of the constructional system.

The burying of aluminium in wall plaster shall be avoided by screwing the frame to the grounds after the plastering has been completed.

## **9.7 CAULKING**

Caulking compounds shall generally conform to BS4254 or BS5212. They shall be non-staining, elastic, waterproof, and non-corrosive, firm after setting but not brittle.

The mixing of the material and its application shall be in strict accordance with the manufacturer's instructions.

All joints and spaces to be caulked shall be clean and dry before compound is installed.

Joints and spaces shall be completely filled with caulking compound to form a smooth finish with the adjoining faces.



## **10.0 GLAZING**

### **10.1 MATERIALS**

#### **10.1.1 Glazing**

Glazing shall comply with BS952, BS4315, BS5286, BS5357, BS5544, BS5713, BS6206, BS6262 and CP153 and shall be of uniform thickness free from waviness, air bubbles and other defects. Glass shall be of best quality, as manufactured by "Glaverbel", "Saint-Gobain", "Pilkington" or similar and approved.

The glazing shall be co-ordinated with and adhere to the recommended procedures of the window manufacturer to ensure proper water tightness of the glazing and in any position where aluminium opening windows are used, they must be set strictly as the window manufacturer's instructions and BS6262.

The type and thickness of glass shall be as shown on drawings and schedules and as indicated below:-

4,6,8 or 10 mm clear float glass

6 mm grey float glass

6 mm grey laminated glass (2 sheets x 3 mm thick + 0.38 mm clear polyvinyl butyral interlayer)

6 mm georgian wired polished plate glass

10 or 12 mm clear tempered safety glass

10 mm grey tempered safety glass

#### **Insulating glass units (double glazing)**

Insulating glass units (double glazing) shall comprise 6 mm grey float glass for the external skin, 12 mm thick airspace and 6 mm clear float glass for the internal skin. The glazing units shall be hermetically sealed with dehydrated air in between to the Architect's approval.

#### **10.1.2 Putty**

Putty for glazing to timber frames shall comply with BS544 and shall be a proprietary brand recommended by the window or door manufacturer and approved by the Architect.

Putties are to be full to the sidelines of the glazing bars and are to be neatly trimmed and cleaned off.

Beds shall be used where indicated and shall be of the type specified.

#### **10.1.3 Transparent Silicone Cement**

Transparent silicone cement shall be used where specified and shall be a proprietary brand approved by the architect. The cement shall be applied strictly in accordance with the manufacturer's instructions.

#### **10.1.4 Intumescent Compound**

Intumescent compound for glazing shall be by "Sealmaster" or similar and approved

#### **10.1.5 Preformed Rubber Gaskets**

Preformed rubber gaskets shall comply with BS4255.

### **10.2 WORKMANSHIP**

#### **10.2.1 Dimensions**

The Contractor shall be responsible for checking the actual work to ensure that the glass ordered is to the correct dimensions to give the required clearance in frames.

All glazing is to be carefully cut to fit the rebates, well and properly bedded, puttied back, puttied and sprung where required.

Back clearance shall be of regular thickness not less than 2 mm.

Edge clearance shall be 3 mm (for single glazing up to 12 mm thick in length/breadth up to 2 m).

#### **10.2.2 Preparation of surrounds**

All timber rebates to be clean, dry and primed (or sealed).

All metal rebates to be cleaned and primed.

#### **10.2.3 Installation**

Immediately after glazing, all glass is to be marked with white water paint. Glass shall be set, where indicated in a wash leather glazing strip, PVC neoprene gasket or intumescent compound.

#### **10.2.4 Cleaning and Replacement**

All glazing bars shall be cleaned of all mortar droppings, rendering etc., before glazing.

On completion all cracked or broken glass or glazing material, shall be replaced and all glass shall be cleaned both sides to the entire satisfaction of the Architect.

### **10.3 MIRRORS**

Mirrors shall be silvering quality clear float or float glass 6 mm with dead flat faces, silvered on one side. The silvering is to be protected against moisture by an electrocopper backing followed by a coating of shellac

varnish and paint to the satisfaction of the Architect. Edges of mirrors shall be ground and polished flat. Sizes should conform to those shown on the drawings and the mirrors should be drilled for fixing holes as necessary unless otherwise indicated.

The mirrors shall be carefully set in position, plumb, square and where adjacent to each other levelled to lie in the same plane.

Unless otherwise noted, they shall be fixed with brass screws, with chromium plated dome caps, and kept proud of the backing surface with fibre, neoprene or rubber washers as necessary, to allow freedom of expansion or contraction without damage to the mirrors.

Where indicated, they shall be fixed with brass angle trim.

#### **10.4 HANDLING AND STORING**

Glass shall be delivered to site in proper containers with manufacturer's name, type of glass and thickness or weight of glass attached to the outside.

Great care must be exercised by the Contractor to ensure that the glass is not damaged in handling.

Glass must be stored under cover, in a vertical position or placed on storage racks.

#### **10.5 CLEANING GLASS**

All glass shall be cleaned inside and outside with anti-static cleaning solution and all broken or cracked panes shall be replaced at the Contractor's expense prior to handing over the works.

#### **10.6 PROTECTIVE SURFACE TREATMENT FOR GLASS**

Where specified "Clear-Shield" or similar and approved surface treatment shall be applied to all exposed surfaces of external glazing and solar heating panels strictly in accordance with the manufacturer's instructions.

## **11.0 FINISHES**

### **11.1 MATERIALS**

All materials shall be stored, measured, mixed and used in accordance with BS5492. The mix proportions stated hereinafter are by volume.

#### **11.1.1 Cement**

Cement shall be ordinary Portland Cement and shall comply with BS12.

#### **11.1.2 Lime**

Lime shall comply with the requirements of BS890 or otherwise it shall be prepared to the approval of the Architect.

#### **11.1.3 Sand**

The sand for gypsum plastering, screed and beds shall comply with BS1199 and 1200 as appropriate for the particular purpose for which it is to be used.

#### **11.1.4 Aggregate**

Fine aggregate for screeds shall comply with BS882 for maximum size 14-5 mm.

### **11.2 KEY FOR IN SITU FINISHES**

The Contractor is to rake out joints of blockwork, as work proceeds and not afterwards, prepare concrete to form a key and provide any necessary bonding agents to ensure that an adequate key is obtained for plaster, cement and sand beds, backing etc.

### **11.3 CEMENT AND SAND BEDS AND BACKINGS**

Cement and sand beds and backing shall be composed of one part cement to four parts of sand and shall be laid in alternate bays not exceeding 3 metres wide in any direction to eliminate cracking and finished with the surface recommended by the manufacturer of the particular finish which is to be applied. No more water should be added to the mix than necessary to provide workability.

"Harbourite" 100% polypropylene fibres or equal and approval shall be incorporated in the mix to inhibit cracking due to drying shrinkage.

### **11.4 EXPANSION JOINTS AND MOVEMENT JOINTS**

Expansion joints and movement joints shall be incorporated into beds, backings and finishings where required and shall be as "MIGUA" or equal and approved in the position given on the Architect's drawings, or as otherwise directed.

All cement and sand beds, backings, etc. shall be kept damp after initial set by spraying or other suitable method for a period for at least seven days to delay evaporation. Before cement and sand beds and backings are laid, the concrete under or behind the same shall be thoroughly hacked, cleaned and wetted and every precaution taken to ensure complete adhesion.

Beds to receive sheet, tiles or carpet are to be kept at a lower level than the adjacent finished floor levels so as to allow for the thickness of the tiles or carpet and underfelt and so that the edge of the carpet can be turned into an under-carpet holding strip.

### **11.5 FLOOR SCREEDS**

Screeds composed of concrete grade C20 with coarse aggregate size 14-5mm shall be at least 50mm thick and laid in accordance with BS8204. "Fibermesh" 100% polypropylene fibres or equal and approved shall be incorporated in the mix to inhibit plastic cracking. Screeds shall be finished as described in the Schedule of Finishes. Water addition is to be kept to a minimum. Only sufficient water is to be used as to allow compaction. Screeds are to be laid in areas not exceeding 9 M<sup>2</sup>, the ratio between the sides being as near 1:1.5 as possible. Joints between bays shall be vertical with clean sharp edges which abut each other as closely as possible. Movement joints shall be provided as directed by the Architect.

Where specified screeds shall be protected with a hardening agent applied in the proportions recommended by the manufacturer so as to ensure a finished hard-wearing, dust-free surface. The whole of the screeds to be kept covered and wet for 7 days, after placing and protected from wear and other damage until the laying of the floor finish.

No moisture sensitive floor finish shall be laid unless a reliable moisture test shows that the screed is sufficiently dry to receive covering.

Defective screeds shall be cut out and made good in such time as to allow a sufficient interval for drying out prior to the scheduled laying of the finished floor coverings.

## **11.6 LIME PLASTERS**

Internal and External walls and ceilings shall be rendered with a mixture of a 1,5:4-4.5 lime:sand undercoat. With a clean, well-graded sand, use the higher figure given. Before the undercoat is applied "running screeds" shall be provided as a datum line in order to regulate or control the thickness of the undercoat and to ensure that it is finished to a true, flat surface. When the undercoat has begun to stiffen it shall be combed with evenly spaced wavy horizontal lines approximately 20mm apart and 5mm deep (less in the case of the pricking-up coat on metal lathing) to provide stress-relief points and a key for subsequent coats. The surface of the undercoat shall not be combed if the final coat is to be a tyrolean finish.

After the undercoat, a final coat of a 2:5-6 lime:sand render shall be applied and finished with a wood skimming float and transversed with a floating rule to a true and even surface, 25mm thick in total. With a clean, well graded sand, use the higher figure given.

Each coat shall be allowed to harden for several days before a further coat is applied. If required it shall be left for a week or longer in cold or wet weather. Early drying out shall be prevented. In warm dry weather, the undercoat shall be cured by draping the wall with polythene, held against the surface to prevent evaporation. Four days' curing shall be followed by three days' drying out before a further coat is applied. It may then be found necessary to damp down the surface of the undercoat to control the sunction for the next coat.

Rendering to receive ceramic tiles shall be combed to form a key, before setting. The Contractor shall allow for carrying out a suitable wall of his selection of approximately 10m<sup>2</sup> before setting.

## **11.7 GYPSUM PLASTER**

Gypsum plaster for internal walls and ceilings for the Church and Chapel and buildings No. 2 & 3 shall conform to BS1191 Part 1 and shall be used in accordance with the manufacturer's instructions.

All surfaces to be plastered shall be reasonably dry and protected from the weather.

Gypsum plastering on blockwork shall be carried out in two or three coats to finish 22 mm or 25 mm thick as specified. The floating coats shall conform to type A1 of BS1191 Part 2, 1973, browning plaster and sand, 20 mm or 23 mm thick, and shall conform to the BS5492 Internal Plastering. The finished plaster shall be appropriate for the foregoing undercoats.

Gypsum plastering on concrete work shall be carried out in two or three coats to finish 22 mm or 25mm thick as specified. The floating coats shall conform to type A3 of BS 1191, Part 2, 1973, bonding plaster and sand, 20 mm or 23 mm thick, and shall conform to BS5492: 1977 Code of Practice for internal plastering.

The finishing shall be 2 mm thick and shall conform to type B of BS1191 Part 2 and shall be the appropriate plaster for the foregoing coats.

The Gypsum plaster floating coats shall be applied with a firm pressure built out to the required thickness, ruled to an even surface and lightly scratched to form a key for finishing plaster coat. The surfaces of concrete and blockwork shall be wetted with a damp brush 5 to 10 minutes before application of the floating coat.

Gypsum plastering on expanded metal lathing shall be carried out in three operations, consisting of bricking-up coat, floating coat and finishing coat. The pricking-up coat, floating coats shall be metal lathing plaster and sand to conform to type A2 of BS 1191 Part 2 and shall be appropriate plaster for the foregoing undercoats.

The gypsum plaster pricking-up coat shall be scratched to form a crossed undercoat key.

The floating coat shall be applied as soon as the bricking-up coat sets, ruled to an even surface and lightly scratched to form a key for finishing plaster.

The Contractor shall be wholly responsible for providing and fixing of any temporary grounds necessary to produce a satisfactorily even and plain finish.

The gypsum plaster aggregates shall be pre-mixed and clean water shall be added. Mixing is to be carried out on a clean platform or in a clean mixing box which shall be free from dust, dirt and debris and all set plaster shall be cleaned from the platform or box before the following mix is undertaken.

Notes 1 – 6 applied to paragraph 11.6 apply also to paragraph 11.7.

## **11.11 SUSPENDED CEILINGS AND BEAMS**

### **11.11.1 PLASTERBOARD FOR SUSPENDED CEILINGS AND BEAMS**

Plasterboard shall be used for the suspended ceiling systems and as lining to ceilings, walls and columns where and as shown on the drawings. It shall be manufactured to BS1230:1970 of rated gypsum encased in and bonded to strong durable paper liners with one surface suitable for direct decoration, as supplied by

British Gypsum Ltd, Westfield, Singlewell Road, Gravesend, Kent, DA 117 RZ, U.K. or other equal and approved.

Plasterboard shall be of such thickness as appropriate to the purpose it will be used for, i.e. 13 mm for lining to suspended ceilings or of such other thickness as recommended by the suppliers or shown on the drawings.

Gypsum baseboard, lath and plank shall be fixed with their lengths (i.e. their round edges) across the joints, studs or battens. Wallboard may be fixed either parallel to or across the studs for partitions and across the joists for ceilings.

Nails along the edges of adjacent boards or laths should be opposite to one another and not staggered, the boards should be nailed to every support beginning from the centre of the boards and working outwards. All edges of gypsum wallboard shall be lightly butted and properly supported by studs, joists, furring or headers. Nails for 9.5 mm boards shall be 30 mm long, nails for 12.5 mm boards shall be 40 mm long, 2 mm galvanised steel small flat headed nails. They shall be driven in at right angles to the face, well home, but not so deep as to break through the paper cover. They shall not be closer than 13 mm from the edges of the board and shall normally be 100-150 mm apart. In the case of gypsum baseboard a gap not exceeding 5 mm shall be left between all edges of the boards. In the case of gypsum lath the cut ends shall be butted together wherever possible. A gap not exceeding 3 mm shall be left between the bound edges. Continuous joints over the supports shall be avoided as far as possible by staggering the end joints of the boards. Nails for gypsum baseboard, lath and plank shall be 2.65 mm galvanised steel clout nails, 30 mm long for 9.5 mm, 40 mm long for 12.5 mm and 60 mm long for 19 mm plank.

Apply scrim to all joints between plasterboards or between plasterboards and solid plastered backgrounds. Allowance shall be made for expansion joints as necessary and to coincide with the structural expansion joints.

Skim coat of Retarded Hemihydrate gypsum plaster (class B, type b2 of BS1191 Part 1 to a thickness of 5 mm shall be applied to all ceiling plasterboard.

Access panels to suspended ceilings shall be 600 x 600 mm unless otherwise indicated on the drawings.

#### **11.11.2 SOFTWOOD TIMBER BOARDS FOR SUSPENDED CEILINGS**

16 mm thick T & G soft wood timber board slats with 25 mm thick softwood perimeter frieze shall be used for the suspended ceiling systems, secret nailed on to soft wood timber frame 40 x 40 mm at 500 mm c.c. suspended from purlins or spars with softwood hangers size 40 x 40 mm at 500 x 1000 mm c.c. as detailed on drawings.

#### **11.12 EXPANSION JOINT COVERS IN PLASTERED WALLS**

Expansion Joint Covers shall be "Clipstrip" joint covers of types and finish as indicated on the drawings and as supplied by Expandite or other equal and approved unless otherwise stated on the drawings

#### **11.13 GLAZED CERAMIC WALL TILES**

The glazed wall tiles shall be coloured 200 x 200 x 8 mm or white 200 x 200 x 8 mm or other approved size ceramic glazed round edged tiles to comply with BS6431 to approved samples. Glazed round edge tiles are to be used on outer edges and external angles. Coved tiles are to be used at internal angles.

