

GENERAL TECHNICAL SPECIFICATIONS

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1.0 GENERAL**1.1 GENERALLY**

- A. Unless otherwise stated or contradicted, materials and workmanship specifications are to apply reciprocally between trades and sections.
- B. All work is to be executed in accordance with the specifications and the drawings.
- C. All references to and descriptions containing trade names, materials and procedures shall be deemed to include the phrase "or other equal and approved".

1.2 MATERIALS AND STANDARDS

- A. The works shall be designed, manufactured, delivered and applied in accordance with the latest revisions of the relevant sections / parts of the appropriate norms and standards.
- B. All materials, components and methods of workmanship are to be of the best quality consistent with the character of the works. All components are to be no lesser standard than those contained in the appropriate current standards specifications referred to in this specification. The quality of workmanship shall not be less than that set out in the latest appropriate Code of Practices or Trade Association guidance documents.
- C. Where local practice is such that an alternative material or quality of material to that specified is generally accepted, then the Engineer's approval must first be obtained before such alternative will be permitted to be used.
- D. If the contractor allows for such alternative in his rates without the prior approval of the Engineer, no extra cost or time will be allowed if subsequently the alternative is not approved.
- E. 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.
- F. All materials, components and workmanship are to be in accordance with good building practice.
- G. Samples of all materials shall be submitted for the approval of the Engineer.
- H. Materials rejected by the Engineer are to be removed from the site within 24 hours of such rejection and the Contractor shall substitute proper and suitable materials to the approval of the Engineer. 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

- A. Except where otherwise stated or contradicted, workmanship is to comply with British Standard Codes of Practice where applicable and in particular to BS 8000.
- B. 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.
- C. The Contractor is to do everything necessary to ensure that the standard of finish which is hereby demanded by this contract is achieved.
- D. Construct, exhibit and finally demolish and clear away sample panels of concrete, brickwork, block work, steelwork, of all finishing and of painting and decorating for approval. The finished work is to correspond to the samples.
- E. Provide such other samples of materials and workmanship as the Engineer may require.
- F. Work rejected by the Engineer is to be demolished and cleared away within such time as may be specified by the Engineer and re-executed to his approval. All additional costs in connection therewith shall be borne by the Contractor.

1.4 PIPE SIZES

- A. Pipes, tubes, bars, cables, conduits, standards and the like have been grouped and described as follows:-
- a. Small (i.e. not exceeding 55 millimetres diameter)
 - b. Large (i.e. over 55 millimetres but not exceeding 110 millimetres diameter)
 - c. Extra Large (i.e. over 110 millimetres diameter)

1.5 NOISE CONTROL

- A. The Contractor shall employ the best practical means to minimise noise produced by his operations and shall comply with the recommendations in BS 5228 and applicable legislation.

1.6 USE OF DOCUMENTS AND INFORMATION

- A. Any specification, plan, drawing or any other documents issued by or on behalf of the Engineer for the purposes of the contract shall remain the property of the Engineer and must be returned on completion of the Contract.
- B. The Contractor and his sub-contractors and suppliers shall not communicate with representatives of the general and technical press, radio, television or any other communications media about the contract, without the prior approval of the Engineer.

1.7 DELETERIOUS MATERIALS

- A. The Contractor shall inform the Engineer immediately if any deleterious materials are discovered on Site.

1.8 PROHIBITED MATERIALS

- A. The following prohibited materials shall not be used in the carrying out of the Works:
1. High alumina cement in structural elements
 2. Wood wool slabs in permanent formwork to concrete or in structural elements.
 3. Calcium chloride in admixtures for use in reinforced concrete.
 4. Aggregates for use in reinforced concrete which does not comply with CYS EN 12620.
 5. Blue and brown asbestos and blue and brown asbestos bearing products.
 6. Lead based paints or lead used in situations which could contaminate drinking water.
 7. Urea formaldehyde containing materials which may release formaldehyde quantities which may be hazardous with reference to the limits set.
 8. Materials comprised of un-stabilised mineral fibres of diameter of 3 microns or less and length 200 microns or less; other substances generally known to be deleterious at the time of use, including but without limitation, substances referred to as being hazardous to health and safety in "Hazardous Building Materials: A Guide to the Selection of Alternatives", edited by S R Curwell and C G Marsh, according to the current edition.
 9. Any materials containing chlorofluorocarbons (CFCs) which are listed in the Montreal Protocol as depleting the ozone layer in the upper atmosphere.
 10. Lead or any products containing lead other than for flashings and damp-proof coursing.

- 11. Leather or animal derived products.
- 12. Aggregates that do not comply with CYS EN 12620 (For use in pavements).

1.9 CO-ORDINATION OF THE WORKS

- A. The Contractor shall co-ordinate and submit to the Engineer for review all the fabrication and installation drawings including builder's work details from sub-contractors, suppliers and statutory undertakers. The Contractor shall agree and be responsible for the positions of chases, holes, pockets, mortices, fixings, sleeves, pipes, cast-in elements, and the like before work is put in hand to ensure that there is no conflict with other work.

1.10 CO-ORDINATION WITH MECHANICAL AND ELECTRICAL INSTALLATIONS

- A. Refer to all relevant Mechanical and Electrical drawings and specifications. Fully co-ordinate, raise any discrepancies in writing for clarification by the Engineer in writing prior to continuing with the design or installation.

1.11 HEALTH AND SAFETY PLAN

- A. In accordance with the relevant directive and the stipulations of Volume VI the Contractor is required to submit to the Engineer for review a health and safety plan (HSP).
- B. Clarify any discrepancies in writing for clarification by the Engineer prior to commencing any task or operation.

1.12 SAMPLES

- A. The Contractor's attention is directed to the Specification clauses which require samples. The Contractor's prices shall include for all additional materials, labour and charges incurred and for obtaining any necessary certificates, reports and evidence and for maintaining and clearing away samples.

1.13 INSPECTION, EXAMINATION AND TESTING

- A. The Contractor's attention is directed to the Specification clauses which require inspection, examination and testing. The Contractor's prices shall include for all additional materials, labours, testing equipment, facilities, and charges incurred and for obtaining any necessary certificates, reports and evidence.

1.14 STANDARDS

- A. Commodities specified to conform to Standards shall be clearly and indelibly marked with the reference specified. Where this is impracticable the relevant advice/delivery notes shall include the Standard reference with which they are to comply. The Contractor shall provide certificates of compliance with Standards when required by the Engineer.

1.15 ACCURACY AND DISCREPANCIES

- A. The Contractor shall at all stages before any work is commenced check dimensions and levels shown on all documents for compatibility with each other, with the Site and work completed to date including the documents of any sub-contractor. The Contractor shall accept full and sole responsibility for the accuracy of all dimensions and levels and any discrepancies relating to the Works as constructed.

1.16 STABILITY OF UNFINISHED WORK

- A. The Contractor shall ensure the stability of the Works at all times, with particular regard to the erection sequence and temporary condition of the various elements of construction where different from the final design condition. The Contractor shall provide and maintain temporary supports as necessary.

1.17 QUALITY, TESTING AND APPROVALS

- A. The Contractor shall construct the Works in a manner which fully accords with the Design in all respects. All commodities shall be of new manufacture unless otherwise stated.

- B. Where commodities are not of national manufacture the Contractor shall be required to demonstrate to the Engineer's satisfaction, that their compliance with the prescribed standards has been demonstrated in tests by a recognised authority and the replacement and the spares can be obtained in the country of installation.

1.18 PROPRIETARY PRODUCTS/ NAMED COMPANIES

- A. The mention of the names of any company or proprietary product is only an indication of the quality, performance and workmanship required. Products of equal quality, performance and workmanship and for which spares and replacements are readily available in the country of installation, may be offered by the Contractor as alternatives. All alternative products shall be subject to the approval of the Engineer.

1.19 OTHER EQUAL AND APPROVED

- A. The Contractor shall indicate in his tender any equivalent products he proposes to use if different from any proprietary products specified within the Tender Documents. Mention in the documentation of the name of a manufacturer or model number of a product is an indication of the product upon which the Design was developed. Products of equivalent class, size, quality, performance, and workmanship and for which spares and replacements are readily available nationally may be offered to the Engineer for approval. Should the Contractor offer an alternative, it shall be at no additional cost to the Employer. It shall be the Contractor's responsibility to demonstrate to the satisfaction of the Engineer, of the "equivalence" of all alternative products offered.

2.0 EXCAVATION AND EARTHWORKS**2.1 SITE PREPARATION****2.1.1 Clearance Vegetation**

- A. Generally, the site shall be cleared of rubbish, bushes, shrubs, vegetation, etc., and the debris shall be cleared and carted away leaving the site ready for excavation.
- B. For road works, an area generally 2,00m beyond the limits of earthworks shall be cleared of all trees, bushes and other vegetation.
- C. No trees or saplings shall be cut down without the prior approval of the Engineer.
- D. Where specified, trees shall be removed complete with the roots. The holes caused by removing the roots shall be backfilled as required by the Engineer with approved material compacted in layers, not exceeding 150mm, to a density of 95% of the maximum dry density achieved in test 13 of BS 1377.