The walls shall be prepared for tiling and the backings and fixing shall be carried out in accordance with BS5385: Parts 1 and 2.

All tiling shall be set out with whole tiles at the top edge and cut tiles where necessary at the lower edge. Setting out of tiles shall conform to the drawings and ensure that cut tiles, where necessary, shall be, wherever possible, not less than one half tile in any dimension.

The tiles shall be bedded in an adhesive approved by the Architect, which shall be a thin bed latex based adhesive. The tiles shall have straight joints on flatted plaster backings and be grouted with a compressible, premixed, coloured grouting cement for ceramic tiles approved and in colours to be selected by the Architect. Movement joints shall be provided as directed by the Architect.

#### **11.14 CERAMIC FLOOR TILES**

Ceramic floor tiles shall comply with BS6431.

The ceramic floor tiles shall be fully vitrified coloured non-slip ceramic floor tiles 400 mm x 400 mm x 8 mm to approved samples, or as otherwise specified on the drawings. Coved skirting tiles and other special fittings including internal and external edges shall be included as required.

The pre-wetted ceramic floor tiles shall be laid on screeds as in 11.5 of a true and level nature, which shall be treated with an approved compound to prevent bond. The tiles shall be bedded on 1:3 cement:sand latex modified thin or thick bed mortar and grouted with a cement:sand grout containing colour additives to the Architect's approval. The proportions of cement and sand shall be 1:1 for joints up to 3mm wide, 1:2 for joints between 3-6mm wide and 1:3 for joints wider than 6mm. In environments subjected to particularly severe stress, use the double glueing technique.

Grouting of the joints may be carried out at any time to suit the convenience of the work, but shall preferably be left for at least 12 hours to allow adequate setting of the bedding material. The grouting operation shall not be delayed unduly as open joints collect general building dust and other deleterious substances. Movement joints shall be provided as directed by the Architect.

#### **11.15 MOSAIC TILE BEDDING**

First a key coat shall be applied followed by a base coat, then a bedding coat in which the mosaic tiles shall be set.

The key coat shall consist of cement and sand (1:2 mix) at least 5 mm thick which shall be applied four or five days before the mosaic. The irregularities of the wall surface shall first be levelled off. Application to walls etc, shall generally commence from the bottom, working upwards by means of throwing the mix vigorously against the surface with a casting trowel and pressing it firmly into joints etc., to ensure adhesion. The surface shall be finished plumb and straight, and shall be scratched in an approved manner, before setting, to form a key. The key coat shall be well wetted before the base is applied.

The base coat shall consist of cement::lime:sand mortar (1:0.5:4-4.5). With a clean, well graded sand, use the higher figure given.

The base coat shall be applied with the aid of "running screeds" which shall be provided at the edges of key coat surfaces and in between as required to permit accurate application. The base coat shall be applied and carefully levelled between the screeds to give a smooth flat surface which shall be kept moist until the mosaic is fixed. The mosaic tiles shall be bedded in an adhesive approved by the Architect, which shall be a thin bed latex based adhesive. Movement joints shall be provided as directed by the Architect.

#### **11.16 QUARRY TILES**

The quarry tiles shall be 150 x 150 x 16 mm heavy duty non-slip acid resistant tiles to BS6431. Skirtings shall be coved with a rounded top.

The quarry floor tiles shall be bedded as in 11.14. Floor quarries shall be fixed with joints greater than 6mm wide and in this instance sand for grouting shall comply with the grading limits of Type B sand in Table 1 of BS1199.

#### **11.17 SURFACE HARDENER AND ANTI-SKID FINISH**

Concrete hardener shall comprise two coats "Sealocrete Epoxy Wetecote" or similar and approved applied strictly in accordance with the manufacturer's instructions.

For floors subject to a high degree of abrasion the second coat shall be "Sealocrete Florshield". To produce a non-slip finish use "Sealocrete" fine grade aggregate applied strictly in accordance with the manufacturer's instructions.

#### **11.18 MARBLE**

##### **11.18.1 General**

The marble slabs shall be selected by the Architect from an approved range to suit the applications, cut to size, and to such finishes as indicated on the drawings, or the schedules of finishes.

All marble work shall be fixed in accordance with BS8298.

The Contractor shall prepare fully dimensioned and detailed shop drawings of the work from details supplied by the Architect and from site survey. The drawings shall show clearly the location of marble slabs and shall indicate jointing, bonding, connections, with other work, typical and special anchoring, typical and special details for joints and pointing, location of expansion and control joints and dimensions.

No work shall proceed until the Architect's approval has been obtained. Such approval shall not affect the responsibility for the design and accuracy of the details which shall rest with the Contractor.

Fetching or hiding of defects will not be permitted without the permission of the Architect. Defective work shall be corrected by cleaning, redressing or replaced with new at the discretion of the Architect.

All exposed edges of marble shall be finished as the main face. External corners shall be birdsmouth jointed and internal corners butt jointed unless otherwise directed.

#### **11.18.2 Marble Wall Lining**

The wall lining marble shall have a polished finish, producing a mirror-like glossy surface which brings out the full colour and character of the stone, unless otherwise indicated on the drawings. This finishing shall be carried out in the workshop.

Wall linings and facings shall generally be set 20 mm clear of the structural backing unless otherwise shown on the drawings. They shall be set square, true and with face joint edges rubbed true, straight and even.

The Contractor shall design suitable supports, anchor slots, anchor cramps and dowel required for the satisfactory completion of all wall linings etc. They shall be of approved non-ferrous material. Each slab shall be supported by 2 No anchors and "S" hooks per slab from 0.6-1.2 M2.

All anchors and other fixings shall be concealed when the work is complete.

Notwithstanding the above, the Contractor shall be entirely responsible for the sufficiency of the fixings.

Interior work shall be set with anchors cramps, dowels and "S" hooks, plaster of paris or non-staining cement mortar coloured to match the marble. Exterior work shall be set as interior but with non-staining quick-setting cement mortar sports.

#### **11.18.3 Marble Paving and Flooring**

Marble paving and flooring shall generally be 30 mm thick slabs, unless otherwise indicated with a polished gloss finish. Polishing means polishing after tiles are laid. Stair treads shall be 40 mm thick marble or as indicated on the drawings.

The pre-wetted marble slabs shall be laid on 10 mm Laticrete 4237 Latex/211 filler adhesive to the required depth of bed, and finish and tamped with a rubber mallet until firmly bedded to the proper level of the finished floor. In environments subjected to particularly severe stress, e.g. external floors, floors in public environments, floors to be polished, etc, use the double glueing technique where a thin layer of adhesive, 2-3mm thick, is also applied to the back of the marble slab.

Slabs shall show an even joint when laid and finished.

The floor shall be roped off for 24 hours after which it shall be grouted with water and neat, coloured non-staining cement.

#### **11.18.4 Marble Columns and Mouldings**

All marble columns and mouldings shall be carved out of solid marble and shall be selected by the Architect from an approved range to suit the applications and shall be to the sizes and shapes as shown on the drawings.

All jointing, bonding, connections with other work, typical and special anchoring, typical and special details for joints and jointing shall be carried out as shown on the drawings.

The face of columns and mouldings shall have a polished finish producing a mirror-like glossy surface which brings out the full colour and character of the stone unless otherwise shown on the drawings. This finishing shall be carried out in the workshops.

#### **11.18.5 Expansion and Compression Joints in Marble**

Expansion and compression joints shall be clearly shown on the shop drawings and sealed with an approved coloured, non-staining sealant on foam backing which shall extend to the full depth of bedding in pavings.

No such joint shall be less than 10mm wide and shall be kept clear and free of all fixing materials. Corbels etc, shall not be permitted to bridge the joint. All expansion and compression joints shall be inspected by the Architect prior to filling.

#### **11.18.6 Protection and Cleaning of Marble**

All marble shall be protected from chipping and staining during delivery, storage and erection. Marble shall be stored prior to erection in a water free area on raised platforms with tarpaulin or similar covers.

Erected work shall be protected at corners and other vulnerable points with non-staining wood formwork, boards etc. Floors shall be protected with polythene sheeting and softboard with a further protection of 12 mm plywood or scaffold boards where subject to traffic or other trades. Any marble damaged or stained shall be cleaned or replaced to the Architect's satisfaction.

All marble work shall be cleaned on completion, by thoroughly scrubbing with fibre brushes and a mild alkaline solution, containing no caustic or harsh fillers. The use of wire brushes or acid solutions will not be permitted. Cleaning shall be commenced at the top of the building and proceed downwards.

All marble shall be left clean, free from stains and all traces of cleaning fluid and with all joints pointed to the entire satisfaction of the Architect.

### **11.19 "MAPLE" TIMBER FLOORING**

Timber flooring shall be "Maple", unless otherwise stated, well seasoned with a moisture content of not more than 10% in accordance with BS or Industry Standards and shall be clean, straight, sound, of matured growth, free from shakes, splits, pithwood and other defects. Floor boards shall be tongued and grooved and laid in as long lengths as possible. Heading joints shall be evenly distributed and no two joints shall be nearer than 300 mm apart measured in any direction and they are to be formed with splayed joints over joists or bearers.

Flooring shall be "secret nailed" on the tongued side with nails well driven and punched home.

The boarding shall be adequately protected against damage. All floor boards shall be treated with preservatives after machining but before fixing. Liberally, apply preservative to all new surfaces exposed by minor cutting.

The Contractor shall prepare control samples complete and shall obtain the approval of the Architect of appearance of part of the finished work in advance of the remainder.

### **11.20 TERRAZZO**

#### **11.20.1 General**

Marble chippings shall consist of good quality marble angular in shape as distinct from elongated and flaky. Aggregates shall not contain deleterious matter which may affect adversely the bond or strength or cause surface failure. High fines or dust content must be avoided.

The cement shall comply with the physical test requirements of BS12.

Pigments used shall normally comply with BS1014.

#### **11.20.2 Precast Terrazzo**

Precast terrazzo shall have a facing layer of cement and marble chippings with sizes from 10 to 25 mm (quality A and from 3 mm to 6 mm (quality B), (1:2 nominal mix) using coloured cement. The facing shall provide a minimum wearing thickness of 10 mm after grinding. The base layer shall consist of Ordinary Portland cement and aggregate (1:4 nominal mix complying) with the requirements of BS882.

The marble chippings shall be evenly distributed and the face of the work shall be free from projections, depressions, flakes and crazes.

Samples are to be submitted for selection and approval by the Architect.

The overall colour of precast terrazzo work shall be uniform in any one delivery.

Terrazzo floor tiles and units shall comply with BS4131 and BS4357 and shall be cast in heavy metal moulds under pressure.

The precast terrazzo units shall be supplied factory ground. Terrazzo tiles shall be square with flat tops and of rectangular cross section. The dimensions shall be 400 x 400 x 35 mm nominal size with an allowance for jointing.

Terrazzo skirtings shall be 120 mm high x 20 mm thick produced in the same manner and dimensions as for tiles, and they shall have rounded top edges.

The edges of the tiles and skirtings shall be perpendicular to the surface. The planes of the upper and lower surfaces shall be parallel and adjacent vertical edges shall be at right angles to each other. All arrises shall be sharp and true.

Terrazzo stair components shall be manufactured to the details shown on the drawings to precise fit with adjacent components with a joint between.

Terrazzo work shall be laid and bedded in a minimum 15 mm thick layer of cement and sand mortar (1:3-4) on to screed as in 11.5. All tiles shall be laid with square joints parallel with the walls, as shown on the drawings and finished to a true and flat surface.

All work shall be grouted upon completion using neat cement of matching colour. Care should be taken to fill all joints completely. Surplus grout shall be immediately cleaned off the face of the work and surrounding surface and all work shall be carefully cleaned.

All terrazzo surfaces shall be polished on completion. Large areas shall be wet polished by means of approved machines using No 140 carborundum abrasive and clean potable water. Care must be taken not to damage any angle or arrises during polishing operations. The expansion joints in terrazzo paving are to be formed with "MIGUA" expansion joint system or equal and approved installed strictly in accordance with manufacturer's instructions with top edges truly levelled with finished polished terrazzo level.



### **11.21 VINYL SHEET FLOORING**

The abrasive Vinyl Sheet flooring shall be extra heavy duty and non-slip as "Altro Safety Flooring K35" 3.5 mm thick colour to approval manufactured by Altro Floors, Caxton Hill, Hertford U.K. or other similar and approved.

All flooring shall be hot welded and laid strictly in accordance with the manufacturer's instructions and with their recommended adhesives and sealants.

No dressing or polish shall be applied to the Safety Flooring which shall be covered as a protection from other trades. Prior to the handing over of the installed floor, it shall be machine scrubbed thoroughly using nylon or hard bristle brushes and "Altro Floor Cleaner 44" or other similar and approved floor cleaner.

### **11.22 PVC FLOORINGS**

PVC flooring to BS3261 Part 1, shall consist of a thoroughly blended composition of thermoplastic binder, fillers and pigments. The thermoplastic binder shall consist substantially of one or both of the following :

1. vinyl chloride polymer
2. vinyl chloride copolymers

The polymeric materials shall be compounded with suitable plasticisers and stabilisers.

The flooring shall have a uniform wearing surface. The colour and the pattern, marbling or mottling, if present, shall extend through the full thickness of the flooring and shall match the approved samples.

Laying operations of the flooring shall only begin when the moisture content of the underlying screed has fallen to a low enough value that will not result in defects in the finished floor as bubbling or debonding, and as recommended by the supplier.

The surface of the screed shall be checked to be smooth and without cracks. The surface shall be cleaned thoroughly from dust and other impurities. Levelling compound shall be applied to the screed surface as recommended by the manufacturer, to achieve a level surface.

The flooring shall be laid in accordance with BS8203. The joints between the adjacent sheets of flooring shall be made using a special welding rod which is melted in the joint in order to provide a uniform appearance of the floor.

### **11.23 LINOLEUM FLOORING**

Linoleum flooring shall be in accordance with BS6826. Linoleum composition shall consist of a thoroughly blended mixture of Oxidised and polymerised linseed or other suitable vegetable oils, Resins, Wood flour and/or cork, Pigments, and inorganic fillers

Woven backings shall be a canvas of jute or other fibres. The canvas shall be of plain weave with not less than 4.0 ends per centimetre and not less than 3.5 picks per centimetre.

Non-woven backing shall be a felt of natural or synthetic fibres held together by needling, spin bonding, impregnation or partial impregnation with a resin or similar material.

The thickness and finish of the flooring shall be as shown on the drawings and schedules and shall be to the Architects approval.

Laying operations of the flooring shall only begin when the moisture content of the underlying screed has fallen to a low enough value that will not result in defects in the finished floor as bubbling or debonding, and as recommended by the supplier.

The surface of the screed shall be checked to be smooth and without cracks. The surface shall be cleaned thoroughly from dust and other impurities. Levelling compound shall be applied to the screed surface as recommended by the manufacturer, to achieve a level surface.

The finished surface shall be smooth, antislip, have a high resistance to decay and to a wide variety of chemicals, low absorbency and low combustibility.

The skirting to be used shall have a coved junction with the wall and have the same properties as the flooring material.

## **12.0 PAINTING AND DECORATION**

### **12.1 GENERALLY**

Every possible precaution shall be taken to keep down dust before and during painting processes. No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, efflorescence, etc, before the application of each coat.

Primed or undercoated, woodwork and metalwork shall not be left in an exposed or unsuitable situation for an undue period before completing the painting process.

No exterior or exposed painting shall be carried out under adverse weather conditions, such as rain, extreme humidity, dust storms, etc.

Metal fittings such as ironmongery, etc, not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed, the fittings shall be cleaned and refixed in position.

The Contractor shall be required to repaint, at his own expense, any work on which the paint is found to be incorrectly applied. The Contractor shall be responsible for protecting from damage the paintwork and all other work during and after painting operations including the provision of all necessary dust sheets, covers etc.

Brushes, pails, kettles, etc, used in carrying out the work, shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different colours, types or classes of material.

The decorating materials shall be obtained from approved manufacturers and shall be supplied in the manufacturer's sealed and branded containers. All materials must be thoroughly stirred before use.

Details of mixing and application shall be in accordance with the Specifications of the manufacturers concerned and to the approval of the Architect. The mixing of paints, etc, of different brands, before or during application, shall not be permitted. No dilution of painting materials shall be allowed except as detailed by the manufacturers and as approved by the Architect.

### **12.2 PREPARATION OF SURFACES**

Concrete, blockwork, plaster and timber surfaces which are to be painted shall be washed down prior to painting with a toxic wash applied by brush or spray. A second wash shall be applied two days after the first wash and the surfaces shall then be allowed to dry out thoroughly before applying paint. The surfaces shall be rubbed down smooth and any cracks cut out and filled. Before applying the paint, the surfaces shall be free from dust, and shall be dry.

### **12.3 EMULSION PAINTING**

Emulsion paint shall be applied in three coats in accordance with the manufacturer's instructions. The first "mist" coat may be mixed with equal parts of water but the two further coats are to be applied undiluted. The finished surface shall present a satin finish. Gloss or semigloss finish shall not be used. The internal plastered walls and ceilings shall be primed and then painted with 2 coats of Laxon Acrylic paint and the external plastered walls shall be primed and then painted with 2 coats of weathershield smooth masonry paint.

### **12.4 GLOSS FINISH**

Prepared timber, plywood or plastered walls internally shall be coated with an approved exterior grade leadless primer, imperfections filled with approved stopping and smoothed down and two undercoats and one full gloss finishing coat of alkyd resin type paint applied by brush.

Parts of timber to be enclosed in walls shall always be impregnated and primed. Priming shall be brushed on and a minimum of two coats applied to end grain. When the priming paint is hard, all cracks, holes, open joints etc., shall be made good with hard stopping and rubbed down with fine abrasive paper. For internal surfaces, the primer coat shall be carefully flattened. Hardwood surfaces shall be primed and painted as directed by the Architect.

### **12.5 GLOSS LACQUER**

Gloss lacquer finish to plasterboard ceilings and hardwood surfaces is to be two coats of lacquer finish to be applied strictly in accordance with the manufacturer's instructions.

### **12.6 CLEAR FINISH**

Clear finish to hardwood surfaces internally is to be three coats of approved oleoresinous seal to be applied by brush strictly in accordance with the manufacturer's instructions. The seal shall be mixed with linseed oil

in the following proportions:

90% Polyurethane 10% Linseed oil

Clear finish to hardwood surfaces externally is to be three coats of linseed oil applied by brush to the entire satisfaction of the Architect. Linseed oil for clear finishes shall comply with BS6900 : Boiled Linseed oil.

Clear polyurethane finish is to be three coats spray applied of "Cetol Transparent" and one coat of "Rubboe BB" clear polyurethane from Sikkens Lakjfasrieken N.V., Sassenheim, Holland or other equal and approved.

## **12.7 PAINTING METALWORK**

### **12.7.1 Generally**

Metalwork shall be rubbed down and shall then receive one zinc phosphate priming coat. This shall be followed by two coats brushing filler undercoat and one finishing coat of an alkyd resin type gloss paint to be applied when the previous coat is perfectly dry.

Metalwork surfaces delivered primed shall be checked to ensure that priming is satisfactory and any areas damaged shall be cleaned off and primed with zinc phosphate primer.

External metalwork shall receive 2 coats of zinc phosphate primer.

### **12.7.2 Painting Galvanised Metalwork**

Metalwork shall be rubbed down and then shall receive one priming coat of zinc cromate primer. This shall be followed by two coats brushing filler type undercoat and one finishing coat of an alkyd resin type gloss paint, each coat being applied when the previous coat is perfectly dry.

External galvanised metalwork shall receive 2 coats of zinc cromate primer.

## **12.8 "EPONITE G23"**

"Eponite G23" shall be as manufactured by Shell Products Ltd, or other equal and approved and shall be applied where specified in strict compliance with the manufacturer's instructions and to the satisfaction of the Architect.

## **12.9 SAMPLE PANELS**

Sample Panels of colour schemes will be provided as required by the Architect.

## **12.10 SPRAY PAINTING**

Spray painting may only be permitted with the express approval of the Architect and in strict compliance with his instructions regarding safety measures, protection of operatives, masking and protection of other finishes and the application of additional coats to achieve acceptance film thickness and coverage.

## **12.11 SUPPLIERS**

Cement paint shall be obtained from Blue Circle Products and shall comply with BS4764.

## **12.12 PROTECTION**

The finished painted surfaces must be protected from damage and any damage must be made good to the satisfaction of the Architect. Paint splashes, drips or spills must be thoroughly cleaned off other surfaces or areas.

## **12.13 WALL COVERINGS**

Surfaces to receive wallcoverings shall be structurally sound thoroughly dry, smooth and clean before hanging wallcoverings.

All dirt, grease, distemper and any nibs or other surface irregularities shall be removed. Cracks, joints, screwholes etc., shall be made good with a proprietary crack filler, and when dry lightly rubbed down to a smooth surface.

All wallcoverings unless otherwise specified shall be hung only with adhesives containing fungicide. The adhesive shall be made up and used in accordance with the manufacturer's instructions.

All rolls of wallpaper and wallcovering shall be examined before hanging to check that they are undamaged and of the same shade and number. Shades of adjacent lengths shall be compared before hanging, and alternative lengths shall not be reversed unless specified.

All wallcoverings shall be hung in strict accordance with the manufacturer's instructions and with recommended and approved adhesives.

### **13.0 SANITARY FITTINGS**

#### **13.1 GENERAL**

All sanitary fittings shall be of vitreous china unless otherwise specified and shall be as shown on the drawings and schedules.

Sanitary fittings and fixtures shall be fixed and tested to the manufacturer's recommendations and in accordance with BS 6465: Part1 and be handed over at completion in perfect working order.

All materials used in the manufacture of sanitary fittings shall be first quality and shall be durable, impervious, corrosion resistant, always remain hygienic and have a smooth surface which can be easily cleaned.

## **14.0 RAINWATER DRAINAGE INSTALLATION**

### **14.1 RAINWATER INSTALLATION (ABOVE GROUND)**

#### **14.1.1 General Requirements**

The installation of all rainwater pipework above ground shall comply with the requirements of BS5572.

The Contractor shall prepare working drawings based on the specification and drawings issued which shall be submitted to the Architect for approval.

The Contractor shall ensure that the details of his approved working drawings are not deviated from in any way. Any alterations made to the design without the prior approval of the Architect shall, at the discretion of the Architect, be removed and restored to the original working drawings design at the Contractor's expense.

The Contractor shall liaise and co-ordinate his activities with all interested parties at all stages of the contract before and during the installation of any pipework.

The whole of the installation shall be carried out in accordance with the statutory requirements and to the entire satisfaction of the Architect.

All materials used in the construction of the works and all suppliers shall be approved in writing before orders are placed.

All materials for which "Kitemark" quality assurance schemes of the British Standards Institution are in operation, shall be produced by manufacturers licensed under the schemes.

Pipework where penetrating any floor slab above ground level shall be installed in a non-combustible material, and the openings shall be fire stopped around the pipe with non-combustible material to the Architect's approval.

All pipes passing through compartment walls or floors must be fire stopped at each penetration with non-combustible material to the Architect's approval.

#### **14.1.2 Setting out of work**

The Contractor shall provide for attending on the site as and when required to mark out the positions of holes, supports, chases, etc, to accommodate the rainwater pipework.

The Contractor shall be responsible for the dimensional accuracy of his work, and shall, when required, provide the Architect with drawings showing the positions and dimensions of all holes, chases etc.

#### **14.1.3 Pipework Installation**

The Contractor shall ensure that all horizontal pipework is installed to the correct gradient and levels as shown on his working drawings. Unless previously agreed with the Architect, inconsistencies in gradient in individual pipe lengths shall not be accepted.

Before enclosure in false ceilings, or other spaces and before testing, all horizontal pipework gradients shall be checked, and if necessary re-aligned to the correct gradient.

All vertical pipework shall be plumb.

No pipework joints shall be built into the structure.

Where cast into reinforced concrete, pipes are to be positioned so that nowhere are they in contact or unduly close to the reinforcement. They are to be supported rigidly in place during the placing and vibrating of the concrete and shall be tested to the Architect's approval before concreting commences.

#### **14.1.4 Pipe Cutting**

All pipework shall be cut clean and square with the axis of the pipe. Before installation, the ends of the pipe shall be made square and smooth, and any internal burs shall be removed by filing.

#### **14.1.5 Pipework Clearances**

Pipework shall be installed with adequate clearance from other engineering services and the structure to enable maintenance to be carried out with a minimum of disruption.

UPVC plastic pipework shall not be located adjacent to steam or HPHW services.

#### **14.1.6 Care and Storage of Pipes and Fittings**

The Contractor shall be responsible for the protection of all pipework during the installation.

Pipes and fittings shall be stored in accordance with the manufacturer's recommendations. Provision shall be made for the necessary stacking frames for pipe storage as required.

Joint sealing rings and gaskets shall be carefully stored in boxes to prevent damage.

#### **14.1.7 Sealing Open Ends of Pipework**

To prevent the entry of building debris, the Contractor shall seal all open ended rainwater pipework immediately after installation. This shall be carried out with suitable purpose made plugs, temporarily fixed in position to avoid removal.

Should an open end be found or a plug removed for any reason, the Contractor shall, at his own cost, rod the pipework concerned and flush it with clean water. The plugs shall then be reinstated and fixed in position.

#### **14.1.8 Flushing out and Cleaning System**

At the completion of the rainwater pipework installation all plugs shall be removed and the rainwater pipework shall be rodded and flushed with water. The operation may be phased at the direction of the Architect.

#### **14.1.9 Covering Work**

Under no circumstances shall any of the pipework installation be covered up, until it has been inspected by the Architect and tested. If the work is covered before inspection, the Architect shall be empowered to have the coverings removed for the purpose of any inspection or test he deems necessary.

#### **14.1.10 Testing Installation**

At the commencement of the installation, the Contractor shall agree with the Architect a test programme. The Contractor shall notify the Architect of the anticipated start date for testing.

The Contractor shall provide clean water and all assistance and appliances for testing during the process of the contract and for final tests. The Contractor shall give not less than 48 hours notice not including a Sunday or day appointed for public thanksgiving or mourning.

No testing shall be considered valid unless performed in the presence of the Architect.

During the progress of the contract, the horizontal runs of rainwater pipes shall be subjected to air or water tests as appropriate. The water test shall be carried out as follows:-

The rainwater pipes under test shall be filled with water under a head of not less than 3 M. After a reasonable period has elapsed, the water level shall be maintained for half an hour without the addition of further water.

The air test shall be carried out as follows:-

Air shall be blown or pumped into the length of drain under test until a pressure equivalent to that as recommended by the pipework manufacturers but not less than 40 mm of water. Without further blowing or pumping, the pressure shall remain constant for a period of three minutes to the complete satisfaction of the Architect.

#### **14.1.11 Final Testing**

Final inspections and tests of the whole system may be required by the Architect. The fact that any part of the work has passed any test will not relieve the Contractor of any of his obligations, and any defects shown by the independent final tests or appearing during the period of maintenance shall be located and made good at the Contractor's expense. On completion, all above ground rainwater pipes shall be subjected to an air-pressure test as described above.

#### **14.1.12 Pipework**

The rainwater pipework and fittings shown on the drawings as UPVC plastics shall be in compliance with the requirements of BS4514.

The rainwater pipework and fittings shown on the drawings as cast iron shall be in compliance with the requirements of BS437 and BS416.

The fabrication of any set or bend in the pipework by means of the cut and shut hot air or solvent welded joints method on site will not be allowed.

All pipework fittings shall be of the correct angle swept in the direction of flow, with no restriction to the pipe bore.

#### **14.1.13 Jointing**

All UPVC pipes and fittings except where otherwise stated shall be jointed using ring seal joints. Spigot ends shall be cut squarely ensuring that the pipe internal bore is continuous in the completed joint.

Cast iron pipes shall be jointed as "Timesaver Drainage System" or similar and approved in which joints are made using special bolted couplings with synthetic rubber sealing gaskets.

The Contractor shall ensure that all joints conform to the manufacturer's instructions.

#### 14.1.14 Pipework Supports

Intermediate guide brackets shall be provided for both horizontal and vertical pipework between fixed points, to the pipe barrel, and shall allow free movement of the pipework in the direction of natural expansion. Each bracket shall be so installed to ensure that the load is proportionally carried throughout. Intermediate guides shall be vertically adjustable, and shall be fixed to the structure at two points, single fixing will not be allowed.

Distance between pipework supports shall be in accordance with Table 14.1.1

**Table 14.1.1**

Pipe Size (mm)	Vertical Pipe (m)	Horizontal Pipe (m)
75	1.8	0.9
100	1.8	0.9
150	1.8	1.2

#### 14.1.5 Sleeves

All UPVC pipework that penetrates the structure shall be inserted through steel sleeves. Unless otherwise stated, the free movement of the pipe shall not be impaired.

All cast iron pipework that penetrates the structure shall be inserted through cast iron sleeves.

Any pipework that penetrates fire barriers shall be suitably fire stopped, and unless otherwise stated, capable of thermal movement.

To minimize frictional noise transmission during expansion, all pipework shall as far as is practicable be kept clear of the structure. Where this is not possible a soundproof material shall be used between the structure and the pipework to eliminate noise transmission to the Architect's approval.

#### 14.1.6 Access Points

Access points shall be provided:

- At the base of all internal rainwater pipes.
- At all changes in direction (horizontally and vertically)
- At positions shown on the working drawings.

N.B. Access points shall be positioned in a way which will allow for uninhibited access.

#### 14.1.17 Termination of Cast Iron Pipework and Jointing to an Asbestos Cement Drain

Connection shall be made in such a way that separate testing of below and above ground pipework can be achieved.

Sockets for connection to underground drains shall be terminated at finished floor level to allow an effective joint to be made.

Termination of Cast Iron Pipework and jointing to Asbestos Cement Drains shall be as recommended by manufacturers and to the Architect's approval.

#### 14.1.18 Termination of UPVC Pipework and Jointing to a Vitrified Clayware Spigot

The termination of UPVC Pipework and jointing to a vitrified clayware spigot shall be carried out by means of a patent type Densleeve or Hepsleeve adaptor as manufactured by the Hepworth Iron Co Ltd, or Naylor Bros (clayware) Limited, or equal and approved.

#### 14.1.19 Termination of UPVC Pipework and Jointing to a Cast Iron Drain

The termination of UPVC pipework and jointing to a cast or spun iron pipework shall be carried out by means of a metal caulking bush supplied complete with seal ring joint for expansion.

The joint between the metal caulking bush and the cast iron drain shall be made in the proportions of 2/3 tarred gaskin and 1/3 run molten lead well caulked.

On completion and after testing, the lead joint shall be given two coats of bitumen material to BS 3416 compatible with the coating supplied on the pipework.

#### 14.1.20 Roof Balcony and Planter Outlets

Roof outlets shall be in high density plastic.

Roof outlets shall be fitted with domical gratings to prevent clogging unless otherwise stated on the drawings.

## **14.2 RAINWATER INSTALLATION (BELOW GROUND)**

### **14.2.1 General**

All workmanship shall comply with the BS8301 Building Drainage.

### **14.2.2 Working and "as built" Drawings**

The Contractor shall prepare working drawings and "as built" for this section of the works based on the specification and drawings issued which shall be submitted to the Architect for approval

### **14.2.3 Reference to Other Section**

For full specification regarding general requirements for setting out, pipe installation, pipe cutting, clearances, storage sealing open ends, flushing out and cleaning, jointing, backfilling, testing, manholes, petrol interceptor, the contractor should refer to the section "Rainwater Installation" (above ground) and "External Foul Drainage" as applicable.