2.1.2 Obstructions

- A. The Contractor shall break out foundations, drains, services, septic tanks and all other obstructions as required by the Engineer and shall remove all the debris from the Site.

2.1.3 Services

- A. The Contractor shall 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

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

2.1.5 Records

- A. Records shall 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 General**

- A. The whole of the work shall be carried out in accordance with the current editions of BS 6031 "Code of practice for earthworks" and BS 8004 "Code of practice for foundations" unless otherwise stated in the Specification.
- B. Notwithstanding any authorization, approval or direction given by the Engineer 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.
- C. Excavation shall be carried out in all materials and all soil types 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 Engineer may direct. The Contractor shall allow in his rates for working in water and disposal as directed.
- D. Should any dimensions of any excavations exceed those shown on the drawings or ordered by the Engineer, or should the sides fail, the Contractor shall at his own expense fill and tightly pack such extra space with concrete grade C10/15 or other approved material as the Engineer may direct. Should the Contractor excavate to greater depth than shown on the drawings or as directed by the Engineer, he shall at his own expense make good the excess excavation in concrete grade C10/15 up to the required level.

- E. 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 Engineer the benefit of natural support to be obtained from the surrounding ground is impaired, then the Contractor shall be required to backfill the whole of the excavation with concrete grade C10/15 or other approved material and this together with any other costs arising from this operation shall be entirely at the expense of the Contractor.
- F. Slopes and formation surfaces shall be trimmed true to line and the required profiles and shall be left well consolidated, neat and smooth.
- G. Where the Contractor carries out excavation in stages and where material is filled and rammed around foundations, all foundation walls, beams, columns, slabs, etc., shall be adequately propped and supported while such work is being carried out and the Contractor must include for this in his rates or price.
- H. 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 C10/15 or suitable fill properly consolidated to the satisfaction of the Engineer.
- I. The Contractor shall report to the Engineer 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

- A. Rock in this context is any material met which is, in the opinion of the Engineer, of such size, position or composition that it can only be removed by means of wedges, compressed air or other special plant or explosives.
- B. Boulder rock in this context is any material met which is, in the opinion of the Engineer, 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.
- C. The use of explosives shall not be permitted without the prior approval in writing of the Engineer. Blasting shall not be allowed if, in the opinion of the Engineer, the rock at the foundation level to any building is likely to be disturbed.
- D. In no case blasting shall be allowed below 400 mm from the proposed base level of the foundation. Pneumatic or other approved means of excavation shall be used for this purpose.
- E. 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 the Site, including buildings completed or partly completed by any third party.
- F. 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.
- G. 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

- A. The Contractor shall, to the satisfaction of the Engineer, shore the sides of excavations for structures, trenches and pits to prevent them from slipping or falling. Nevertheless, should any slips, falls or settlement occur, they shall be made good by the Contractor, at his own expense, with selected fill or with concrete grade C10/15 as may be directed by the Engineer.
- B. 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.

- C. 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 Engineer.
- D. The Contractor shall, not later than two weeks before commencing any excavation, submit to the Engineer 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 Engineer's written consent.
- E. The receipt of such consent shall not relieve the Contractor of any of his duties and responsibilities under the contract.

2.3 OVER-EXCAVATION OF TRENCHES

2.3.1 General

- A. The Contractor shall erect all forms and bracings 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 Engineer.
- B. Trenching shall be opened to the lengths, widths and depths as shown on the drawings or specified or as the Engineer may approve or direct.
- C. Trench widths shall be as small as practicable but not less than the external diameter of the pipe plus 300 mm or larger dimensions if shown on the drawings. Trench sides must be vertical from the bottom up to 300 mm above the crown of the pipe.
- D. Any over-excavation carried out by the contractor to enable pipe laying shall be deemed to be included in the Contractors prices.
- E. 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 concrete grade C10/15 up to the level of the underside of the adjacent foundations.
- F. Excavation for manholes, septic tank, 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.
- G. 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 and the Contractor must include for this in his rates or price. All excavated material not required or unsuitable for backfilling shall be removed and carted away to an approved dumping area.

2.4 GRADING

- A. 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.
- B. Particular attention shall be paid to the installation of sheeting and shoring as may be necessary, for the protection of the Works and for the safety of personnel, workmen and adjoining property.
- C. 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 Engineer 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 BS 1377, to produce a firm bearing.

- D. No pipes, conduits or any utility shall be placed prior to filling and compacting the earth work 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.
- E. 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.
- F. 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. 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 100 mm of granular material beneath the joints.
- G. 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 CYS EN 752 Parts 1-4. 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 CYS EN 752. Pegs used for alignment or to resist pipe driving impact must be withdrawn before side filling commences.

2.5 FILLING OF TRENCHES

- A. 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.
- B. For uPVC pipes fine granular material Type A in size or sand shall be used for filling around the pipes and for a minimum of 100 mm over the crown of the pipes and consolidating carefully by hand to avoid damaging the pipes.
- C. The material shall be tested as detailed in the test devised by the Building Research Establishment (BRE) and shall have a compaction factor not exceeding 0.1, unless otherwise approved by the Engineer.
- D. For pipes in areas with vehicular traffic special arrangements shall be made as directed by the Engineer. Generally, the use of concrete around pipework shall not be permitted since it converts a flexible pipeline into a long unreinforced concrete beam of negligible flexural strength, liable to fracture with a minor ground movement due to static or dynamic loads. Where desirable to indicate that there is a service below to avoid damage from subsequent excavation, driving fence posts, etc., a concrete slab or tile shall be placed above the crown of the pipe with a 100mm cushion fill in between.
- E. Under concrete slabs or raft foundations a satisfactory installation shall be achieved by providing a minimum of 100mm of cushion fill between crown of pipe and soffit of concrete. Where a pipe passes through a ground beam or footing a lintel, a relieving arch or similar device shall be employed to provide a minimum of 75mm clearance.
- F. For A.C. pipes, cable ducts, cables etc, trench fill shall be clean, well graded, free draining, coarse sand (CYS EN 12620), free from dirt, organic or any objectionable matter, and shall have a particle size 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.
- G. Underground pipes shall be laid with not less than 610 mm cover below finished ground level, unless otherwise indicated on the drawings.
- H. Backfilling material for the first 300 mm over the crown of the pipe shall be thoroughly compacted by hand in layers not exceeding 100mm. Thereafter, backfilling shall be laid and compacted by mechanical means in layers not more than 150 mm thick to the requirements of section 2.8 of the Specification.
- I. This fill shall be selected excavated material Type B free from tree roots, vegetable matter, building debris, and frozen soil and shall exclude any material retained on a 75mm sieve and stones retained on a 25.4 mm sieve.

2.6 FINISH OF EXCAVATION AND INSPECTION

- A. No excavation shall be refilled nor any permanent work commenced until the formation is inspected by the Engineer and his permission is given to proceed. The bottom 150 mm of all excavations shall be taken out by hand immediately prior to the commencement of any 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

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

2.8 FILLING (For roads and parking areas refer to appropriate section).**2.8.1 General**

- A. Foundation trenches, column bases and the like shall be backfilled with selected excavated materials, well rammed and consolidated by hand tamping to the satisfaction of the Engineer in layers not exceeding 150 mm thick after compaction and well watered during tamping.
- B. For all other areas, backfilling shall be well consolidated in layers not exceeding 200 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 BS 1377 at +1% to -2% of the optimum moisture content.
- C. 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.
- D. 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.
- E. All fill material shall be placed at moisture content appropriate to the type of material being used which shall in all cases be to the approval of the Engineer.
- F. The Contractor must ensure that all material 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.
- G. Surfaces of filling to receive concrete shall be finished smooth with a layer of sand to provide a true and compact base for the concrete work.

2.8.2 Approved Filling Material - Other than Rock

- A. Only suitable material shall be used as fill and it shall be to the approval of the Engineer.
- B. 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 complying with the following requirements:

Table 2.8.2.1 Approved Filling Material and Capping Layer

- | | | |
|----|---------------------------|----------------------------|
| 1. | <u>BS sieve size (mm)</u> | <u>% by weight passing</u> |
| | 75 | 100 |
| | 37.5 | 85 - 100 |
| | 10 | 45 - 100 |
| | 5 | 25 - 85 |
| | 0.600 | 8 - 45 |
| | 0.750 | 5 - 10 |
2. 4-day soaked CBR compacted to 95% of the maximum dry density at moisture content on the dry side of optimum achieved in test 13 of BS 1377 shall be at least 20%.
3. Liquid Limit (LL) not more than 35%.
4. Plasticity Index (PI) not more than 12% for the material passing the BS 0.425mm sieve.
5. Plasticity Modulus (PM: product of PI and percentage passing BS 0.425 mm sieve) not more than 250.
6. Percentage swell at 4-day soaking not more than 1%.
- C. Where the excavated material arising from the excavations is to be used as filling, the Engineer 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.
- D. The fill material other than rock fill to be used beneath ground floor slabs shall be free of clay, rock or gravel larger than 75 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 the optimum moisture content.
- E. For landscaped areas, fill material when required shall be as above. For top soil requirements and treatment refer to the appropriate sections of the specification.
- F. Concrete used as fill for making up to correct level areas of over-excavation shall be, where required by the Engineer, grade C10/15.
- G. For the "capping layer" to the asphalted roads and parking the fill material shall be as above.