### **14.2.4 Pipework and Fittings**

The underground pipework and fittings shall comply with BS4660 or BS4514 for pipes less than 100mm in diameter.

Gully inlets, yard gullies, road gullies, manhole covers and frame shall be in cast iron and shall comply with EN124, BS437 and BS497.

Pipework and fittings and associated equipment shall be installed and tested strictly in accordance with the manufacturer's instructions and recommendations.

Pipes and fittings shall be of the flexible joint type scheduled in this Specification or on the Drawings and shall comply with the appropriate UNI EN Standards .

Flexible joints between pipes having integral sockets shall be formed by a shaped rubber gasket fitted within the socket or by a rubber of circular cross section (O-ring) placed on the pipe spigot. The type of flexible joint to be used shall be subject to the approval of the Architect .

### **PVC Pipes and Fittings**

The unplasticised polyvinyl chloride (uPVC) pipes for sewers shall conform to the requirements of BS 4660: 1989. Specification for unplasticised polyvinyl chloride pipes and plastics fittings of nominal sizes 110 and 160 mm for below ground gravity drainage and sewerage or BS 5481: Specification for unplasticised PVC pipes and fittings for gravity sewers with pipe dimensions in accordance with Table 1 of the respective standards, reproduced hereunder. The joints shall be of the compression ring push type, complying with BS 4346 "Joints and fittings for use with unplasticised PVC pressure pipe".

### **High Density Polyethylene Pipes**

High density polyethylene pipes (HDPE) shall be used for the construction of water distribution pipelines. These pipes shall be manufactured in accordance with ISO 161/I, ISO 3607 and ISO 1167. The nominal pressure of the polyethylene pipe shall be 160 kPa (PN 16). The pipes shall be manufactured with polyethylene having a minimum density of 0.941 g/cm<sup>3</sup> and a melt flow index of 0.03.

The pipes shall be jointed by means of electro welded joints or other types of jointing to the approval of the Engineer. The connections and fittings shall have a nominal pressure rating identical to the polyethylene pipe on which they shall be mounted and they shall fit the same pipe exactly.

### **Low Density Polyethylene Pipes**

Low density polyethylene (LDPE) shall be manufactured in accordance with AFNOR T 54-043 and shall have a nominal pressure rating of 6 bar at a temperature of + 20 oC. The assembled joints as specified in Clause 0 hereto.

The pipes shall be made of low density polyethylene, as specified in AFNOR T 53-020, to which shall be added only specified in AFNOR T 53-020, to which shall be added only those anti-oxidants and pigments (carbon black) necessary for the manufacture and use of pipe to this Specification. Re-worked materials shall not be used.

The pipes shall be supplied by the manufacturer in coils having a maximum length of 100 m. The pipes shall be coiled at a temperature inferior to 30 oC and the minimum permissible ratio between the radius of coiling and the external diameter of the pipe shall be 15.

### **Polyethylene Fittings**

Polyethylene fittings to be supplied shall be of the electro fusion types and shall be as described below:

Polyethylene electro fusion fittings shall have embedded heating coils with contact terminals or shall alternatively be supplied with electro fusion couplers.

The fittings shall have deep insertion lengths with a wide fusion zone and a cold zone in the center or shall alternatively be supplied with electro fusion couplers. They shall also have fusion indicators.



The fittings shall be made of high density polyethylene and be of black colour to withstand 16 bars test pressure i.e. a nominal 10 bars pressure. They shall also have high tensile and compressive strengths with a density of approximately 0.9 g/cm<sup>3</sup> at 230C. Their melt index shall be within the range of 0.4 to 1.3 gm/10min. i.e. MFI 190/5 within the melt flow index groups 005 and 010.

The fittings shall have a bar code label which can be read by the want of the electro fusion equipment. They shall be compatible for electro fusion with HDPE pipes with melt flow index groups voltage within the range of 16 volt to 48 volt to suit the electro fusion welding equipment owned by this Authority.

Tapping tees shall be suitable for electro fusion on live mains with a metal threaded drive cutter of limited cutting depth to protect the opposite pipe wall from damage. The cutter shall also allow the disc cut from the pipe wall to be retained in the cutter and shall not produce debris while cutting through the pipe wall.

Electro fusion tapping tees and branching saddles shall comprise a lower half and upper half under and over the pipe bolted together prior to electro fusion.

The Contractor may propose alternatives to the type of jointing proposed, subject to the Engineer's approval.

#### **Polyethylene Push fit Fittings**

Polyethylene push fit fittings shall conform to BS 864 part 3:1975; BS 5114 1975, DIN 8075; 1969 and ISO 3458; ISO 3459; ISO 35011; ISO 3503.

The Polyethylene push fit fittings shall be used with Polyethylene pipes which are specified in the preceding Clause.

The body of BSP threaded adaptors shall be made of Delvin 107 black actual homopolymer, ultraviolet resistant. The body of other fittings shall be made of Hoeschst T1020 black acetalter polymer, ultraviolet resistant. That for ferrules and stopcocks shall be gunmetal to BS1400 - LG2.

The grip ring shall be made of PVC. The material of the "O" ring shall be EPDM or nitrile elastomer.

The insert shall be of copper to BS 2870 C106.

The pressure seal shall withstand 48 bar pressure.

#### **Polyethylene Adaptor and Reducing Connector**

P.E. adaptor and reducing connector shall be of mechanical type.

Material used shall be high grade polymer

The P.E. adaptor and reducing connector shall comprise of a high grade polymer body and nut, acetyl split ring and insert and a nitrile rubber O-ring.

#### **Transition fittings - Polyethylene/Other Pipe Connections**

All Specifications for Polyethylene fittings shall apply

The Polyethylene side shall have integral heating coil or provided with long end with electro fusion couplers.

Electro fusion safety manufactured as per specifications of the relevant pipe connector.

The transition fitting shall be a monolithic product guaranteed to axial bursting and internal pressure tightness.

#### **Flanged Adaptors**

Flanged Adaptor shall be polyethylene except when specified and can be safely electro fused with electro fusion couplers. Length of the adaptors shall therefore be sufficient to allow proper fusion widths.

Relevant clauses of the Specifications for Polyethylene fittings shall also apply.

The flange adaptors shall be compatible with the steel flange complying with BS 4504: Table 16/11 unless otherwise specified on the Drawing.

#### **Mechanical Joints for HDPE Pipes**

Notwithstanding Clause 0 above, mechanical joints may also be used for converting HDPE pipes of bigger diameter i.e. as from 160 mm diameter. The Contractor shall in this respect follow the instruction of the Engineer or his representative.

#### **Assembled Joints for LDPE Pipes**

Electro fusion connections shall be used for jointing low density polyethylene pipes and for connecting these pipes and fittings.

The connections shall fit the low density polyethylene pipes having a pressure rating of 6 bar. The fitting itself shall be designed and manufactured for the aforesaid nominal pressure. These joints shall be manufactured in accordance with ISO 58.

#### **Flanges and Bolting for Pipes, Valves and Fittings**

Flanges and bolting for pipes, valves and fittings shall all be to BS 4504 or alternatively to AFNOR NF E 29-201 or ISO 2084 or to any other standard to the approval of the Engineer, provided that they are each compatible with the other for the purposes of jointing like-sized components and are such that corrosion by

galvanic action shall be avoided. Unless otherwise specified the rating and test pressure of the flanges shall not be less than the rating and test pressure of the pipeline.

#### **Bolts, Nuts and Washers**

Black hexagonal bolts and nuts and flat washers shall be to BS 4190 or alternatively to AFNOR NF E 27-411 or other standard approved by the Engineer.

#### **Gaskets and Joints Rings**

Gaskets and Joints rings shall be manufactured from natural or approved synthetic rubber conforming to BS 2494.

Flanged joint gaskets shall be the inside bolt circle type, unless specified otherwise, and shall comply with BS 4865.

#### **Flexible Couplings and Flange Adaptors**

Flexible couplings for steel and cast iron pipes and flange adaptors at Valves and specials as shown on the Drawings shall be Viking Johnson, Gibault or similar approved couplings suitable for use with water at a maximum temperature of 40 oC and for the appropriate pipes test pressure.

The flexible couplings for uPVC pipes shall be automatic rubber ring joints as specified in Clause 0 hereto.

Flexible couplings and flange adaptors exposed in chambers shall be protected internally and externally with an approved nylon or epoxy coating to minimum thickness 250 microns. Bolts and nuts shall have similar coating or be in stainless steel to BS 970 Grade 316 S16. Buried couplings shall be protected by approved molten bitumen molding or paste and tape wrappings.

#### **Pipe work for Sewerage**

The Contractor's attention is drawn to the fact that the acceptability for use on this Contract of any materials, construction methods and equipment shall be subject to the approval of the Wastewater Management Authority (WMA) based on their existing regulations. Tenderers are therefore advised to consult the latter at the time of tendering for the choice of materials and workmanship; the Tenderer shall thereafter choose the least expensive materials accepted by the WMA.

The following list is indicative and is not exhaustive. Tenderers may propose alternative materials, methods of construction and equipment, acceptable to the WMA.

#### **Gravity Sewers**

Gravity sewers have been dimensioned assuming an absolute roughness coefficient of 1.5mm. Changes in pipe materials will not therefore affect the hydraulic design. However, where the internal diameter is considerably inferior to the specified nominal diameter, the Engineer shall be notified. The Contractor may be required to use pipes of a higher ND.

#### **Vitrified Clay Pipes**

Vitrified clay pipes shall be suitable for sewerage systems and shall conform to the requirements of BS 65 or BSEN 295 – vitrified clay pipe fittings and joints, DIN 1230 – clayware for drains, and sewers or ASTM C700 – vitrified clay pipe and shall be provided with sockets or sleeve couplings.

The joints shall be flexible and of the compression ring push type. The rings shall satisfy the physical property and type test requirements of rings specified in BS 2494.

The pipes shall have the strength characteristics shown in the Table 0-1 below and shall not deviate from the nominal size beyond the limits of minimum and maximum shown.

Table 0-1: Strength Characteristics

Nominal Diameter	Crushing Strength	Bore Diameter	
		Min	Max
150	22	146	158
200	25	196	210
225	25	221	236
250	29	246	262
300	29	295	313

The selection of raw materials for the manufacture and manufacturing process shall be such as to achieve a low permeability in the finished pipe of less than 1 litre/mm pipe diameter/km length/day.

#### **PVC Pipes**

Plain uPVC pipes of ND 300 mm or higher may not be used. uPVC pipes and fittings for sewerage works shall fully comply with specifications given at sub-section 0

Structured Walled uPVC, Polypropylene or Polyethylene Pipes

These pipes may be used for all diameters. They shall be jointed by means of propylene couplings fitted with elastomere joints. All fittings shall be of the same material as the pipes, and fittings such as junctions made

of plain uPVC shall not be used. Unless otherwise specified by the WMA, the nominal ring stiffness tested as per NF EN 9969 shall be SN6 for pipes of ND less than 300mm and SN8 for pipes of ND equal or greater than 300 mm.

### **Piping Materials for Rising Mains**

The pipe material for rising mains shall be HDPE. Rising mains and fittings such as valves shall have the same specifications as water pipelines, except that pipes shall be appropriately colour-coded for wastewater, as per the regulations of the WMA.

### **Valves**

#### **Assembly of Equipment and Protection**

Except where otherwise specified all valves and generally all pipeline equipment shall be completely assembled at the manufacturer's workshop as no item shall be imported as unassembled components. They shall have also received their complete protective coatings before dispatch from the manufacturer's works and shall be additionally protected by approved means for the period of transit, storage and erection against corrosion and accidental damage.

#### **Gate or Section Valves**

Unless otherwise specified by the Engineer, gate valves shall be flanged, in ductile cast iron GS 400.15 (UNI ISO 1083), certified ISO 9001 in factory, standard n. 10269, with stainless steel push rod with double elastomeric sealing O-rings, with outer and inner coating in epossidic powder, minimum thickness 150 micron, with ductile cast iron gate coated in nitrilic rubber, test pressure 18 bar with closed gate and 24 bar with opened gate, flanges as per ISO PN 10/16, 40 mm diameter

The valves shall have inside screw spindles and shall close clockwise. The spindle shall be shouldered to allow repacking of the gland whilst the pipeline remains in service.

The spindle shall be made of stainless steel at least equivalent to X20 C13. The wedge gate shall be solid and the wedge facing rings and body seats shall be made of stainless steel or alternatively of bronze or gun-metal.

The valves which are to be installed in the ground shall be of the double flanged type with fully enclosed gearing and operating mechanism and shall be so designed that no bolts, nuts, etc, are exposed to the soil and shall be in stainless steel.

The valves which are to be directly installed in the soil shall be provided with surface boxes which can withstand a 10 ton load and shall be supplied complete with protection tube, extension spindles and accessories at no extra charge. The extension spindles and protection sheath shall be of such a design that, if necessary, cutting to the true total length is possible. The surface boxes, protection sheaths and extension spindles shall be protected from corrosion by a 150 micron coating of bitumen epoxy.

The extension spindles shall be equipped with square headed key handles with dimensions of 19 mm x 19 mm for all sizes of valves.

The valves to be installed in chambers shall be supplied with either a cast iron or malleable iron hand wheel.

The valves to be installed directly in the ground shall be supplied with cast iron caps and one solid forged valve tee key for every five valves to be installed.

The flanged valves shall be supplied with flange adaptors and connecting bolts and nuts at no extra charge where specified or required.

The Contractor shall submit to the Engineer the manufacturer's certificate which shall show that the valves and their components comply with the above specified requirements.

### **Air Valves**

Air valves for automatically exhausting or admitting air from and into pressure pipelines are specified on the Drawings. Air valve, shall be certified ISO 9001 in factory, in ductile cast iron GS 400.15 (UNI ISO 1083), coated in epossidic powder, minimum thickness 150 micron, flanged ISO PN 10 –16 –25. The orifice of these valves shall allow large volume of air to be released during pipe filling and admit large volumes of air into the pipeline during emptying.

The orifice of the air valves shall be designed to prevent premature closure whilst air is being released from the pipeline. The floats shall be made of rubber coated carbon steel.

The valves shall be fitted with a gauged outlet orifice designed to prevent water hammer resulting from the sudden filling of the drained air pocket by the flow of water.

The valves must allow the evacuation of small volumes of air that can accumulate at the highest points of the pipeline during normal operation.

All the air valves shall be fitted with an isolating valve to allow safe dismantling during operation.

The dimensions given on the Drawings and in the Bill of Quantities are indicative of the recommended sizes

and do not prejudice the manufacturer's recommendations which shall prevail.

#### **Drain Valves (water outlet valves)**

The low points of the pipeline shall be fitted with drain valves where specified on the Drawings.

The water outlet valves shall be flanged, in ductile cast iron GS 400.15 (UNI ISO 1083), certified ISO 9001 in factory, standard n. 10269, with stainless steel push rod with double elastomeric sealing O-rings, with outer and inner coating in epossidic powder, minimum thickness 150 micron, with ductile cast iron gate coated in nitrilic rubber, test pressure 18 bar with closed gate and 24 bar with opened gate, flanges as per ISO PN 10/16, 40 mm diameter

#### **Steel Berths for Gate Valves**

All gate or section valves to be installed on manhole chambers shall be fixed to their concrete supports by means of galvanized steel berths as shown on the drawing.

The distance between the external faces of the vertical flaps shall fit the distance between the internal faces of the flanges of the valves they are supporting.

The vertical flaps shall be flanged. The bolts that shall be supplied with the valves shall have a length sufficient to accommodate the thickness of the steel flaps, which shall be 8 mm.

The steel berths shall be fixed to the concrete support by means of four 12 mm anchor bolts

#### **14.2.5 Manholes**

Manholes shall be provided:

- a. At all changes in direction except where access points and/or surface bases are provided as shown on the drawings.
- b. At distances not exceeding 40 m.
- c. Where shown on the Drawings.