2.8.3 Rock Fill

- A. Rock fill within the main building area shall only be used in areas previously approved by the Engineer.
- B. "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

- A. 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. The material shall be compacted with at least 12 passes of a vibrating roller with a static mass per metre width of roll of at least 3000Kg or other approved plant. 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 embankments 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.

- B. 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. The rock fall shall be compacted as wet as possible to at least 95% of its maximum dry density as determined in test 13 of BS 1377.

2.8.5 Compaction of Rock Fill

- A. Each layer in rock fill shall be compacted by at least 12 passes of a vibrating roller with a static mass per meter width of roll of at least 3000 kg.
- B. 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.

2.8.6 Filling Test Procedures

- A. Where defined, tests for the following shall be carried out in accordance with the procedures specified in the relevant part of BS 1377 "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
- B. 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 $(\% \text{ passing } 20 \text{ mm} \times \text{test optimum} \times 0.01) + (\% \text{ retained on } 20 \text{ mm} \times \text{moisture content of particles retained on } 20 \text{ mm after immersion in water followed by drainage but not drying})$.

2.8.7 Field Dry Density

- A. Field dry density tests shall be carried out by the sand replacement methods (large pouring cylinder) in accordance with BS 1377. For material with a large percentage of coarse particles which in the opinion of the Engineer makes the sand replacement method unsuitable, a water replacement method will be used using a ring of 600 mm diameter suitably manufactured for the purpose and thin flexible rubber membrane. The procedure to be used shall be agreed with the Engineer and control testing shall be carried out prior to the use of the method. **Frequency of Testing (for areas other than roads and parking areas)**

2.8.8 Filling Materials

- A. For every 300 m² 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 Engineer. This analysis shall consist of tests 1 to 6 as defined in Clause 2.8.5.1.

2.8.9 Non-compacted Fill

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

2.8.10 Hardcore

- A. Hardcore shall be approved granular material complying with the requirements of Table 2.8.2.1, 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:
- a. Crushed hard rock or gravel or quarry waste,
 - b. Crushed concrete,
 - c. Crushed block or tile, free from old render
 - d. Crusher run.

- B. 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.

2.8.11 Existing Service Mains Etc

- A. The Contractor shall ascertain the routes of any existing service mains under the Site. Any such main so ascertained or otherwise discovered on Site shall be protected, temporarily supported or permanently re-routed as may be required by the Engineer.
- B. Care shall be taken in all excavation work to avoid unnecessary disruption of public supplies.

3.0 CONCRETE WORK

3.1 GENERAL

- A. Unless otherwise stated, the provisions of **CYS EN 1992 Eurocode 2: Design of concrete structures** and the **"Seismic Code for reinforced concrete structures in Cyprus"** shall be held to be incorporated in this Specification.
- B. The work is to be carried out in accordance with drawings, sketches, specifications and instructions which are issued to the Contractor by the Engineer 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, shall refer to the Engineer before proceeding.
- C. The workmanship throughout the work shall be the best possible and to the satisfaction of the Engineer.

3.2 AGGREGATES

3.2.1 General

- A. Aggregates for concrete shall consist of naturally occurring materials complying with the requirements of CYS EN 12620 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.
- B. 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.
- C. Aggregates shall comply with the mechanical properties in CYS EN 12620 and in addition, the flakiness and elongation indices when determined by the method described in CYS EN 12620 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.
- D. The amount of material passing a 0.075 mm BS sieve, wet analysis, shall not exceed 3% by weight of the natural fine aggregate, 5% by weight of the crushed fine aggregate and by 1% by weight of the coarse aggregate. Crushed fine aggregate shall be washed.
- E. The sulphate content as SO₃ (Sulphur Trioxide) of both the fine and coarse aggregates shall not exceed 0.25% of the dry weight of the aggregate.
- F. The chloride content of the fine aggregates 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:
 - 1. 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.
 - 2. The sulphates in the aggregates shall not be more than double those present in the cement and the total acid soluble sulphates (as SO₃) in the whole mix shall not exceed 4.0% by weight of cement.
- G. Prior to commencing the work, the contractor shall submit to the Engineer 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 are been given by the Engineer.

3.2.2 Grading of Aggregates

- A. The grading of coarse and fine aggregates when tested in accordance with CYS EN 12620 is to be within the limits defined in Tables 4 and 5 or to such gradings as the Engineer may require or deem necessary having regard to the availability of materials locally. The impact value of the coarse aggregate determined in accordance with CYS EN 12620 shall not exceed 23% by weight.

3.2.3 Soundness

- A. 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.
- B. 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

- A. 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 aggregate and between separate heaped sizes of coarse aggregate which may have been segregated for mix control.
- B. Aggregates which in the opinion of the Engineer are not clean or which have become mixed due to defective storage shall be removed from the site immediately.

3.3 CEMENT**3.3.1 General**

- A. No cement shall be used until the supply is approved by the Engineer and the approved source of supply shall not be changed without the written permission of the Engineer.
- B. Portland cement is to be normal setting, of the specific gravity, fineness and chemical composition described in CYS EN 197-1 shall be capable of satisfying the tests specified therein.
- C. Sulphate resisting cement shall conform to BS 4027 and shall be capable of satisfying the tests specified therein.
1. The tricalcium aluminate content of any cement shall not exceed 10.0%.
 2. The total alkali content, expressed as soda (Na_2O) shall not exceed 1.2%.
 3. The sulphuric anhydride (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 SO_3 content shall not be greater than 3%.
 4. The specific surface (fineness) when determined by the method specified in CYS EN 197-1 shall be at least 225 m^2/Kg .
- D. The heat of hydration when determined by the method specified in BS 1370, shall not exceed 70 cals per gram when tested at 7 days nor exceed 80 cals per gram when tested at 28 days.
- E. Certificates of cement tests by the manufacturers shall be submitted to the Engineer before the work commences. Where cement is obtained from an indirect supplier, the Engineer 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

- A. 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 manufacturer's bags unless the written permission of the Engineer is obtained for delivery in bulk by means of purpose made bulk delivery containers.

- B. 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

- A. Each consignment of cement delivered to the 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.
- B. 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.
- C. Any cement that fails to comply with the above clauses, and which the Engineer considers to have deteriorated as a result of dampness or other causes shall be removed from the site immediately.
- D. 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 Engineer and, if so directed, the Contractor shall remove such cement from the site at his own expense.

3.4 REINFORCEMENT

3.4.1 General

- A. Steel fabric reinforcement shall comply to the requirement of BS 4483 and shall be delivered to the site in flat mats.
- B. Hot rolled mild steel bars and hot rolled deformed high yield bars shall comply with the requirements of BS 4449.
- C. Where indicated by "R" on drawings and schedules, the reinforcement shall be mild steel bars with a minimum yield stress of S250 MPa.
- D. Where indicated by "T" on drawings and schedules, the reinforcement shall be high yield steel bars with a minimum yield stress of 460 MPa to BS 4449.
1. Uniform elongation at maximum load (charact. value) ($\epsilon_{su,k}$) shall be $\geq 6\%$.
 2. The tensile strength to yield strength ratio (mean value of the ratio) (f_t/f_y) shall be between 1.15 and 1.35.
- E. Plain and deformed steel wire shall comply with the requirements of BS 4482.
- F. Tying wire shall either be:
- a. 1.6 mm diameter soft annealed iron wire, or
 - b. 1.2 mm diameter stainless steel wire
- G. The source of reinforcement shall be approved by the Engineer, and the Contractor shall submit test certificates from an independent approved laboratory prior to proceeding with the work.
- H. Reinforcement of all types and diameters must comply with the above-mentioned Standards to the satisfaction of the Engineer.
- I. Should the results of any test prove unsatisfactory, the reinforcement shall not be used in the works, and any of that consignment which may have been delivered shall be removed from the site or otherwise disposed of as directed by the Engineer. In the interpretation of the test results, the Engineer's decision shall be final.

3.4.2 Storage of Reinforcement

- A. 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.

- B. 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 Engineer, the reinforcement shall be thoroughly cleaned with wire brushes and immersion in chemicals.

3.4.3 Bending of Reinforcement

- A. The Contractor is to prepare bending schedules for all parts of the work, based on the drawings and sketches provided by the Engineer. These should be submitted to the Engineer for approval prior to concreting. All reinforcement shall be bent sufficiently in advance of the concreting programme.
- B. Bending of reinforcement shall be in accordance with BS 8666 and CYS EN ISO 3766. All reinforcement shall be bent cold. Re-bending of high yield reinforcement will not be permitted.
- C. The Contractor shall provide facilities on site for bar cutting and bending.
- D. The Engineer may require tests to be conducted on a random sample of bars selected by the Engineer. These tests will comprise:
- a. Tensile test (in accordance with CYS EN 10002-1)
 - b. Bend tests (in accordance with BS 4449)
- E. For each test 3 specimen lengths (of approximately 2 metres) from each of 8, 10, 12, 16, 20, 25 and 32mm diameter reinforcing bars will be taken.
- F. The Contractor is to allow for the cost and execution of one such set of tests for each consignment.
- G. 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 Engineer, until it is established that the material proposed is complying with the relevant Cyprus/ British Standard.

3.4.4 Placing of Reinforcement

- A. 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.
- B. 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.
- C. 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.
- D. 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.
- E. No splices shall be made in the reinforcement except where described in the drawings or where approved by the Engineer. Offset laps in adjacent widths to prevent continuous laps in either direction. 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.
- F. Steel fabric shall be installed in as long lengths as practicable, adjoining pieces shall be lapped at least two full meshes, and laced with wire.

3.5 WATER

- A. 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.

- B. The maximum content of dissolved chemical impurities shall not exceed two parts per thousand. When required by the Engineer, the quality of mixing water shall be determined in accordance with the requirements of CYS EN 1008.
- C. In sampling water for testing, care should be taken that the containers are clean and that samples are representative. Water from public reticulation systems for human consumption will be accepted without further test.
- D. 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.
- E. 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 Engineer shall be informed and the water shall be tested in accordance with the recommendations of CYS EN 1008 in order to determine the acceptability of the supply for further use. In the interpretation of the test results, the Engineer's decision shall be final.

3.6 CONCRETE QUALITY

3.6.1 General

- A. Mixes for the grades of concrete shown in Table 3.6.1 shall be designed by the Contractor. The grade is denoted by the minimum 28 day works cylinder and cube strengths, e.g. C30/35.
- B. The mixes shall be designed generally in accordance with the requirements of CYS EN 206-1 and BS 8500 Parts 1 and 2.
- C. 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.
- D. Complete calculations for the mix proportions and the information and assumptions on which they are based, shall be submitted to the Engineer 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 for any mix. The Engineer's review of materials is for general applications, features and colour only. Structural performance of materials as specified is the Contractor's responsibility.

3.6.2 Design Mix Details

- A. Where concrete is specified to be made with sulphate resisting cement the mix shall be designed with a maximum water/cement ratio of 0.45. Concrete in contact with the ground and/or water shall also be designed with a maximum water/cement ratio of 0.45.
- B. Mass concrete shall be grade C10/15 with 20-5 mm nominal size graded aggregate.
- C. 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 CYS EN 206-1 and BS 8500 Parts 1 and 2.

3.6.3 Trial Mixes

- A. 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.
- B. No structural concrete shall be placed in the works until the relevant mix is approved by the Engineer.
- C. Any adjustments found to be necessary shall be made in accordance with the provision of BS 8110, and are subject to the approval of the Engineer.

- D. When the mix has been approved by the Engineer, 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 Engineer who may under these circumstances require further tests to be made.

3.6.4 Admixtures

- A. The use of admixtures and additives to promote workability, impermeability, strength or any other property of the concrete shall only be allowed with the prior approval of the Engineer. When the mix and the admixture have been approved by the Engineer, no variations shall be made without the consent of the Engineer who may under these circumstances require further tests to be made.
- B. The admixtures and additives shall comply with the following minimum requirements:
1. Accelerating, retarding and water reducing admixtures shall comply with the requirements of CYS EN 480 and CYS EN 934 and/or ASTM C494, Types A, B, C, D and E depending on composition, properties and dosage.
 2. Air-entraining admixtures shall comply with the requirements of CYS EN 480 and CYS EN 934 and/or ASTM C494, Types A and D, and/or ASTM C260 depending on composition, properties and dosage.
 3. Super plasticizing admixtures shall comply with the requirements of CYS EN 480 and CYS EN 934 and/or ASTM C494 Types F and G depending on composition, properties and dosage.
 4. Integral waterproofing admixtures shall be used strictly in accordance with the manufacturer's instructions and to the satisfaction of the Engineer. They shall comply with the requirements of the French Standard NFP.18-103 regarding classification, definition and marking.
 5. Condensed silica fume (CSF) admixtures shall be used strictly in accordance with the manufacturer's instructions and to the satisfaction of the Engineer. CSF shall comply with the requirements of the relevant standard of Norway and with the "Guide for the use of silica fume in concrete" reported by ACI Committee 234.
 6. Migrating corrosion inhibiting (MCI) admixtures shall be used strictly in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.
- C. Admixtures and additives containing calcium chloride or more than 0.1% chloride ions shall not be permitted.

3.6.5 Mixing Concrete

- A. Unless otherwise agreed by the Engineer, concrete shall be mixed in an approved type of mechanical weigh batcher. No hand mixing will be allowed.
- B. The weighing and water dispensing mechanisms shall be maintained in good order and checked against accurate weights and volumes when required by the Engineer.

Design Mix Details Table -

Mix Designation

Grade (cylinder/cube)		C15/20	C20/25	C25/30	C30/35	C35/40
Characteristic strength of concrete	Mpa	20	25	30	35	40
Specified works cube strength at 28 days	Mpa	20	25	30	35	40
Specified works cube strength at 7 days	Mpa	16	20	24	28	32
28 day target mean cube strength (Standard deviation = 4.0 Mpa)	Mpa	27	32	37	42	47
28 day target mean cube strength without evidence of standard deviation. Margin taken to be 15.0 Mpa	Mpa	35	40	45	50	55
Maximum coarse aggregate size	mm	20	20	20	20	20
Minimum cement content	kg/m3	300	340	360	390	410

Notes:

1. For sulphate resisting concrete use sulphate resisting cement (BS 4027)
 2. For sulphate resisting concrete minimum cement content to be increased by 40 Kg/m³ for each grade of concrete.
 3. The standard deviation of 4 MPa is the absolute minimum it can be considered under a very high standard of quality control.
- C. The weights of cement and each size of aggregate as indicated by the mechanisms employed shall be within a tolerance of ± 2 percent of the respective weights per batch agreed by the Engineer. 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 Engineer immediately before mixing begins and further as the Engineer 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.
- D. 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 Engineer, 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

- A. 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 CYS EN 206-1 and BS 8500 Parts 1 and 2.
- B. The concrete shall be brought to the 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

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

3.6.8 Quality Control of Concrete

- A. A slump test shall be carried out in accordance with the requirements of BS 1881 whenever the Engineer 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.
- B. The slump shall be 80-130 mm for all grades of concrete. Concrete containing a super plasticizer shall have a slump not exceeding 230mm after the addition of the super plasticizer to a verified 50-80mm slump concrete.
- C. 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.
- D. Samples shall be taken for every 25 cubic metres of concrete placed with a minimum of one sample taken every day on which a mix is used. From each sample, 6 cubes shall be made, two for testing seven days after casting and two for testing twenty-eight days after casting.
- E. The other two cubes shall be retained in reserve for later testing as directed by the Engineer. Higher or lower rates of sampling may be implemented at the discretion of the Engineer taking into account the nature of the work.
- F. The results of the tests shall be analysed in accordance with the procedure laid down in BS 8110. The testing laboratory shall be approved by the Engineer and the test results shall be reported to the Engineer in writing within 24 hours of testing.

- G. All cubes shall be clearly marked with the date of casting and accurate records shall be supplied to the Engineer, stating the dates of taking and testing samples, together with the results of tests and the exact position from which the sample was taken.
- H. If ready mixed concrete is supplied from more than one plant, then, the number of test cubes stated shall relate to each plant.
- I. If, in the opinion of the Engineer, from the evidence of the cube test, the concrete is not likely to be capable of fulfilling its purpose, the Engineer shall require 3 cores to be taken from the area represented by the test cubes. The actual location shall be decided by the Engineer.

3.6.8 Quality Control of Concrete

- J. 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. Non-destructive testing may be permitted, but it shall not be used as the sole basis for acceptance or rejection.

3.6.9 Cost of Testing

- A. 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

- A. Formwork shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction required for their support. The Contractor shall submit for review shop drawings for fabrication and erection of formwork for all finished concrete surfaces.
- B. The Engineer's review is for general applications and features only. The design of the formwork for structural stability, efficiency and safety is the Contractor's responsibility.
- C. 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.
- D. 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 will 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. The Contractor shall erect the formwork in the largest practicable sizes to minimize the number of joints and to conform to the joint system shown on the approved shop drawings.
- E. 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.
- F. 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

G. 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.

H. The design and construction of formwork shall comply with the requirements of Report CS030 of the Concrete Society and BS 5975.

3.7.2 Formed Surface - Classes of Finish

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

3.7.3 Sawn Formwork (Type A)

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)

A. Where concrete is described as having "Fair Face" finish it shall have a "Type E" finish to the surface in accordance with BS 8110.