The Contractor shall propose a schedule of manholes (Rainwater Drainage) and shall refer to the details issued regarding manholes, which shall be submitted to the architect for approval.

Manholes shall be constructed as shown on the drawings. Manhole chambers shall be subjected to water test as directed by the Engineer. The chambers to be tested shall be filled with water and allowed to stand full for 48 hours. They shall then be tested and deemed to be watertight if the drop in water level is not more than 12 mm in a further 24 hours. Any chambers which fail the test shall be repaired and made watertight at the Contractor's expense and retested to the satisfaction of the Engineer.

Benchings shall be constructed in grade C30 concrete.

Channels branches and benching shall be formed in 75 mm granolithic concrete composed of three parts of approved local hard stone chippings crushed down to pass a 1/4" (6 mm) mesh screen in the clear and graded impurities to one part cement by volume, mixed with water to form a homogenous mass. The granolithic shall be finished with a smooth even surface true to radius, line and level and shall be kept well watered for ten days after laying.

Malleable cast iron step irons for use in manholes shall comply with BS1247.

Manhole covers and frames shall be cast iron-heavy duty, medium duty or light duty, as scheduled.

#### **14.2.6 Jointing**

All UPVC pipes and fittings except where otherwise stated shall be jointed using ring seal joints. Spigot ends shall be cut squarely ensuring that the pipe internal bore is continuous in the completed joint.

Asbestos cement pipes except where otherwise specified shall be jointed with flexible push fit couplings with integral ring seal joints.

Cast iron pipes except where otherwise specified, shall be jointed as "Timesaver Drainage System" or similar and approved in which joints are made using special bolted couplings with synthetic rubber sealing gaskets.

Flexible joints shall be provided:

- a. Where pipes "exit" the structure (concrete slabs, ground beams etc.)
- b. Where pipes "enter" and "exit" manholes.
- c. Where shown on the drawings.

The Contractor shall ensure that all joints conform to the manufacturer's instructions.

#### **14.2.7 Access**

Access points (rodding eyes) shall be provided:

- a. At all changes in direction (horizontally and vertically)
- b. At positions shown on the working drawings.
- N.B. Access points shall be positioned in a way which will allow for uninhibited access.

#### 14.2.8 Trenches for Laying Pipes

Pipe trenches shall be as narrow as possible at pipe crown level, but not less than the outside diameter of the pipe plus 200 mm. In wide trenches a narrow sub-trench shall be employed to achieve this condition. Pipes must only be laid on a prepared bed and not on the undisturbed trench bottom. A bed of the type to suit the site condition, as specified below, must be provided:

Granular material for bedding shall be either:

(a) Nominal single size material to BS 882 Table 1, 10 mm size for 100 and 150 mm diameter pipe, 10 or 20 mm size for pipes of diameter 200 mm and above.

or

(b) all-in aggregate maximum particles sizes as indicated in (a) and sand to BS882 zones 1-4.

The material shall be tested for suitability and approval by the Architect. The thickness of the compacted bedding under the barrels of the pipes shall be a minimum of 100 mm thick. The material shall be compacted in layers not more than 100 mm thick to give a uniform bed true to gradient. Wherever possible suitable machines shall be used for compacting the bedding; where this is not possible, the material shall be thoroughly tamped.

Pipes must be laid in straight lines, true to gradients, all in accordance with the procedures laid down in BS8301. Bricks, blocks or battens must not be used to bring the pipe line to gradient. Pegs used for alignment or to resist pipe driving impact must be withdrawn before side filling commences.

Side filling consisting of the same material as for bedding, must be placed and compacted equally on both sides of the pipe to full trench width in approximately 100 mm stages, and hand rammed at each stage. Side filling shall continue to ground level.

Where pipes are located under roads or other surface exposed to the passage of traffic they shall be provided with concrete protection in accordance with the manufacturer's requirements and to the Architect's approval.

The Contractor shall inform the Architect when side filling of the jointed pipes has reached crown level to allow for inspection:-

(i) of the partial withdrawal of trench shuttering or sheeting if used.

(ii) of the presence, quality and compaction of the side fill to full trench width

(iii) to observe air or water tests as appropriate

(iv) to carry out random checks, near joints to ensure that pegs or other prescribed

objects are not present

## **15.0 EXTERNAL DRAINAGE**

### **15.1 GENERAL**

All workmanship shall comply with the BS8301 Building Drainage.

The Contractor shall prepare working drawings for this section of the works based on the specification and drawings issued which shall be submitted to the Architect for approval.

The Contractor shall ensure that the details of his approved working drawings are not deviated from in any way. Any alterations made to the design without the prior approval of the Architect shall, at the discretion of the Architect, be removed, and restored to the original working drawings design at the Contractor's expense.

The Contractor shall liaise and co-ordinate his activities with all interested parties at all stages of the contract before and during the installation of any pipework.

The whole of the installation shall be carried out in accordance with the statutory requirements and to the entire satisfaction of the Architect.

All materials used in the construction of the works and all suppliers shall be approved in writing before orders are placed.

All materials for which "Kitemark" quality assurance schemes of the British Standards Institution are in operation, shall be produced by manufacturers licensed under the schemes.

### **15.2 PIPEWORK INSTALLATION**

The Contractor shall ensure that all horizontal pipework is installed to the correct gradient and levels as shown on his working drawings. Unless previously agreed with the Architect, inconsistencies in gradient in individual pipe lengths shall not be accepted.

Where cast into reinforced concrete, pipes are to be positioned so that nowhere are they in contact or unduly close to the reinforcement. They are to be supported rigidly in place during the placing and vibrating of the concrete and shall be tested to the Architect's approval before concreting commences.

### **15.3 PIPE CUTTING**

All pipework shall be cut clean and square with the axis of the pipe. Before installation, the ends of the pipe shall be made square and smooth, and any internal burs shall be removed by filing.

### **15.4 JOINTING**

All UPVC pipes and fittings except where otherwise stated, shall be jointed using ring seal joints. Spigot ends shall be cut squarely ensuring that the pipe internal bore is continuous in the completed joint.

### **15.5 PIPEWORK CLEARANCES**

Pipework shall be installed with adequate clearance from other engineering services and the structure to enable maintenance to be carried out with a minimum of disruption.

UPVC plastic pipework shall not be located adjacent to steam or HPHW services.

### **15.6 CARE AND STORAGE OF PIPES AND FITTINGS**

The Contractor shall be responsible for the protection of all pipework during the installation.

Pipes and fittings shall be stored in accordance with the manufacturer's recommendations and shall be protected from sunlight. Provision shall be made for the necessary stacking frames for pipe storage as required.

Joint sealing rings and gaskets shall be carefully stored in boxes to prevent damage.

### **15.7 MATERIALS**

Pipework and fittings shall be as indicated on the drawings and shall comply with the following British Standards:

UPVC pipes, bends, access points, rodding eyes, flexible joints, reducers, adaptors, joints shall comply with BS 4660 or BS4514 for pipes less than 100mm in diameter.

Pipework, fittings and associated equipment shall be installed and tested strictly in accordance with the manufacturer's instructions and recommendations.

### **15.8 SEALING OPEN ENDS OF PIPEWORK**

To prevent the entry of building debris, the contractor shall seal all open ended pipework immediately after installation. This shall be carried out with suitable purpose made plugs, temporarily fixed in position to avoid removal.

Should an open end be found or a plug removed for any reason, the Contractor shall, at his own cost, rod the pipework concerned and flush it with clean water. The plugs shall then be reinstated and fixed in position.

### **15.9 FLUSHING OUT AND CLEANING SYSTEM**

At the completion of the drainage pipework installation all plugs shall be removed and the drainage pipework shall be rodded and flushed with water. The operation may be phased at the direction of the Architect.

### **15.10 COVERING WORK**

Under no circumstances shall any of the pipework installation be covered up, until it has been inspected by the Architect and tested. If the work is covered before inspection, the Architect shall be empowered to have the coverings removed for the purpose of any inspection or test he deems necessary.

All pump mains shall be UPVC piping to BS 3505 or BS3506. All pipes 28 mm and below shall be class "E" and all pipes 35 mm and over shall be class "D". Pipes 42 mm and below shall be jointed with solvent cement and pipes 54 mm and over shall be jointed with mechanical joints (rubber O rings).

Fittings shall be UPVC to BS4346.

### **15.11 CONCRETE MANHOLES**

In situ concrete manholes shall be constructed as per detail drawings. The section of this specification related to concrete work shall apply.

Malleable cast iron step irons for use in manholes shall comply with BS1247.

### **15.12 MANHOLE FRAMES AND COVERS**

All manhole frames and covers shall comply with BS497 and EN124.

### **15.13 PIPE LAYING, PIPE BEDDING AND SURROUND**

Refer to section "Excavation of Trenches" in the "Excavation" section of this specification (Section 2.3)

### **15.14 BACKING OF TRENCHES AND COMPACTION**

Refer to sections "Excavation of Trenches" in the "Excavation" section of this specification (Section 2.3).

### **15.15 UPVC PIPES UNDER ROADS**

Where pipes are located under roads or other surface exposed to the passage of traffic, they shall be provided with concrete protection in accordance with the manufacturer's requirements. The pipes must be isolated from the concrete by a minimum of 150 mm depth of small granular material over the crown.

### **15.16 TESTING PRIOR TO BACKFILLING**

After the pipes have been laid and jointed all foul drains shall be filled with water under a head of not less than 1200 mm above the crown of the pipe. After a soaking period of at least one hour or longer if the Architect so approves, the water level shall be maintained for 1/2 hour without loss of water.

A hardwood ball of an approved profile, shall be drawn through all foul drains from manhole to manhole and through all branch foul drains before soil pipes, gullies and WCs are fixed. The diameter of the ball or profile shall differ from the nominal internal diameter of the pipe by not more than 6 mm or by not more than 1/24 of the nominal internal diameter of the pipe, whichever is the greater difference.

All works shall be tested as specified and to the satisfaction of the Architect before refilling of excavation is commenced.

The Contractor shall provide clean water and all assistance and appliances for testing during the progress of the contract, and for the independent final tests. The Contractor shall give notice of testing to the Architect. The Contractor shall locate and remedy all defects before further pipe laying proceeds, and shall repeat the test until a satisfactory result is obtained. Where a length of pipe under test terminates at a manhole, the restriction on further pipe laying will not apply.

The Contractor shall provide and fix testing branches and bends as required and seal off or remove them as directed by the Architect.

#### **15.17 TESTING AFTER BACKFILLING AND CONSOLIDATION**

After drain laying has been completed, the excavations refilled and the filling consolidated, all lines of pipes shall be tested as in 15.16 and the Contractor shall locate and remedy all defects to the satisfaction of the Architect.

#### **15.18 FINAL TESTING**

Final inspections and tests of the whole of the works in this section may be required by the Architect. The fact that any part of the work has passed a test will not relieve the Contractor of any of his obligations and any defects shown by the independent final tests or appearing during the period of maintenance shall be located and made good at the Contractor's expense.

#### **15.19 GREASE TRAPS**

All drainage from kitchen areas shall pass through grease traps before entering the main sewage system unless otherwise shown on the drawings.

The traps shall either be installed in the ground, or if the invert levels require, within a purpose made manhole as detailed elsewhere in this specification.

The traps shall be fully vented and have UPVC pipework on the inlet and outlet with associated purpose made adaptors.

#### **15.20 WORKING AND AS-BUILT DRAWINGS**

The contractor shall prepare working and as-built drawings of this section of the works based on the specification and drawings issued which shall be submitted to architect for approval.



## **16.0 FLOORING AND EXTERNAL WORKS**

### **16.1 ROADWORKS, PARKING AREAS, KERBS AND PAVEMENTS**

#### **16.1.1 Generally**

This section includes all work in connection with the widening and resurfacing of existing roads, making the connection of new roads to existing roads, and the construction of new roadways and parking areas.

#### **16.1.2 Site Clearance**

A working strip of 2 metres over the width of the earthworks shall be cleaned of all debris, bushes, vegetation and other obstructions. Trees shall not be cut down without the prior approval of the Architect. Roots of any cleared vegetation shall be grubbed out and taken to tip. The holes resulting from removing the roots shall be backfilled with approved material and compacted to at least 90% of the maximum dry density of the material achieved in test 13 of BS1377.

All materials arising from the site clearance shall be disposed of in tips off the site to locations approved by the Architect.

#### **16.1.3 Definitions**

"Excavated level" shall denote the level at which excavation ceases, and upon which the first layer of fill is placed.

"Embankment" shall denote the fill lower than 600 mm below the finished level of the road.

"Sub-base" shall denote the material between the base and the sub-grade.

"Sub-grade" shall denote the top layer of fill in embankments or the existing ground in cut.

"Base" shall denote the material immediately below the base course.

#### **16.1.4 Compaction under embankments**

The ground below embankments shall be prepared to receive fill after the completion of the site clearance. The surface shall be levelled to the full width of the embankment and the top 150 mm shall be compacted to at least 90% of the maximum dry density of the material achieved in test 13 or test 14 where applicable of BS 1377, at +1% to -2.5% of optimum moisture content.

#### **16.1.5 Cuttings**

Cuttings shall be shaped by excavation to the lines and levels shown on the drawings and in accordance with such further instructions as may be issued from time to time by the Architect.

When unsuitable soils are encountered in cuttings or below shallow fills, they shall be excavated to the depth directed by the Architect and carted to spoil.

Maximum slope of cuttings to be 1:1. Cuttings to terminate at least 0.5 M. away from pavements in order to protect the construction from possible erosion and sliding.

On completion of the cutting, the ground shall be shaped and the top 300 mm shall be compacted to at least 95% of the maximum dry density of the material achieved in test 13 of BS1377, at +1% to -2% of optimum moisture.

#### **16.1.6 Embankments**

Embankments shall be constructed with approved fill material obtained from cuttings and approved borrow pits or rock fill. Fill material with high clay and or organic content are not acceptable.

The minimum requirements for the fill material other than rockfill are:

- a. 4-day soaked CBR compacted to 95% of the maximum dry density achieved in test 13 of BS1377 shall be at least 20%.
- b. Liquid Limit not more than 35%
- c. Plasticity Index not more than 10% for the material passing the BS 0.425 mm sieve.

Embankments shall be constructed in layers parallel to the final road grade in compacted layers with thickness not exceeding 200 mm.

The fill for embankment shall be compacted to at least 95% of its maximum dry density achieved in test 13. The moisture shall be uniform throughout the thickness of the layer to be compacted.

#### **16.1.7 Sub-base Material**

Sub-base material other than rockfill shall comprise well graded crushed sands and gravels, or crushed rock with the following minimum requirements:

- a. 4-day soaked CBR compacted to 95% of the maximum dry density achieved in test 13 of BS1377 shall be at least 30%.
- b. Liquid Limit not more than 25%.
- c. Plasticity Index not more than 6% for the material passing the BS 0.425 mm sieve.

d. The material shall have a smooth grading curve within and approximately parallel to the grading envelope limits shown below:

B.S. Sieve Percentage	Weight passing (mm)
75	100
37.5	85-100
10	45-100
5	25-85
0.600	8-45
0.075	0-10

The material shall have an impact value not exceeding 45% when tested in accordance with BS812.

The compaction of the sub-base material shall be carried out as soon as possible after laying and spreading in layers of 150 mm when compacted, to at least 95% of the maximum dry density of the material achieved in test 13 of BS 1377 and at +1 to -2% of optimum moisture content.

The surface of the material shall on completion of compaction be closely packed, free from movement under the compaction plant and free from compaction planes ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be dug out to at least 15M2 area and made good with new material to the full thickness of the layer and recompacted.

High spots shall be graded off and low spots shall be scarified, watered and filled with selected material and compacted to the required limits.

The sub-base to extend beyond the road and under the pavements as shown on the drawings.

The finished surface shall comply with the tolerances given in clause 16.1.26 "Surface Levels and Tolerances of Construction Layers".