B. 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.

C. 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

A. 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

A. 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

A. 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 Engineer.

3.7.8 G.R.P. Formwork

A. 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 Sliding Formwork

A. Concrete members, where indicated or agreed, shall be constructed using the slip form method of construction. The contents of other specification sections on concrete shall be applicable to this section with the following additional clauses:

3.7.9.1 Preparatory Work

- A. The Contractor shall, not later than 8 weeks before the planned start of the slip forming, forward the following to the Engineer for approval:
- Drawings of the slip form structure and all associated equipment.
 - A list of all standby equipment to be utilized on the slip form structure.
 - A list of key personnel vital in the continuous operation of the slip form together with back-up personnel to cover for accidents, absenteeism etc.
- B. The Engineer's approval of the slip form method will not indemnify the Contractor from his responsibility for the structural adequacy and stability of the slip form structure.
- C. The Contractor shall not later than 6 weeks before the planned start of the slip forming forward to the Engineer for his approval a detailed slip forming programme comprising the following:
- The start date and completion dates of the slip forming operation, showing the periods required for erection and dismantling of the slip form structure.
 - Slip forming schedules giving detailed information on reinforcement, location of openings, recesses, cast in items, pull out bars, etc shown in relation to levels commencing from bottom to top.
 - List of on call service personnel for the maintenance of all equipment to be utilized on the slip form.
 - Emergency procedures with regards to an alternative supply of concrete on a 24 hour basis.
 - Emergency electricity supply on a 24 hour basis.
 - Emergency procedures with regards to the safety of personnel.
 - A specification for the control of the correct concrete mix design, constant supply of concrete and checking and maintaining the correct alignment of the slip form.
- D. The Contractor must indicate a back-up batching plant during slip forming. Supply of concrete from an alternative batching plant including transport time to the site shall be within a period of 30 minutes. The alternative concrete supply shall be of the exact mix design as the primary batching plant and this shall be confirmed by testing of the concrete from both plants.
- E. All costs in relation to standby plant, equipment and personnel shall be included in the Contractor's tender prices.
- F. The slip forming shall not commence until the slip form programme has been approved by the Engineer.
- G. The Contractor shall carry out all the necessary fencing and marking of the safety zone around the slip forming area and shall liaise with the Local Authorities with regards to obtaining the necessary approvals for the slip form arrangement and safety procedures.

3.7.9.2 Tolerances

- A. The following tolerances apply for the slip forming of concrete members as indicated or agreed:

Internal diameter of circular members	+/- 15mm
Other internal measurements	+/- 15mm
Thickness of the walls	+ 20mm
	- 0mm
Levels	+/- 20mm
Centres deviation from plumb (on minimum 4 checkpoints around the walls of each member at a frequency of every 12 hours)	+/- 15mm
All setting out of horizontal measurements shall be carried out using the vertical centre of the sections.	
For cast-in items, openings and recesses the following tolerances shall apply:	
Levels (absolute)	+/- 20mm
Levels (relative to each level)	+/- 5mm
Horizontal placement (relative to each level)	+/- 15mm

- B. Cast-in items shall be free of concrete and shall be displaced maximum 15mm from the surface.
- C. The vertical stop ends of openings shall always be set out perpendicular to the specified width.

3.7.9.3 Concrete Surface Treatment

- A. Immediately after the concrete appears below the slip form any surface defects, after being brought to the Engineer's attention, shall be made good as instructed by the Engineer. All the wall surfaces shall be improved to a smooth rendered finish using a finishing trowel or similar, lightly rewetting the surface if necessary.
- B. Immediately after, an approved curing membrane shall be applied to the finished surface.
- C. The chosen curing compound shall be a clear type as to avoid discolouring of the finished surface and must be of a type that disappears after some time to enable a surface treatment at a later stage.

3.7.9.4 Formwork

- A. The form panels shall be manufactured of tight and smooth material e.g. steel sheets or water resistant plywood boards. The height of the form panels shall be between 1 and 1.2 meters.
- B. The form shall be slightly tapered so that the spacing of the two form sides is equal to the wall thickness minus approximately 5 to 7 mm at the top of the form and plus approximately 5 to 6 mm at the bottom.
- C. The yokes shall resist lateral concrete pressure and keep the desired form spacing. Rigidity of the yokes is of vital importance as is the rigidity of all the formwork.
- D. To ensure rigidity adequate bracing must be provided. This bracing can serve a double purpose by incorporating the working deck at the level of the top side of the form enabling direct shovelling of concrete from the deck into the forms.
- E. The jacking system shall be hydraulically operated jacks bearing against rods buried in the concrete. The stroke shall be approximately 25mm (8 strokes per hour gives a capacity of 0.20 meter per hour, 4.80 meters per 24 hours). The jacking system shall be able to lift the slip form with twice this speed (9.60 metres per 24 hours), but casting shall not exceed 4.80 metres per 24 hours unless written acceptance is obtained from the Engineer. The jacks shall permit adjustment of the stroke to enable levelling of the platform.
- F. The jack rods can be left in the walls or removed after use. Where rods pass through large openings they must be braced adequately or a provisional column structure shall be cast around them.
- G. The Contractor may propose other procedures including details of construction joints and time schedule for slip forming works, but any such proposals shall be to the Engineer's approval.

3.7.9.5 Inspection of Slip form Equipment

- A. The slip form formwork and all associated equipment such as yokes, jacks, jacking rods etc, shall be inspected by the Engineer prior to shipping to Cyprus.
- B. Two inspections shall be made:
 - a) The first inspection is to establish the minimum standard of finish required for the formwork facing panels. The Contractor shall notify the Engineer when a trial panel of sufficient size to be representative of the whole slip form arrangement has been prepared.
 - b) The second inspection is to be made when all the equipment has been finished to the standard established by the Engineer during the first visit and prior to its being packed for shipping.
- C. If at the second inspection any item of the slip form equipment is found not to be to the Engineer's satisfaction, then the Contractor shall carry out any repairs, alterations and modifications to the equipment as instructed by the Engineer and shall not be entitled to any claim for additional costs and/or damages and/or delays.

- D. Notwithstanding any of the above, the Contractor shall not be relieved from his obligations arising from the Contract and he shall be solely responsible for providing slip form equipment adequately designed so as to carry out the work as specified.

3.7.9.6 Reinforcement

- A. All reinforcement shall be cut, bent and marked in accordance with the slip forming schedule before the start of slip forming. The vertical reinforcement shall be placed and held in position by templates placed on the slip form. In addition to these templates, a number of U-bars shall be provided and placed between the two layers of reinforcement to assure correct alignment.
- B. The vertical reinforcement shall be in maximum 6 metre lengths. Only one third of the vertical reinforcement shall be lapped at the same level. The laps shall be evenly distributed and the three staggered laps shall be placed at maximum distance of approximately 2m. The lap length shall be clearly marked with paint on the bars enabling correct lapping and to maintain the three lap levels at maximum distance.
- C. The horizontal reinforcement shall be placed nearest to the wall surfaces unless otherwise shown on the drawings. To assure the correct distance between the horizontal bars the placement of these bars shall be marked on the vertical reinforcement at minimum one place between every yoke internally and externally.
- D. The lapping of the horizontal reinforcement shall be evenly distributed along the whole circumference with a minimum distance of one meter between the laps. Minimum lap length shall be marked at the ends of the horizontal reinforcement bars. The horizontal reinforcement shall be fixed to the vertical reinforcement at every other crossing.

3.7.9.7 Concrete Mix Design

- A. Two weeks prior to the commencement of slip forming, the Contractor shall propose the rate of slip desired. By test or otherwise a mix permitting this slip speed shall be obtained. A range of mixes for various ambient conditions may also be proposed.
- B. Having decided on a mix the setting time of the concrete shall be measured by the methods of BS 4550.
- C. A definition of setting time shall be agreed with the Engineer. The vibration limit or a penetration resistance figure corresponding to a partial initial set shall be adopted as the "setting time".
- D. Throughout the duration of the job the concrete supplied shall have a setting time comparable with the test mix irrespective of ambient conditions. The permitted latitude on setting time shall be agreed between the parties concerned, but in no case shall the measured setting time be permitted to deviate from the agreed figure by more than 30 minutes.
- E. Concrete for test for setting time shall be sampled at the mixer. Test specimens shall be stored under conditions such that their temperature does not deviate by more than, 2.5°C from the ambient temperature measured on the slip form deck. The temperature shall be measured at the time of placing the concrete.
- F. The frequency of sampling and testing for setting time shall be every 12 hours during the slip forming operation and each time there is a change in either concrete mix or the batching plant, or as directed by the Engineer.
- G. The Contractor shall exercise close control to achieve the above setting time and shall as required, either:
- a) Modify the mix proportions, or
 - b) Modify the dosage of admixture or
 - c) Modify the temperature of one or more of the materials.
to ensure that the agreed setting time is consistently achieved.
- H. Similarly, the slip form operator shall exercise close scrutiny of the performance of the concrete in relation to any given rate of jacking of forms and he shall modify the rate of climb as required to ensure satisfactory results in the event of variations in concrete delivery time, slump or setting time or sudden changes in ambient conditions.

- I. It is the Contractor's responsibility to monitor the supply of concrete to ensure that the correct setting time is maintained so as to avoid damage to the partly set concrete as it leaves the formwork.

3.7.9.8 Transporting, Handling and Placing

- A. Concrete shall be landed on the deck and from there it shall be shovelled into the forms in even layers of approximately 150mm and vibrated. Placing of concrete shall be continuous and supply of labour and materials shall be organized so as to facilitate continuous operation on a 24 hour basis.
- B. Care must be taken when vibrating freshly placed concrete so as not to disturb the lower layers of previously placed concrete.
- C. The maximum time allowed for placing of the subsequent layer is one hour, and the concrete supply, the crane coverage and the supply of labour shall be sufficient to fulfil this requirement.
- D. Horizontal construction joints shall be avoided. If for any reason whatsoever a stoppage is necessary, the break shall be treated as specified for construction joints. If a stoppage should occur above the hopper a 100 x 1.0 mm galvanized steel sheet shall be placed in the centre of the wall in the construction joint.
- E. Slip forming shall continue during wet weather even during heavy rain. The water content of the mix shall be adjusted accordingly to account for the calculated amount of rainwater falling onto the slip form. An electronic rain meter shall be installed at the mixing plant in order to record the rain intensity on Site to enable the above adjustments to be made.

3.7.9.9 Test Cubes

- A. Concrete cubes shall be cast on site. Four batches of each of 3 cubes shall be made every 24 hours. One third of the cubes shall be tested after 3 days, one third after 7 days and the remaining third after 28 days. Moulds for 3 cubes shall always be available on site for casting of additional cube on the Engineer's instruction. In case of change of mixing plant 3 extra cubes shall be cast from the first delivery from the new plant.

3.7.10 Sand Blast Finish

- A. 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.
- B. 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.

3.7.11 Preparation of Formwork Before Concreting

- A. The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed by the Engineer, be coated with an approved material to prevent adhesion of the concrete.
- B. 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 will be visible in the finished works. When concrete surfaces are to receive an applied finish, the Contractor shall ensure that the release agent used will not affect the finish or bonding to the concrete.
- C. Immediately before concreting, the Contractor shall ensure that all wire clippings, dirt, shavings, loose concrete and any other refuse has been removed.

3.7.12 Unformed Beds

A. 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 laitance 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.

3.7.13 Removal of Formwork

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

B. 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)	-	7	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

C. 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 Engineer and may be changed if other types of cement are used subject to the Engineer's agreement.

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

E. 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 Engineer, prior to it being permitted for re-use and a new coat of the release agent shall be applied as approved for new formwork. "Patched" formwork for exposed concrete surfaces shall not be permitted.

3.7.14 Ties

A. The Contractor shall submit to the Engineer 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**

A. The method of transporting and placing concrete shall be in accordance with CYS EN 206-1 and BS 8500 Parts 1 and 2 and subject to the Engineer's agreement.

B. Concrete shall be so transported and placed that contamination, segregation or loss of constituent materials does not occur.

- C. All formwork and reinforcement contained in it shall be clean and free from standing water immediately before the placing of the concrete.
- D. Concrete shall not be placed in any part of the structure until the Engineer's approval has been given. Submit at the beginning of each month, for the Engineer's approval, the concreting programme for that month, stating placing dates, so that adequate checking and supervision can be provided before and during the placing operation. Submit for review the locations, details and method of construction of all joints in slabs on grade, suspended slabs and walls.
- E. The Contractor must give 24 hours notice to the Engineer for pre-pour inspection.
- F. Any inspections made by the Engineer do not relieve the Contractor from his liability to replace materials which prove to be faulty and do not comply with this Specification.
- G. If concreting is not started within 24 hours of approval being given, approval shall again be obtained from the Engineer. 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 30° C except with the approval of the Engineer. 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 Engineer is satisfied that the concrete can be placed at the required workability. Where placement consists of several layers, each layer shall be placed while the preceding layer is still plastic to avoid cold joints.
- H. Except where otherwise agreed by the Engineer, 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 of 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 Engineer.
- I. In case 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.
- J. During placing of concrete in reinforced concrete work, a competent steel fixer shall be present.
- K. 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 Engineer and his approval obtained before placing begins.
- L. Where the concrete is placed by tremie, its size and method of operation shall be in accordance with BS 8004 "Code of Practice for Foundations". During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended until the Engineer permits them to continue.

3.8.2 Compaction of Concrete

- A. All concrete shall be compacted to produce a dense homogeneous mass. Unless otherwise agreed by the Engineer, 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.
- B. 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.
- C. No vibrator shall be operated by a workman who has had insufficient training in its use.

- D. 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 laitance are formed. Should the supply of concrete from the mixer be interrupted, the vibrators should be lifted clear for the work.
- E. The type and size of the vibrating equipment shall be in accordance with BS 2769, CYS EN 50144-1 and CYS EN 60745-1, and it shall be suitable for the work in hand. Full details of the vibrators proposed shall be submitted in advance to the Engineer and his approval obtained before placing concrete.

3.8.3 Curing of Concrete

- A. Immediately after compaction and for 7 days thereafter, concrete shall be cured and protected against harmful effects of weather, including rain, rapid temperature changes, frost and from drying out. The methods of protection used shall be subject to the approval of the Engineer.
- B. The method of curing used shall prevent loss of moisture from the concrete and the development of high temperature gradients. On concrete surfaces which are to be water-proofed curing membranes shall not be used. Water for all curing shall be fresh well water. Where water is used for curing concrete work buried in the ground, care should be taken to avoid excessive curing water from running below the foundation or the footing.
- C. 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 Cold Weather Working

- A. The concrete shall be protected from physical damage or reduced strength which could be caused by frost, freezing/thawing actions or low temperatures, in compliance with the reports "Cold weather concreting" prepared by ACI Committee 306 and as herein specified:
1. When the air temperature has fallen to or is expected to fall below 4°C, the water and the aggregates shall be uniformly heated, before mixing, to obtain a concrete mixture temperature of not less than 10°C and not more than 27°C at the point of placement.
 2. Frozen material or materials containing ice or snow shall not be used. Concrete shall not be placed on frozen sub grade or on sub grade containing frozen materials.
 3. Calcium chloride, salt and other materials containing antifreeze agents shall not be used.
 4. Protection and curing of concrete shall be carried out by curing and sealing compounds, by maintaining formwork in place, by moisture and heat-retaining covers, and by combinations thereof, as shall be approved by the Engineer.
 5. Concrete shall not be placed in frozen formwork or formwork containing ice or snow.

3.8.5 Special measures for hot weather working

- A. 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 Engineer and shall include some of, or if necessary all of the following:-
1. 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.
 2. With regard to water
 - (a) Water for mixing obtained from the coolest possible economic source and may be cooled with ice or other means subject to the Engineer's approval.
 - (b) Water storage tanks sited in shade, permanent or temporary.
 - (c) Storage tanks insulated or buried below ground where site conditions permit.
 - (d) All distribution pipes or water trucks insulated or painted white.

3. With respect to cement
 - (a) The cement store should be sited in the shade.
4. With respect to mixing and placing concrete
 - (a) 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.
 - (b) Where shade is impossible provide equipment painted white and/or mixer drum insulated.
 - (c) Immediately before concrete placing, formwork, reinforcement, cable ducts, etc, sprinkled with cool water fit for human consumption.
5. With respect to curing and protection:
 - (a) Proper curing with adequate protection from sunlight maintained continuously for a minimum period of 7 days.
 - (b) Exposed surfaces always and, where practicable, shuttering protected from direct sunlight.
 - (c) 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.
 - (d) 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.
 - (e) 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.
6. Comply with the report "Hot weather concreting" prepared by ACI Committee 305.

3.8.6 Watertight Concrete for Water Storage

- A. 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 Engineer.
- B. All water retaining structures shall be constructed in accordance with BS 8007 "Code of practice for design of concrete structures for retaining aqueous liquids".
- C. All concrete work shall comply with BS 8110, BS8102, "Code of practice for protection of structures against water from the ground" and this Specification.
- D. The combined aggregates used in the concrete mix shall have absorption of not greater than 3% measured in accordance with BS 812 and CYS EN 932-6, "Testing aggregates".
- E. The concrete shall be a designed mix grade C30/35, or as previously described with the addition of a plasticiser and a waterproofing agent in the proportions recommended by the manufacturer and all to the approval of the Engineer. The water/cement ratio shall be 0.45.
- F. 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 Engineer. The Contractor shall submit to the Engineer for approval details of ties and cast-in fixings.
- G. All concrete shall be vibrated with internal vibrators and all construction joints and movement joints shall be provided with water stops.
- H. All concrete kickers shall be cast monolithic with the structure and shall be 150 mm high.
- I. The Contractor shall forward to the Engineer a layout of the positions of all joints in the watertight concrete construction for approval prior to commencement of work on site.
- J. 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.

- K. 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 Engineer for approval. Any leakage of the joints shall be made good to the Engineer's satisfaction and the cost of such work shall be at the Contractor's expense.

3.8.7 Over site Blinding Concrete

- A. 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.

3.8.8 Tolerances

- A. Completed work shall comply with the requirements of BS 5606 and the following tolerances must not be exceeded. Any work falling 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.

- (a) Member section - dimensions in each direction ± 5 mm.
- (b) Position of members - centre lines in each direction ± 5 mm.
- (c) Vertical misalignment of members in each direction in storey height ± 5 mm.
- (d) Horizontal misalignment of members (Lozenging) ± 5 mm.