#### **16.1.8 Rockfill**

Rockfill where used in the construction of embankments under roads or as sub-base material shall consist of hard durable inert material which is the result of rock excavation by blasting or other means and its maximum size shall not exceed 2/3 the thickness of the compacted layer.

Rockfill shall be placed in layers not exceed 450 mm compacted thickness and compacted with at least 12 passes of a vibrating roller with a static mass per metre width of roll of at least 1800 kg or a grid roller with a mass per metre width of roll of at least 800 kg or other approved method.

The rockfill shall be compacted as wet as possible to at least 95% of its maximum dry density as determined in test 13 of BS1377.

#### **16.1.9 Road Base**

Road base material shall consist of screened natural sands and gravels or a mixture of natural sands and gravels with crushed sands and gravels. The material should be free of clay, organic substances, sulphates and chlorides.

The coarse aggregate retained on a BS 2.36 mm sieve shall have an aggregate crushing value determined in accordance with BS812 of not more than 25% and a loss of not more than 12% in 5 cycles in the sodium sulphate soundness test.

The fine aggregate passing a BS 2.36 mm sieve shall consist of natural or crushed sand, and fine material which passes a BS0.075 mm sieve. The material shall be non-plastic.

The four day soaked CBR of the material when compacted to 95% of the maximum dry density achieved in test 13 of BS 1377 shall be at least 90%. The road base material shall be a smooth grading curve within and approximately parallel to the grading envelope given below:

<u>BS Sieve size (mm)</u>	<u>%by weight passing</u>
50.0	100
37.5	95-100
20.0	60- 80
10.0	40- 60
5.0	25- 40
2.36	15- 30
0.600	8- 22
0.075	5- 12

For material with non-plastic fines, the proportion passing the 0.075mm sieve shall approach 12%.

The road base material shall be laid in one layer so that after compaction the total thickness and width is as shown on the drawings.

The material shall be compacted to at least 97 % of its maximum dry density achieved in test 13 of BS 1377 at a moisture content of +1% to -2% of optimum.

The surface of the material shall on completion of compaction be closely packed, free from movement under the compaction plant and free from compaction planes, ridges, cracks or loose material.

All loose, segregated or otherwise defective areas shall be dug out to at least 15 M2 area and made good with new material to the full thickness of the layer and recompacted.

High spots shall be graded off and low spots shall be scarified, watered and filled with selected material and compacted to the required limits.

The finished surface shall comply with the tolerances given in clause 16.1.26 "Surface Levels and Tolerances of Construction Layers".

#### **16.1.10 Compaction of Sub-grade, Sub-base and Roadbase**

All pavement layers shall be compacted to the specified limits by plant approved by the Architect.

The Contractor shall submit to the Architect for approval his proposals for the compaction of each main type of material to be used including those in relation to the type of plant, the number of passes and loose depth of layer. The first 2000 M2 of each kind of material placed shall be treated as compaction trial, supplemented by any necessary laboratory investigations, as required by the Architect, using the procedure proposed by the Contractor and shall satisfy the Architect that all the specified requirements regarding compaction can be achieved.

The Contractor shall then compact each layer to the required depths using smooth wheeled, vibrating or pneumatic tyred rollers approved on the basis of the results of the trial compaction areas. During compaction any loose or large stones shall be removed from the layer under compaction.

No layer shall be covered by the next layer until it has been tested by the Contractor and approved by the Architect.

#### **16.1.11 Earthworks Test Procedures**

Where defined, tests shall be carried out in the procedure listed below:

<u>Test</u>	<u>Procedure</u>
1. Liquid limit	BS 1377/1975 Test 2
2. Plastic limit	BS 1377/1975 Test 3
3. Plasticity index	BS 1377/1975 Test 4
4. Particle size analysis	BS 1377/1975 Test 7
5. Compaction test	BS 1377/1975 Test 13 or 14
6. Moisture content	BS 1377/1975 Test 1

The results obtained in test 13 and 14 on the fraction passing, the 20 mm sieve shall be adjusted as follows where that fraction is less than 95% of the soil.

The maximum dry density shall be adjusted to  $(\% \text{ passing } 20 \text{ mm} \times \text{test maximum} \times \text{specific gravity of optimum}) \div (\% \text{ passing } 20 \text{ mm} \times \text{test optimum} \times 0.01) + (\% \text{ retained on } 20 \text{ mm} \times \text{moisture content of particles retained on } 20 \text{ mm after immersion in water followed by drainage but not drying})$ .

7. Field Dry density Sand replacement (large pouring cylinder)	BS 1377/1975 test 15B
8. CBR Test	BS 1377/1975 test 16

#### **16.1.12 Frequency of Testing**

Sub-grade, embankment materials, rockfill, sub-base and base material.

During the first 1000 M2 of each type of material placed, a complete analysis shall be carried out on material recovered from at least three areas selected by the Architect.

During subsequent construction, a complete analysis shall be carried out on material recovered from each layer of construction at intervals not exceeding 2000 M2. A complete analysis shall consist of tests 1 to 8 as defined in clause 16.1.11 "Earthworks Test Procedures" above in this section of the specification.

#### **16.1.13 Prime Coat**

The surface on which bituminous material is to be laid shall be first brushed completely free from all loose particles and dust by a mechanical broom so as to expose a closely knit, compact mosaic of stone. It shall be sealed with a prime coat of cutback bitumen RC70 or RC250 ASTM D 2028 or AASHO M 81 for open surfaces or MC70 or MC250 ASTM D 2027 or AASHO M 82 for tight surfaces. The prime coat shall be applied at a rate approved by the Architect in the range of 1.1 to 1.6 litres per square metre so that it penetrates about

3 to 6mm and dries to a matt surface in 24 to 48 hours, leaving no pools of free bitumen on the surface. The prime coat may be applied on a damp surface to assist its penetration.

The area to be primed shall extend 150mm outside the width to be covered by the bituminous material.

The prime coat shall not be applied until the Architect has approved the course on which it is to be applied.

The overlying bituminous, course shall not be laid less than 24 hours after the completion of the prime coat.

#### **16.1.14 Tack Coat**

All UPVC pipework that penetrates the structure, shall be inserted between the bitmac base course and wearing course. The surface of the base course shall be swept clean of all loose particles and dust with a mechanical broom immediately prior to application of the tack coat which shall be cutback bitumen RC70 ASTM D 2028 or AASHO M81 or emulsified bitumen RS-1 (anionic) ASTM D 977 or AASHO M 140 or CRS-1 (cationic) ASTM D 2397 or AASHO M 208. The tack coat shall be applied at a rate approved by the Architect in the range of 0.3 to 0.5 litres per square metre of residual bitumen.

#### **16.1.15 Bituminous Macadam (Bitmac)**

Bituminous macadam base course and wearing course shall consist of coarse aggregate, fine aggregate, filler and binder in the proportions specified herein and shall be batched, mixed, laid and compacted in accordance with the following requirements.

#### **16.1.16 Aggregates for Bitmac**

1. The coarse aggregate for bitmac base course shall be hard, clean and durable crushed rock or screened and crushed gravels or a combination thereof. At least 50% of the coarse aggregate (retained on the BS 2.36 mm sieve) shall consist of crushed material.

2. The coarse aggregate for bitmac wearing course shall be hard, clean and durable crushed rock or crushed stone from gravels. The coarse aggregate shall have a crushing value of less than 25% flakiness and elongation indices of less than 20% and a loss after 5 cycles of the sodium sulphate soundness test of less than 12%. Its specific gravity shall be in the range or 2.5-3, the water absorption shall be less than 3% and the Los Angeles abrasion less than 25%.

3. Fine aggregate for base course and wearing course shall consist of fines produced in a crushing plant from material satisfying the requirements for the coarse aggregate and/or approved clean natural river or pit sand.

4. Mineral filler shall consist of finely ground particles of Portland cement or other non-plastic mineral matter approved by the Architect. It shall be free from foreign matter or other deleterious material.

#### **16.1.17 Binder for Bitmac**

The binder shall be 60/70 penetration straight run bitumen complying with AASHO Designation M20.

#### **16.1.18 Composition of Mixes for Bitmac**

The particle size distribution of the combined aggregate and filler when determined by the method specified in BS812 Part I, Method 7.1 and the bitumen content shall lie within the following limits:

BS Sieve size (mm)	Bitmac Base	Bitmac Wearing Course
28	100	-
20	80-100	100
14	62-83	95-100
10	53-72	70-79
5	39-55	38-55
2.36	27-43	23-39
1.18	18-32	15-30
0.600	11-27	10-22
0.300	7-20	7-17
0.150	4-13	5-11
0.075	2-8	3-7
Bitumen Content (%)	3.5 to 5.00	4.5 to 5.5

#### 16.1.19 Selection of Job Mixes for Bitmac

Before surfacing begins, the Contractor shall submit in writing to the Architect the precise gradings of combined aggregates and the bitumen content proposed for each mix of bitmac. Such grading when plotted shall be approximate as closely as possible to the shape of the plotted average of the limits of grading specified and shall lie within the grading envelope in each case.

The Architect will then either give approval in writing or order changes to the proposed bitmac mixes and full scale plant trials shall be carried out for each mix using a range of bitumen contents.

The precise combined aggregate grading and bitumen content which complies with the specification and is acceptable to the Architect following the plant trials will be known as the "Job Mix" for that mix. Unless specifically permitted by the Architect, the maximum permissible variation from an approved job mix shall be as follows:

Materials	Percentage of total combined aggregate
Aggregate passing BS sieve sizes other than those referred to below	± 5 percent
Aggregate passing B.S. sieve size 5mm	± 4 percent
Aggregate passing B.S sieve sizes 2.36 mm, 1.18 mm	± 3 percent
Aggregate passing B.S. sieve sizes 0.600-0.150mm	± 1.5 percent
Aggregate passing B.S. sieve size 0.075 mm	± 1.0 percent
Bitumen content	± 0.3 percent

#### 16.1.20 Mixing of Bitmac

Mixing shall be carried out in an approved batching plant conforming to the requirements of ASTM designation D995. The mixing time shall not be less than that recommended by the plant manufacturer, or such longer time as may be required to ensure adequate coating of aggregate and uniform distribution of the bitumen through the mix. The mixing time shall be approved by the Architect. The plant shall not be operated at a higher speed than the manufacturer's rated capacity. The plan shall be such that added mineral filler can be kept dry and can be separately stored and weighed. It shall be possible to introduce the added filler separately in the mixer if required by the Architect. All aggregates on leaving the drier shall have a moisture content of less than 1%.

The Architect shall be satisfied that the plant is capable of accurately proportioning the aggregates, filler and bitumen by weighing, and means shall be provided for checking the accuracy. Such checks shall be carried out whenever the Architect may require. If the checks reveal that the plant is inaccurate no bitmac from the plant shall be used until the fault has been rectified to the Architect's satisfaction.

The bitumen should be heated to a temperature of between 140° C and 170° C before introduction to the mixer and a thermometer shall be fixed in the feed to the mixer in such a position as to measure the average temperature of the bitumen.

The aggregate shall be fed into the mixer at a temperature of between 140° C and 185° C and at no time shall its temperature vary by more than 15° C from that of the bitumen. The aggregate and bitumen shall be thoroughly mixed before admission of any added filler and then mixed for a further 30 seconds or for such longer period as may be necessary to coat all the particles.

The Contractor shall ensure that throughout the mixing and delivery of the bitmac no leakage of any of the materials takes place and no extraneous matter is admitted to the mixture.

#### 16.1.21 Transporting of Bitmac

Bitmac shall be transported from the mixer to the work site as rapidly as possible in dust-proof vehicles with metal floors. If necessary, during the winter, the bitmac shall be protected against loss of heat so as to ensure a suitable temperature at the spreader.

#### 16.1.22 Spreading and Laying of Bitmac

The material shall be laid by a mechanical spreader and finisher except in confined spaces where it is impracticable for a power spreader to work.

The spreader and finisher shall at all times be adjusted and operated to eliminate segregation of the mix and to provide an even flow of mix across the full width of screed.

The vibrating tamper or screed of the spreader and finisher is to be arranged to apply the same degree of compaction across the full width of paving. The speed of the spreader and finisher and the rate of supply of

the mix shall be matched so as to avoid stopping the spreader between successive loads.

The spreader and finisher shall be operated to move up to the trucks transporting the mix, which shall either be stationary or moving in the same direction as the spreader at the time of contact. When laying bitmac on gradients steeper than 4%, the paver shall be operated in an up-hill direction.

The materials shall be spread at a uniform density and struck off at a level such that after compaction, the surface shall conform to the level, grade and uniformity specified.

When the edges of longitudinal joints are irregular, honeycombed or poorly compacted, all unsatisfactory sections of joints shall be trimmed to expose an even, vertical or sharply sloping surface for the full thickness of the course. Fresh mixtures shall be raked uniformly against the joint, flowed by rolling. The Contractor shall so organise his work that as far as possible there are no exposed longitudinal joints left at the end of any day's work. Failing this, the joint shall be cut back to a vertical face and pointed with hot binder immediately before the adjoining surface is laid.

Joints between new work and previously constructed roads or other paved surfaces shall be formed by cutting back the existing work to form a vertical face which shall be pointed with hot binder. The adjoining surface material shall be laid up to the joint and any irregularities at the joint shall be feathered out prior to rolling.

After laying and before rolling, the surface shall be checked for compliance with Clause 16.1.26 "Surface Levels and Tolerances of Constructional Layers".

#### **16.1.23 Rolling of Bitmac**

As soon as rolling can be effected without causing undue displacement of the mixed material and whilst the temperature is in the range of 110 ° C - 140° C the bitmac shall be thoroughly and uniformly compacted by means of 6-8 tonne tandem roller with a drive roll pressure variable between 2200/2500 and 3600/4000 KG/M of roller, or 8-10 tonne tandem roller with drive roll pressure variable between 3200/3600 and 4000/4900 of roller.

The roller shall travel slowly enough to avoid displacement of the hot mixture and successive trips shall overlap. Care shall be taken to avoid displacing the bitmac when reversing the roller.

Rolling shall be finished using a 10-12 tonne tandem or three-wheel roller with a rear roller pressure variable up to at least 5300 Kg/m. Rolling shall be continued until all roller marks are eliminated. Rollers shall not remain stationary on freshly compacted surfaces.

Roller wheels shall be equipped with adjustable scrapers, water tanks, and sprinkling apparatus, which shall be used to keep the wheels wet for the purpose of preventing the bitmac from sticking to the wheels. The rollers shall be otherwise suitable for rolling hot-mix surfacing and shall be capable of reversing without backlash.

#### **16.1.24 Testing of Bitmac**

The following tests are required:

- a. The Marshall Stability test to be greater than 680 Kg.
- b. The Marshall Flow to lie in the range of 2-4 mm.
- c. The voids in the total mix shall be 3-8 percent for the base course and 3-6 percent for the wearing course.
- d. The material passing through the 5mm sieve shall have a Sand Equivalent Value not less than 40 for the base course and not less than 50 for the wearing course.

#### **16.1.25 Frequency of Testing**

Tests on bituminous materials and workmanship shall be carried out any time requested by the Architect or the Architect's representative and shall not be less than the frequencies specified below:-

- a. Aggregates for Bituminous Layers: Prior to the opening of any borrow pit or the use of any stockpile, a complete analysis shall be carried out. A complete analysis shall consist of determination of Flakiness Index, Aggregate Crushing Value and Aggregate Abrasion Value as described in BS 812.
- b. Bitumen: Every consignment of bitumen for use in the Works must be accompanied by a Certificate of Testing. The Certificate shall be that of an approved laboratory.
- c. Bituminous Mixtures: Determination of bitumen content and aggregate grading by the simple hot extractor method, or other approved method, shall be carried out each day.