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

3.9 EXPANSION JOINTS

- A. The expansion joints in concrete structures shall be formed by means of bitumen impregnated softboard cast between the two adjoining edges of concrete.
- B. All joints in the softboard shall be taped to prevent concrete seepage.
- C. The Contractor must ensure that the expansion joint is not bridged at any point by concrete or other solid matter so that the joint is made ineffective.
- D. At exposed faces, of expansion joints, the softboard 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. Where polyethylene foam cannot be used, a polyethylene tape shall be used instead. The sealant shall conform to BS 2499, BS 5212, BS 6093 and BS 6213, as appropriate, shall be non-sagging, and it shall be based on a polyurethane, polysulphide or other synthetic compound approved by the Engineer.
- E. The sealant shall be applied in accordance with the manufacturer's printed instructions and the colour shall be approved by the Engineer.
- F. Generally, expansion joints shall be 30 mm wide, unless otherwise shown on the drawings.
- G. Sealants and water stops shall be fit for bridging the expansion joints without damage during their design life.

3.10 CONSTRUCTION JOINTS

- A. The positions of construction joints are to be as indicated on the drawings unless otherwise approved by the Engineer and shall be so arranged as to minimise the possibility of occurrence of shrinkage cracks. Joints in suspended slabs shall be located within the middle third of any slab or beam span unless otherwise approved by the Engineer. Joint spacing in walls and slabs on ground shall not exceed 8m unless otherwise approved by the Engineer.

- B. 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.
- C. All loose materials shall be removed.
- D. 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. The use of adhesives and/or galvanized expanded metal lathing at construction joints may be allowed with the prior approval of the Engineer.

3.11 PROTECTIVE MEMBRANE

- A. 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 1200 gauge thick polythene sheeting and bitumen emulsion as shown on the drawings and approved by the Engineer.
- B. The membrane shall be applied strictly in accordance with the manufacturer's instructions, and to the approval of the Engineer.

3.12 CAST-IN FIXINGS AND SUNDRY ITEMS

- A. 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.
- B. 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.
- C. The Contractor shall provide dovetailed raglets to receive the top edge of foundation sheet and/or layered waterproofing, and to receive flashings in the outer face of concrete walls, upstands, beams, plinths, etc.

3.13 SUNDRY ITEMS

3.13.1 Bitumen Impregnated Softboard

- A. Bitumen impregnated softboard to BS is to be fixed to form expansion joints. The softboard is to be cut to size and cast against one face of the concrete and then the formwork removed. In expansion joints at suspended slabs the softboard shall be fixed at intervals with copper nails driven through and into the concrete to avoid fall out of the board. The exposed edges of the softboard are to be pointed with a proprietary non-hardening sealant of proven suitability in the prevailing climatic conditions.
- B. Softboard is also to be used at joints where specified as compressible joint filler on the drawings or requested by the Engineer. The filler shall be cut to exact widths and shall have all edges neatly trimmed and recessed as required. Fixing of the filler shall be strictly in accordance with the manufacturer's printed instructions.
- C. Joint fillers shall comply with the requirements of DOT Specification for Highway Works.

3.13.2 Waterstops

- A. Waterstops where specified shall be PVC waterstops complying with BS 2571 and BS 2782. Waterstops shall be installed strictly in accordance with the manufacturer's instructions and to the Engineer's satisfaction to form a continuous diaphragm in each joint. Waterstops shall be supported and protected during the progress of the work.

3.13.3 Chemical Hardener

- A. A chemical hardener where specified shall be used to harden and dustproof concrete strictly in accordance with the manufacturer's instructions. It shall be a colourless aqueous solution containing a blend of magnesium and/or zinc fluosilicates.

3.13.4 "Eponite"

- A. "Eponite Clear Sealer" and "Eponite G23" manufactured by Colas Ltd or similar and approved two part epoxy resins shall be used for sealing and coating concrete and similar surfaces strictly in accordance with the manufacturer's instructions.

3.13.5 "Xypex"

- A. "Xypex" manufactured by Fullstop Technology Ltd or similar and approved shall be used to waterproof and protect concrete strictly in accordance with the manufacturer's instructions.

3.13.6 "Sikaflex-1A"

- A. "Sikaflex-1A" manufactured by Sika AG or equal and approved shall be used to seal joints strictly in accordance with the manufacturer's instructions. The sealant shall comply with USFS TT-S-00230C.

3.13.7 "Burke-O-Lith"

- A. "Burke-O-Lith" manufactured by Burke or equal and approved shall be used to harden and dustproof concrete strictly in accordance with the manufacturer's instructions.

3.13.8 "Burke Para-Flex"

- A. "Burke Para-Flex" manufactured by Burke or equal and approved shall be used as a waterproof coating for concrete and masonry structures strictly in accordance with the manufacturer's instructions.

3.13.9 "Ethafoam"

- A. "Ethafoam" manufactured by DOW Ltd or equal and approved shall be used as a backup material in joints strictly in accordance with the manufacturer's instructions.

3.14 DEFECTIVE WORK

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

4.0 MASONRY**4.1 GENERAL****4.1.1 SCOPE OF THE WORKS**

- A. Extent of each type of masonry work is indicated in the Engineerural drawings.
- B. This specification covers the supply and installation of masonry walling as follows:
1. Concrete unit masonry
 2. Fireclay brickwork.
 3. Lightweight Aerated Autoclaved Concrete Blocks.
 4. Accessories/ sundries for masonry walling.

4.1.2 APPLICABLE CODES AND STANDARDS

- A. Applicable standards:

1. Cyprus Standards:

CYS EN 197-1	Cement. Composition, specifications and conformity criteria for common cements.
CYS EN 413-1	Masonry cement – Part 1: Composition, specifications and conformity criteria.
CYS EN 413-2	Masonry cement – Part 2: Test methods.
CYS EN 459-1	Building lime. Definitions, specifications and conformity criteria.
CYS EN 771-1	Specification for masonry units. Clay masonry units.
CYS EN 771-2	Specification for masonry units. Calcium silicate masonry units.
CYS EN 771-3	Specification for masonry units. Aggregate concrete masonry units (dense and light-weight aggregates).
CYS EN 771-4	Specification for masonry units. Autoclaved aerated concrete masonry units.
CYS EN 771-5	Specification for masonry units. Manufactured stone masonry units.
CYS EN 771-6	Specification for masonry units. Natural stone masonry units.
CYS EN 772	Methods of test for masonry units.
CYS EN 845-1	Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets.
CYS EN 845-2	Specification for ancillary components for masonry. Lintels.
CYS EN 845-3	Specification for ancillary components for masonry. Bed joint reinforcement of steel meshwork.
CYS EN 846	Methods of test for ancillary components for masonry.
CYS EN 934	Admixtures for concrete, mortar and grout.
CYS EN 998-1	Specification for mortar for masonry – Part 1: Rendering and plastering mortar.
CYS EN 998-2	Specification for mortar for masonry – Part 2: Masonry mortar.
CYS EN 1015	Methods of test for mortar for masonry.
CYS EN 1052	Methods of test for masonry.
CYS EN 1998-1	Eurocode 8: Design of structures for earthquake resistance.
CYS EN 13139	Aggregates for mortar.
CYS EN 13658	Metal lath and beads. Definitions, requirements and test methods.

4.1.2 APPLICABLE CODES AND STANDARDS

2. British Standards:

BS 1191-2	Plastering.
BS 1199 & 1200	Specifications for building sands from natural sources.
BS 4027	Specification for sulfate-resisting Portland cement.
BS 4483	Steel fabric for the reinforcement of concrete. Specification.
BS 4551-1	Compressive strength tests – mortar made on site
BS 5628 – Part 1	Code of practice for the use of masonry. Structural use of unreinforced masonry.
BS 5628 – Part 2	Code of practice for the use of masonry. Structural use of reinforced and prestressed masonry.

BS 5628 – Part 3	Code of practice for the use of masonry. Materials and components, design and workmanship.
BS 5642	Sills and copings. Specification for window sills of precast concrete, cast stone, clayware, slate and natural stone.
BS 5977 – Part 1	Lintels. Method for assessment of load .
BS 6073 – Part 2	Precast concrete masonry units. Method for specifying precast concrete masonry units.

4.1.3 CO-ORDINATION OF THE WORKS

- A. The Contractor is to fully co-ordinate his works with all other works and interfacing elements such as underground pipework and services, movement joints to Structural Engineer's details, curtain walling, door thresholds, external finishes, etc. Identify information required by others at the earliest opportunity. Fully co-ordinate, raise any discrepancies in writing (in accordance with the project procedures) for clarification by the Engineer in writing prior to continuing with the design or installation.

4.1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products.

4.1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver masonry units and materials to site in undamaged condition.
- B. Store and handle masonry units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes. Limit moisture absorption of concrete masonry units during delivery and until time of installation.
- C. Store cementitious materials off the ground, under cover and in a dry location.
- D. Store aggregates where grading and other required characteristics can be maintained.
- E. Store masonry accessories including metal items so as to prevent deterioration by corrosion and accumulation of dirt.

4.1.6 SITE CONDITIONS

- A. Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns.
- B. Do not apply concentrated loads for at least 3 days after building masonry walls or columns.
- C. Staining: Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry.
- D. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on the ground and over the wall surface.
- E. Protect sills, ledges and projections from droppings of mortar.
- F. Cold and Wet Weather Protection:
1. Do not lay masonry units which are wet.
 2. Protect completed masonry from rain or snow for at least 24 hours by covering with weather-resistant membrane.