#### **16.1.26 Surface Levels and Tolerances of Construction Layers**

The level of any point on the surface of each of the constructional courses shall conform to the tolerances shown in the Table below:

Type of Constructional Layer Level	Tolerance from true surface level of course	Maximum Depression tested under a 3m straight edge
Sub-grade	+ 5 mm to -25 mm	15 mm
Sub-base and Road Base	+ 10 mm to -15 mm	10 mm
Bitmac Base Course and Single Course work	+6 mm to - 6 mm	6 mm
Shoulder	+0 to -10 mm	10 mm
Bitmac Wearing course	± 6 mm	3 mm

#### **16.1.27 Rectification of Surface out of Tolerance**

The surface area of any layer which does not comply with the requirements of the above clause shall be rectified as follows:

#### **16.1.28 Base Course**

Measurement of level and tolerance shall be made while the material is still warm and rectification where necessary carried out immediately. Regulation of low areas with the same type of material with the coarse aggregate omitted may be permitted, otherwise the whole area involved shall be removed to the full depth of the layer and reconstructed with fresh material.

#### **16.1.29 Wearing Course**

Measurement of level and tolerance shall be carried out immediately after laying and before rolling, and rectification, where necessary, carried out immediately. Regulation after rolling will not be permitted. The whole area shall be removed to the full depth of the layer and reconstructed with fresh material after any necessary regulation of the exposed base.

#### **16.1.30 Shoulders**

Where shown on the drawings, shoulder shall be constructed with the same material as for the Roadbase.

The shoulder shall be constructed soon after the completion of the wearing course.

The surface preparation of the shoulder shall be carried out as defined in clause 16.1.13 "Prime Coat".

Prime coat shall be applied at a rate between 1.1 and 1.6 litres per square metre and left for 24 hours.

A single surface treatment shall be carried out as follows:

Road base material shall be applied at a rate of 13 to 17 Kg per square metre within one minute of the application of the bitumen.

At least 96% of the aggregate shall pass a B.S. 10 mm sieve and not more than 10% shall pass a 2.36 mm B.S. sieve. The shoulder shall be compacted with a pneumatic tyred roller.

#### **16.1.31 Upgrading of Existing Asphalt Road**

All deficiencies of the existing surface shall be made good and all sags and depressions shall be levelled with patches of wedges of thickness not exceeding 80 mm.

The surface of the existing road shall be thoroughly cleaned from foreign matter with compressed air and/or mechanical means to the approval of the Architect. Tack coat of RC70 shall be applied to the surface at a minimum rate of 0.5 litres per square metre.

The tacked surface shall be clear of all vehicular and other traffic.

Wearing course shall be placed as specified with at least 24 hours lapse from the application of the tack coat.

Footpaths, curbs, lay-by and shoulders shall be constructed as specified and as shown on the drawings.

#### **16.1.32 Earthworks to be kept Free of Water**

The Contractor shall arrange for the rapid dispersal of water shed on the earthworks or completed formation during construction or which enters the earthworks from any source and where practicable the water shall be discharged into the permanent drainage systems. The arrangements shall be made in respect of all earthworks including excavations whether for pipe trenches, foundations or cuttings.

The Contractor shall provide where necessary temporary water courses, ditches, drains, pumping and other means of maintaining the earthworks free from water. Such provision shall include carrying out the work of

forming the cuttings and embankments in such a manner minimum cross fall and where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

#### **16.1.33 Use of Surfaces by Constructional Plant**

Constructional plant used shall be suitable in relation to the materials, condition and thickness of the surfaces it traverses so that no damage is caused. Any damage caused by the use of Constructional Plan shall be made good by the Contractor at his own expense.

#### **16.1.34 Kerbing for Roads and Parking Areas**

Kerbs shall be manufactured to the dimensions shown on the drawings. Kerbs shall be bedded and backed on Grade 20 concrete to the correct lines and levels as shown on the drawings.

Kerbs of the appropriate radii shall be used on curves with radii of 12 metres or less.

Tolerances permitted on the dimensions shall be +1.5 mm, -3.0 mm for the width and  $\pm 3.5$  mm, for the height over 3 metres length.

All angles of the products with the exception of the angles resulting from the splayed or chamfered faces in the sections shown on the drawings shall be true right angles. The arises shall be clean and, with the exception of the rounded arises, sharp. The wearing surfaces shall be true and out of winding and shall present a clean, homogeneous appearance.

Expansion joints as shown on the drawings shall be constructed at distances not exceeding 30 m.

The rates for kerbing shall include the supply or manufacture of kerbs, excavation, foundation bed and haunch, laying and backfilling.

### **16.2 CONCRETE TILES FOR PAVEMENTS AND HARD LANDSCAPING**

#### **16.2.1 Manufacturing of tiles**

Concrete tiles for pavements shall be precast using automatic vibrating machine with hydraulic compression using Grade 25 concrete as described in Section "Concrete Work" of this specification.

The dimensions of each tile shall be 400 x 400 x 35 mm. The upper face shall be smooth and level and a chamfer 5 mm wide should be made for the edges of the upper face of the tile. The paving slabs with exposed aggregate facing on the upper face shall be to the Architect's approval.

The aggregate should be sieved to get sand separated. It should be washed so that earth and organic materials could be removed. Then materials should be mixed according to the following gradations.

75%	4-12 mm Aggregate
15%	2-4 mm Sand
10%	less than sand 2 mm

These proportions should be kept during work by means of the necessary sieves.

Blending and addition of water shall be carried out automatically. Twenty-four hours after manufacturing, tiles have to be put into water basins for three days. After, they shall be sprayed with water in the morning and evening for a period of two weeks and kept under shade.

#### **16.2.2 Placing of Tiles**

The tiles for pavement shall be laid on well sprayed and compacted hardcore and on 25 mm of 1:3 cement/sand mortar.

A 5 mm joint shall be left between the tiles and shall be grouted with cement/very fine sand mortar tinted as appropriate to match the colour of the slabs. The mortar shall be brushed well in and afterwards the tiles shall be cleaned off.

#### **16.2.3 Tolerances**

The tolerance permitted on the width of individual tiles shall be  $\pm 2$  mm.

The placed tiles shall have a maximum depression, tested under a 3 m straight edge, of 3mm. The joints shall be parallel to the kerb.

### **16.3 CONCRETE BLOCK PAVING**

#### **16.3.1 Paving Blocks**

Concrete blocks to be used for external paving shall be 200 x 100 x 60 mm thick of colours as indicated on the Architectural drawings and shall be supplied by Messrs Dalico Ltd, P. O. Box 1417, Nicosia or other similar and approved.

#### **16.3.2 Sub base Bedding Materials**

Concrete for sub base shall be Grade 20, maximum aggregate size 20 mm, with high workability.

Sand for bedding shall be sharp and well washed (Zone 2 or 3 to BS 882 with silt and dust content not exceeding 3 percent by weight and not more than 15 percent retained on a 2.36 MM sieve).



### **16.3.3 Workmanship**

Construct concrete sub base to a thickness not less than 100 mm. The Contractor shall ensure that no traffic is allowed on the sub-base until 14 days after casting. If earlier access for traffic is desired, the Contractor must submit his proposals to the Architect for approval.

The Contractor shall ensure that the sub-base is constructed to the correct levels and falls and shall make good all damage to the sub-base and clean off excessive dirt before laying the blocks.

### **16.3.4 Laying Blocks**

Provide and lay 60 mm blocks as described in accordance with block manufacturer's recommendations.

The Contractor is to ensure that all kerbs, channels, and other edge restraining features are complete before laying blocks to keep the blocks in compression so that they act integrally.

Lay blocks at junction with asphalt road and working into the site.

Lay bed of sand not less than 50 mm thick and carefully adjust so that finished paving is to correct levels and even falls. Prevent trafficking by vehicles or pedestrians until blocks are laid.

Lay blocks butt jointed to a regular herringbone and/or stretcher bond pattern as indicated on the Architectural drawings and neatly cut blocks to fit at margins.

Use a vibrator with a plate area between 0.2 and 0.3 m<sup>2</sup> and a centrifugal force of approximately 1 tonne to thoroughly compact blocks into sand bed to final levels.

Dry sharp sand shall be brushed over the laid paving and vibrated into position using 2 or 3 passes of a plate vibrator as used for compaction until the joints are filled. Surplus sand shall be brushed off the finished surface.

## **16.4 NATURAL STONE PAVING**

Natural stone for paving shall be either laid in an irregular stone pattern or cut stone pattern as indicated on the drawings.

### **16.4.1 Natural stone laid in an irregular stone pattern**

These shall be bedded on a concrete sub-base or a drainage course on compacted subgrades.

### **16.4.2 Natural stone laid in a cut stone pattern**

These shall be soft laid directly on a drainage course on well compacted subgrade.

### **16.4.3 Drainage Course**

The drainage course shall comprise a minimum of 150 mm well compacted hardcore of stone, bricks, broken concrete or other approved hard material of 75 mm gauge hand packed solidly and evenly. The surface shall be blinded with broken stone or other approved fine well graded material which shall then be rolled with two passes of the roller. Final levels shall be true.

### **16.4.4 Concrete sub-base**

Concrete for sub-base shall be Grade 20, maximum aggregate size 20 mm, with high workability constructed to a thickness not less than 100 mm. The contractor shall ensure that no traffic is allowed on the sub-base until 14 days after casting. If earlier access for traffic is desired the contractor must submit his proposals to the Architect for approval.

The Contractor shall ensure that the sub-base is constructed to the correct levels and falls and shall make good all damage to the sub-base and clear off excessive dirt before laying the stone.

### **16.4.5 Laying Natural Stone Paving**

Provide and lay local sandstone or other similar and approved stone paving with split face and a minimum thickness of 40 mm. The stones shall be of random size and laid according to the pattern indicated on the drawings. No continuous straight joints shall run for over 1 M unless otherwise directed. The joints shall be 10 mm + 2 mm wide for the stones laid in a cut stone patterns.

Stone cutting necessary on site shall be carried out using an approved saw and hammer and bolster to leave a straight broken upper edges (except for irregular stone pattern pavings).

Brush semi-dry 1:2 by volume cement: sand mortar into the joints and firmly pack to leave rounded joints 5 mm below paving surface. All surplus mortar shall be brushed off the completed surface as work proceeds and the finished joints watered carefully using a watering can fitted with a fine rose.

Completed work containing cement shall be protected from frost and premature drying for at least seven days from completion by securely fastened impermeable plastic sheeting with 100 mm joints.

## **PART 2 - PARTICULAR SPECIFICATION**

### **17.0 PARTICULAR SPECIFICATION**

#### **17.1 SAMPLES**

The Contractor shall submit samples of all materials to the Engineer for his approval as soon as possible after the commencement of the Works. Such samples shall be accompanied by a letter describing the material together with any test or other certificates where appropriate.

#### **17.2 APPROVAL OF DIRECT SUBCONTRACTORS/SUPPLIERS**

The Contractor immediately after his appointment shall submit to the Architect for his approval the names of all his direct sub-contractors and suppliers. The Architect and Client reserve their right to object to the appointment of any direct sub-contractors or suppliers against whom the Architect or Client shall have reasonable objection of being appointed to execute work on this project.

In such case, the Contractor shall appoint another sub-contractor or supplier to the approval of the Architect or Client at no extra cost.

#### **17.3 WORKING AREAS**

The area to be used by the Contractor during construction of the Works is restricted. The Contractor shall not make use of other areas apart from the allocated site. The contractor must establish strict controls of his personnel that no one should enter to areas outside the delineated working areas.

Any damages caused by the Contractor or his sub-contractors shall be made good at the expense of the Contractor.

#### **17.4 EARTHWORK SUPPORT**

Earthwork support shall mean providing everything requisite to uphold the sides of excavation by whatever means are necessary. The Contractor is to allow in his rates for earthwork support to all excavations.

#### **17.5 SPOIL HEAPS**

Selected excavated material from existing spoil heaps on site is to be utilised as backfill to the volumes of excavation. The Contractor's attention is drawn to the fact that he is to provide sufficient drainage to the areas of the spoil heaps to prevent the flow of the material to prepared or completed Works, or maintain such drainage, is existing, to the areas of the spoil heaps until such time as the backfilling material is utilised or carted away.

#### **17.6 EXISTING SERVICES**

The Contractor shall take all precautionary measures not to disturb any existing services. All damage caused to these services shall be reinstated at the expense of the Contractor. The Contractor must allow in his tender for all necessary hand digging where work has to be carried out adjacent to existing services installations and for preparing and submitting as-built drawings for all existing services.

#### **17.7 TEMPORARY PROTECTIONS**

The Contractor shall delineate the areas of works with proper fences/barriers and canvass at least to a height of 2 meters. These shall be maintained throughout.

When working on roofs, the contractor shall establish temporary railings for safety purposes. No materials shall be stored on roofs and not more than 5 persons at any given time shall be allowed on the roof of the hall.

The Contractor must allow in his tender for all costs associated with the temporary protections.

#### **17.8 DEMOLITION OF CONCRETE AND OTHER STRUCTURES**

Where possible, breaking-up of concrete and other structures above and below ground levels to be done using special methods. The use of compressed air plant is to be minimised. Any demolition includes loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required to complete the work. Intervention to be carried out without damaging neighbouring structures.

### **17.9 CONTRACTOR TO KEEP SITE CLEAR**

During the progress of the Works, the Contractor shall keep the site reasonably free from all unnecessary obstructions and shall store or dispose of any constructional plant and surplus materials and clear away and remove from site any wreckage, rubbish or temporary works no longer required.

### **17.10 CLEARANCE OF SITE ON COMPLETION**

On completion of the Works, the Contractor shall clear away and remove from the site all constructional plant, surplus materials, rubbish and temporary works of every kind, and leave the whole of the site and Works clean and in a workmanlike condition to the satisfaction of the Architect.

### **17.11 CONCRETE WORK**

All corners to fair face concrete shall be chamfered by the use of triangular beads.

### **17.12 TUBE AND COUPLER SPECIFICATIONS**

#### **THE MATERIALS**

The Tube-Coupler system foreseen for the protection belongs to the production line of Marcegaglia group - Ponteggi Dalmine division.

#### **The tubes**

Raw material: Steel grades S235JR and S355JR

Protection:

- Surface protection
- Hot dip galvanizing: guaranteed min. coating thickness 55 micron (mean value)
- Sendzimir galvanizing: guaranteed min. coating thickness 15 micron (mean value)
- Painting, minimum durability tested to ASTM D 2247-87 moist-room test.

Dimension:

Outside diameter: 48,3 m  
Nominal thickness: 3,25 m  
Section: 4,59 cm<sup>2</sup>  
Geometric moment of inertia: 11,69 cm<sup>4</sup>  
Section modulus: 4,85 m<sup>3</sup>  
Radium of gyration: 1,59 cm

**Cut length:** 6,0 m; 5,4 m; 5,0 m; 4,5 m; 3,25 m; 3,0 m; 2,75 m; 2,5 m; 2,25 m; 2,0 m; 1,8 m; 1,5 m; 1,25 m; 1,2 m; 1,0 m; 0,9 m; 0,75 m; 0,6 m; 0,5 m; 0,4 m.

#### **The couplers**

Coupler material: Steel grade S355JR, Cold formed High resistance and ductility

- 4,75 mm thickness

#### **Protection**

- Tropicalization
- Hot dip galvanizing, passivation
- min. coating thickness 8 micron

Characteristics

- Right angle couplers tested to EN74, Class B; swivel couplers tested to EN74, Class A
- Live load allowance: 1100 daN (gathered from 5% frattile value)
- Tensile strength: 420÷540 N/mm<sup>2</sup>, steel grade S355JR
- Yield point: steel grade S355JR  $\geq$  365 N/mm<sup>2</sup>
- Elongation: steel grade S355JR  $\geq$  19%

### **17.13 CUT AND FILL & STONE TREATMENT**

17.13.1 Detachment and replacement of existing masonry when stones have lost their stability, or when removal is necessary to make structural works. After removal of decayed masonry, stones shall be

replaced in their original position and texture.

17.13.2 Masonry work carried out by “cut and fill”, step by step, partial or full width/depth, on existing masonry structures, damaged or to be repaired, with whole sandstone stones at any height or depth. To be carried out with:

- erecting scaffolding and shoring for safety of masons, if necessary.
- Removal of any decayed masonry with appropriate metal chisels avoiding damage on stones.
- Work should be done removing mortar from the joints, eventually using micro milling cutter.
- Cutting the old masonry shall be done one section at a time;
- Prepare adequate connections to existing masonry.
- Deep cleaning and wetting of surfaces.
- Insertion of masonry with suitable cement-free binder
- Masonry shall reproduce original texture, alignments, horizontality of layers, if existing, and hypothetical shape of missing parts.

17.13.3 Work includes: supply of all the materials required; loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required to complete the work.

17.13.4 Colour veil aesthetical treatment on new stones to reduce tonality of new stones in order to guarantee a homogenous colour between new and old stones. Application of the 2 or 3 coats of colour veil to be done with a soft brush and taking into consideration the different absorption of the stones. Composition must be decided upon samples to be approved by the site architect. Typically, the composition shall use the following materials: water, primal AC33, lime and natural colours (such as Siena Yellow, Burnt Umber, etc.). Proportions to be decided upon sampling (e.g. – 1 part of water (1 white jar) + 1 brushes of primal AC33 + 4variable brushes of Colour).

## **17.14 MORTARS**

Samples of mortars with different tones and coarseness shall be prepared in order to use the materials most matching to the existing ones. In the samples the proportions of stone dust and sand shall vary and the sand shall be selected and mixed from various colours and sieved to varying degrees of coarseness as may be appropriate for any particular mortar.

17.14.2 Hydraulic lime mortar. Natural hydraulic lime (lime obtained from calcareous stone containing a little percentage of clay, mainly silicium and alumina, without additives. Lime with medium hydraulicity (NHL 3,5) shall be used. Binder: sand ratio: from 1:1.5 to 1:3 depending on the support/background conditions, the size of the joint and the fineness of the sand. Always use well graded sands (3 - 4mm down to 75 microns).

All exterior mortar shall include acrylic emulsion (see below *Acrylic Emulsion*) diluted at 10% solution in chlorothene.

17.14.3 Transpirant render (Mape antique intonaco NHL or similar approved). Cement free light-coloured pre-mixed powder mixture of hydraulic binders with pozzolanic action and finely graded natural sand to be applied as render. The mortar shall have the porosity and transpirability properties of antique lime and pozzolan based mortars to allow crystallisation of salts in its porosity and a slow and gradual evaporation of capillary flow of rising damp from the foundations. Mortar shall be prepared with a drill fitted with an agitator, mixing a 25 kg of mortar with 5.75-6.0 litres of water until completely blended. Mortar shall be applied by trowel or spatula on clean substrates that have been saturated with water beforehand, 1 mm under original plaster surface. After 15-20 minutes the surface can be float finished with a sponge to achieve a coarse finishing.

17.14.4. Fine grained plaster finishing (Mape Antique FC civile or similar and approved). Salt-resistant, fine-grained lime and Eco-Pozzolan-based transpirant smoothing white pre-blended sulphate-resistant mortar to be applied on lime-based render. Mix a 25 kg bag with 5.75-6.0 l of water with a drill fitted with an agitator until completely blended. Apply with a trowel or spatula on clean substrates that have been saturated with water beforehand, in a thickness of 1-max 2 mm. After 15-20 minutes the surface must be finished with a sponge float.

17.14.5 Acrylic emulsion (Acrylic 33 or similar and approved). Acrylic emulsion with non-volatile residue 46+-1%n.v.r. specific weight 1,07aspect white milky liquid colloidal charge non-ionic White liquid - Ph: 9

ca. - Viscosity: 3500 mPA.S. ca. Emulsion shall have: good inside and outside resistance, good stability to frost/thaw, great compatibility with charges and pigments, very good resistance to soluble salts including bivalent salts, good mechanical stability, very thin dispersion and good pH stability.

#### **17.19 SCAFFOLDING FOR WORKS**

17.19.1 Scaffolds made of Tube-Coupler system, with working levels carried out in such a way as to allow the restoration works on the masonry, including safety ladders, two protective side railings, side feet board, grounding and synthetic fibre net for shielding of scaffoldings. Installation and maintenance of scaffolding shall be guaranteed all along the restoration works of external surfaces. Ground floor level must be secured against not authorised access.

17.19.2 Duty of the site architect will be to verify condition of all surfaces and advise if any critical condition, which is not described in the emergency intervention design, is detected, in order to amend/modify works that have been tendered.

17.19.3 Mounting of scaffolds in the interior must be carefully realised in order not to let fall material on the protection box.

#### **17.20 REMOVAL OF MORTARS AND NEW POINTING**

17.20.1 Removal to be carried out without damaging the neighbouring stones with small chisel, deep to remove all decayed or pulverised material.

17.20.2 Bedding mortar. Cracks exceeding 2 cm must be filled with small rubble and bedding mortar to create a support to mortar, as follows:

- Remove dust and debris.
- Dampen joints to control suction as necessary.
- Apply the mortar with a spatula in the deep voids that need to be filled, adding some fragments of wet brick if needed. Bedding mortar surface has to be recessed from the final surface of the stone.
- Press the mortar with proper tools.
- Once the carbonation process has started, the surface has to be impressed by several crossed lines in order to make easier the adhesion of the following layer of mortar.

17.20.3 Repointing/seal to opened or damaged joints. To be carried out as follows:

- Remove mortar carefully and without damaging adjacent masonry or widening joints. Form a neat square recess of depth not less than twice thickness of joint. Remove dust and debris.
- Dampen joints to control suction as necessary. Press mortar well into joints so that they are fully filled. Ensure that no mortar encroaches upon the face of the masonry.
- Finish joints neatly to match existing adjacent joints.
- Press mortar with a sponge to let the stone grains come out.
- Wash the surface with atomized water in order to remove the superficial layer of lime.
- After the starting of the carbonation process press and damp with atomized water must be repeated to slow down the carbonation and to improve the mechanical resistance of the mortar.

#### **17.21 INTERVENTION ON DRAINS**

17.21.1. During the intervention on the down pipe to protect area against rain water by means of a temporary barrier around the drains, in order to divert water to existing drains. Intervention must be carried out after intervention on roof membrane and the drain on the south facade is reactivated. In case of rain area will be protected with polyethylene sheet.

17.21.2. Demolition of manhole. Demolition of the drains to downpipe on the terrace. Demolition of the separation wall between the two roof terraces, as described in the drawings. Clear the site of rubbish, grub up bushes, shrubs, vegetation, etc., clear and cart away. During demolition works, protection from debris entering the downpipes and manholes should be ensured.

17.21.3. New downpipe. On the terrace the downpipe will be properly connected to a drain channel protected by a removable (for inspection) dome grating. Joint between the downpipe and the terrace made with double sealing, with damp-proof fibre-reinforced membrane.

17.21.4 Open-air channel from north terrace to south terrace: damp-proof membrane, bedding mortar and terracotta tiles to the drain corresponding to the downpipe, as described in the drawings and copper metal waterspout.

17.21.5 Copper cover around interior pvc pipe, fixed to the wall with screws placed on the mortar joints.

17.21.6 Copper downpipe and leader head on the south facade, under the waterspout, according to drawings. All straps fixed to the wall with screws placed on the mortar joints.

## **17.22 REPLACEMENT AND/OR REPAIR OF WOOD CLOSINGS/ WALLINGS**

17.22.1. Dismantling of existing closings, including wooden boards, glasses, insulating panels, and interior panels. The timber frame must be preserved, transformed and fixed, to be as good as new.

17.22.2 Decayed timber elements must be cut off and supplemented with new ones in order to transfer properly loads into the shear walls. New timber must be scarfed to existing, wedged and bolted top to bottom. Treatment of timber against fungal and insect attack made by a non-layer-forming wood finishing treatment based on natural raw materials.

17.22.3 Propping of frames must come first any cut is done to existing timber frames.

17.22.4 Metal frames supporting new doors must be connected to timber frames by metal brackets and flanges.

17.22.5. New timber closings to be realised as follows:

- Cut timber frame and adapt to new openings.
- Insert metal frame of new doors.
- Screw exterior 20mm thick OSB panel to timber frame. Boards need to be placed as close as possible to the border stone wall, to seal any possible joint, taking care not to damage the stone. Joints between boards to be covered by sealing tape for OSB panels.
- Black waterbased acrylic paint on surface, taking care to protect all contact areas with stone work against paint damage.
- Extra seal to joints OSB /stone and osb/metal frames with a L shape flexible galvanised metal element and a self expanding gasket. Metal seal and gasket need to be positioned simultaneously. Metal element to be nailed to OSB panel. Self-expanding gasket will give a perfect seal to the borders of the OSB surface, though using a "dry" technique.
- Protection of the footing of the OSB surface with a galvanised sheet L shaped element.
- Flexible wood fibre insulation in between the timber frame th. 110cm density 50Kg/m3, placed from the inside against the osb panels.
- Interior panelling of the closing with gypsum fibre board 25 mm screwed on the timber frame. Panels will be placed horizontally.
- Plasterboard, skim and paint on gypsum fibre panels.
- Jump stud to support exterior timber cladding 80x40 mm (to leave a cavity 80mm thick).
- Larch timber cladding 25mm. Boards with scurf cut on both ends in order to increase resistance to rain. Boards will be secret-nailed with stainless steel nails.

17.22.6 Finishing/protection of larch: the larch is intended to get the colour of graphite through aging. Protection against fungal and insect attack made by a non-layer-forming wood finishing treatment based on natural raw materials, to be applied on all the surfaces of the wood. Exterior surface to have a weathered appearance, to be accomplished or with specific natural surface wood treatment or through impregnation fluid added with grey colour pigment.

17.22.7 White paint to fiber-gypsum panels.

17.22.8 Gypsum Fibre panels recommendations:

### **Cleaning**

The sheets should be cleaned with a solution of warm water with a little neutral soap and rinsed with water employing a very soft sponge or chamois leather.

### **Cutting**

The common types of saws employed in wood or metal carpentry provide good results when sawing sheets: disc, band, sabre, jigsaw, hewing and handsaw. Disc or band saws produce the best edges and can perform almost all cutting operations. Blade shape plays an important role in sawing plastics. It is recommended to employ a band saw with separated teeth because the empty space will facilitate the exit of the cut chips. The best results are obtained using teeth without any inclination and also somewhat jumped. To prevent the plastic from cracking or melting, the blade must be very sharp and the guide should be very close to the cut to prevent vibration.

#### Polishing

The sheet edges can be buffed using buffing paste, first with a rigid fabric disc and then with a soft cloth to produce the final finish. The surfaces to be glued should be cleaned with a soft cloth and alcohol to eliminate all dirt and grease. For perfect gluing of the surfaces to be joined, they must fit together well (without exerting force and without leaving any cavities) and should also be smooth and unpolished. Some adhesives can contract on drying. This effect can be compensated by cutting the joint at an angle, thus leaving space to be filled with a slight excess of adhesive.

#### Drilling

Drill bits designed for use with plastics are recommended. It is occasionally possible to use ordinary drill bits, but they should be sharpened to reduce the depth or cutting angle. During the drilling operation, the sheet must be firmly held, but avoiding excessive pressure at the same time. The hole must be larger than the screw to allow for thermal dilation and contraction.

There must be a separation between the edge and the hole of at least twice the hole diameter. Speeds of up to 1,750 rpm are preferred for small drill holes and for larger holes, whereas speeds as low as 350 rpm are advised. The use of compressed air is recommended to prevent overheating, especially in cases where sheet thicknesses exceed 5 mm.

#### Gluing

##### Gluing with adhesives

Among the recommended adhesives are those based on solvents, hot melt, silicone, two-component polyurethane based, two-component epoxy based and adhesive tapes.

The following should be taken into considerations when selecting an adhesive:

- Chemical compatibility with the PC sheets
- Aesthetics of the finished joint
- Dilation and contraction with temperature changes
- Fragility, rigidity and flexibility
- Alterability with respect to outside weather, where applicable
- Duration / useful lifetime
- Adhesive strength (adherence to the plastic)
- Final usage requirements

## **17.24 DRY CLEANING WITH MICRO SANDBLASTER**

17.24.1 Sandblast cleaning of dust deposits with Garnet (abrasive natural mineral with hard grains and low hygroscopicity). Grade size: G3060. Pressure between 2 and 3 bars. Protective glasses and masks are mandatory while sandblasting.

17.24.2 Ancient plaster to be protected during sandblasting against damage.

17.24.3 Adjust with knob the pressure every time that needed, in order to have a perfect control of the cleaning.

17.24.4 Deep cleaning of surfaces and of Garnet powder after sandblasting.

## **17.26 REPLACEMENT/NEW OF MASONRY UNITS**

Masonry units: to match existing.

Mortar: As section 17.14, mix: to suit conditions.

Clean off old mortar from joints and dampen to control suction as necessary. Lay unit on a full bed of mortar and ensure that joints are fully filled. Prevent mortar from dropping into cavity.

Finish joints neatly to match existing as work proceeds or rake out for repointing where specified elsewhere.

## **17.27 EPOXY COATING ON MEMBRANE**

Aesthetical presentation of the terrace surface to hide the black waterproofing membrane. The treatment will be made with an epoxy, two component, equal volume epoxy system in combination with thoroughly dispersed fillers, including sandstone powder and other natural colours to look like stone, and a compatible hardener. Samples must be realised to address properly the colour and texture of the treatment.

Area must be clean and dry. Dirt, oil, rust, dust, grease, old coatings and other contamination should be removed. Area may be cleaned using acid-etching solutions.

### **MIXING:**

Base and hardener components are to be blended in equal volumes. When preparing less than a premeasured unit, use separate paper cups for measuring.

Stir each component separately before starting.

Stir and blend together thoroughly until a uniform, streak-free colour appears.

Always use clean mixing receptacles. Mixing can be manually with a stout wood stick or using a slow speed drill equipped with mixing propeller or cross-bar. Mixing can also be accomplished by placing both components onto flat tray and mixing with a trowel. Uniform dispersion of both components is important to assure proper curing and development of optimum chemical and physical properties.

### **APPLICATION:**

The thickness mortar is the one that will achieve to hide the membrane. Sufficient material must be used when joining to assure uniform contact and maximum adhesive strength. Fill entire void, opening or defect following conventional application methods for this type of treatment. Mortar should be pressed firmly to avoid bridging. Application can be by trowel, knife, or screened bar. Feather edges are best avoided. Square cut shoulder, regardless of whether floor, or other surfaces are recommended. Mortars are easily smoothed by keeping application tools clean and lightly wetted with mineral spirits. The latter acts as a skinning agent. Its use is intended strictly for surface finishing. Solvent additions of any type are not recommended for blending with this.

## **17.28 FERROMICA PAINT**

Properties: Water-based alkyd resin, lamellar aluminium, micaceous iron oxide and zinc phosphate anticorrosive enamel.

### **Application**

#### **On new ironwork**

The surface must be abraded slightly. Dust and degrease by washing down with thinner.

Apply one coat of water-based all-purpose primer.

Leave for 24 hours. Apply a two coats of water-based ferromicaceo, leaving 24 hours between coats. Do not apply when humidity is high, with low temperatures or on surfaces exposed to direct sun light during application.

#### **On wood**

Apply impregnating varnish used as a deep-acting preservative (preventing a film from forming on the surface), abrade slightly and free from dust.

Leave for 24 hours. Apply a two coats of water-based ferromicaceo, leaving 24 hours between coats. Do not apply when humidity is high, with low temperatures or on surfaces exposed to direct sun light during application.

The product must be stirred thoroughly in the tin before application to mix in any precipitate on the bottom, which is easily recovered. Stir the product every now and then during application. Because of the



special nature of the raw materials used, the product must be applied all in one go, without leaving off and resuming work later. For best results on particularly large surfaces, spray on the last coat required for final treatment. For special work requiring greater thicknesses to be applied, we recommend applying three coats of different colours.