4.2 PRODUCTS**4.2.1 MASONRY UNITS**

- A. General: Comply with referenced standards (Section 4.1.2) and other requirements indicated below.
1. Provide concrete masonry unit special shapes where required for corners, jambs, sash, control joints, headers, bonding and other special conditions.
 2. Provide square-edged units for outside corners, except where indicated otherwise.
- B. Concrete Blocks: Provide units complying with characteristics indicated below.
1. Manufacture: produce blocks from cement and sand 1:5 mix (300 kg cement to 1m³ sand) in vibrated pressure machine moulds. Adjust the mix as necessary to achieve compressive strength requirements.
 2. Size: Manufacturer's standard units. Work sizes shall be in accordance with CYS EN 771-3, CYS EN 772-2 and BS 6073.
 3. Type: unless otherwise shown on the drawings, concrete masonry units shall be hollow blocks of a design approved by the Engineer.
 4. Blocks to be used below ground level shall be manufactured with sulphate resisting cement.
- C. Fireclay bricks: To CYS EN 771-1. Provide bricks made from fireclay containing a high percentage of silica and suitable for the conditions of proposed use.
1. Obtain bricks from a manufacturer approved by the Engineer.
 2. Obtain fireclay cement from the brick manufacturer.

4.2.1 MASONRY UNITS

- D. Autoclaved Aerated Concrete Blocks: To CYS EN 771-4.
1. Obtain blocks from a manufacturer approved by the Engineer.
 2. Do not use blocks delivered warm from the manufacturing process.

4.2.2 MORTAR AND GROUT MATERIALS**4.2.2.1 Cement Gauged Mortars**

- A. Sand for site made cement gauged masonry mortars:
- Standard: To CYS EN 13139 and BS 1200 Table I
 - Grading: 0/2 (FP or MP).
 - Fines content where the proportion of sand in a mortar mix is specified as a range (e.g. 1:1: 5–6): Lower proportion of sand: Use category 3 fines. Higher proportion of sand: Use category 2 fines.
 - Sand for facework mortar: Maintain consistent colour and texture. Obtain from one source
- B. Ready-mixed Lime: Sand for cement gauged masonry mortars:
- Standard: To CYS EN 998-2.
 - Lime: Non-hydraulic to CYS EN 459-1.
 - Type: CL 90S.
 - Pigments for coloured mortars: To CYS EN 12878.
- C. Site made Lime: Sand for cement gauged masonry mortars:
- Permitted use: Where a special colour is not required and in lieu of factory made ready-mixed material.
 - Lime: Nonhydraulic to CYS EN 459-1.
 - Type: CL 90S.
 - Mixing: Thoroughly mix lime with sand, in the dry state. Add water and mix again. Allow to stand, without drying out, for at least 16 hours before using.
- D. Cements for mortars:

- Cement: To CYS EN 197-1 and CE marked.
- Types: Portland cement, CEM I.
Portland limestone cement, CEM II/A-L or CEM II/A-LL.
Portland slag cement, CEM II/B-S.
Portland fly ash cement, CEM II/B-V.
- Strength class: 32.5, 42.5 or 52.5.
- White cement: To CYS EN 197-1 and CE marked.
- Type: Portland cement, CEM I.
- Strength class: 52.5.
- Sulfate resisting Portland cement:
- Types: To BS 4027 and Kite marked.
To CYS EN 197-1 fly ash cement, CEM II/B-V and CE marked.
- Strength class: 32.5, 42.5 or 52.5.
- Masonry cement: To CYS EN 413-1 and CE marked.
- Class: MC 12.5.

E. Admixtures for site made cement gauged mortars:

- Air entraining (plasticizing) admixtures: To CYS EN 934-3 and compatible with other mortar constituents.
- Other admixtures: Submit proposals.
- Prohibited admixtures: Calcium chloride, ethylene glycol and any admixture containing calcium chloride.

F. Retarded ready to use cement gauged mortars:

- Standard: To CYS EN 998-2.
- Lime for cement: lime: sand mortars: Nonhydraulic to CYS EN 459-1.
- Type: CL 90S.
- Pigments for coloured mortars: To CYS EN 12878.
- Time and temperature limitations: Use within limits prescribed by mortar manufacturer.

G. Water: Clean and potable.

H. Storage of cement gauged mortar materials:

- Sands and aggregates: Keep different types / grades in separate stockpiles on hard, clean, free-draining bases.
- Factory made ready-mixed lime: sand / ready to use retarded mortars: Keep in covered containers to prevent drying out or wetting.
- Bagged cement/ hydrated lime: Store off the ground in dry conditions.

I. Making cement gauged mortars:

- Batching: By volume. Use clean and accurate gauge boxes or buckets.
- Mix proportions: Based on dry sand. Allow for bulking of damp sand.
- Mixing: Mix materials thoroughly to uniform consistency, free from lumps.
- Mortars containing air entraining admixtures: Mix mechanically. Do not overmix.
- Working time (maximum): Two hours at normal temperatures.
- Contamination: Prevent intermixing with other materials.

4.2.2.2 Lime: Sand Mortars

A. Lime: Sand mortar mixes:

- Specification: Proportions and additional requirements for mortar materials are specified elsewhere.

B. Sand for Lime: Sand mortar mixes:

- Type: Sharp, well graded.
- Quality, sampling and testing: To CYS EN 13139.
- Grading/ Source: As specified elsewhere in relevant mortar mix items.

C. Admixtures for hydraulic Lime: Sand mortar mixes:

- Air entraining (plasticizing) admixtures: To CYS EN 934-3 and compatible with other mortar constituents.
 - Prohibited admixtures: Calcium chloride, ethylene glycol and any admixture containing calcium chloride.
- D. Storage of Lime: Sand mortar materials:
- Sands and aggregates: Keep different types/ grades in separate stockpiles on hard, clean, free-draining bases.
 - Ready prepared non-hydraulic lime putty: Prevent drying out and protect from frost.
 - Non-hydraulic lime: sand mortar: Store on clean bases or in clean containers that allow free drainage. Prevent drying out or wetting and protect from frost.
 - Bagged hydrated hydraulic lime: Store off the ground in dry conditions.
- E. Making Lime: Sand mortar generally:
- Batching: By volume. Use clean and accurate gauge boxes or buckets.
 - Mixing: Mix materials thoroughly to uniform consistency, free from lumps.
 - Contamination: Prevent intermixing with other materials, including cement.
- F. Site prepared non-hydraulic Lime: Sand mortars:
- Mixing: Mix materials thoroughly by compressing, beating and chopping. Do not add water.
 - Equipment: Roller pan mixer or submit proposals.
 - Maturation period before use (maximum): Seven days.
- G. Ready to use non-hydraulic Lime: Sand mortars:
- Materials: Select from:
 - Lime putty slaked directly from quicklime to CYS EN 459-1 and mixed thoroughly with sand.
 - Quicklime to BS EN 459-1 slaked directly with sand.
 - Maturation period before use (maximum): Seven days.
- H. Knocking up non-hydraulic Lime: Sand mortars:
- Knocking up before and during use: Achieve and maintain a workable consistency by compressing, beating and chopping. Do not add water.
 - Equipment: Roller pan mixer or submit proposals.
- I. Making hydraulic Lime: Sand mortars:
- Mixing hydrated hydraulic lime: sand: Follow the lime manufacturer's recommendations for each stage of the mix.
 - Water quantity: Only sufficient to produce a workable mix.
 - Working time: Within limits recommended by the hydraulic lime manufacturer.
- J. 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).
- K. Mortar for non-loadbearing 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).
- L. 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.
- M. 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.

4.2.2.3 **Mixing of Mortar**

- A. General: Do not add admixtures including colouring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds or other admixtures, unless otherwise indicated and/or approved by the Engineer. Do not use calcium chloride in mortar or grout.
- B. Mixing: Combine and thoroughly mix cementitious, water and aggregates in an approved mechanical batch mixer

which shall supply all working points; comply with standards for mixing time and water content. Other arrangements may only be used with the written approval of the Engineer.

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.

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.

- C. Mortar for Unit Masonry: Comply with Proportion mixes, for types of mortar required, unless otherwise indicated.

1. Limit cementitious materials in mortar to Portland cement-lime.

- D. Grout for Unit Masonry: Comply with BS for grout used in construction of reinforced and unreinforced unit masonry. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.

4.2.2.4 Testing of Mortar

- A. Preliminary tests and work sample tests shall be made on the mortar as and when instructed by the Engineer during the progress of the work.
- B. 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.
- C. The preliminary test cubes shall exceed the value of the specified cube strength as listed in the table below with a maximum individual cube variation of not more than 10% of the average strengths.

Mortar Mix Table

Mortar Mix Cement:Lime:Sand (By volume)	Mean compressive strength at 28 days (N/mm ²)
1:1/4:4	6.5
1:1:6	3.6

4.2.2.5 Mortar Plasticisers

- A. The written approval of the Engineer 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.

4.2.3 JOINT REINFORCEMENT AND TIES

- A. Materials: Comply with requirements indicated below and obtain approval of the Engineer for each type of joint reinforcement and tie for size and other characteristics.
- B. Wall Ties: Galvanized steel ties conforming to CYS EN 845-1.
- C. Joint Reinforcement (wires to BS 4483 or galvanised expanded metal wall reinforcement to CYS EN 13658 Parts 1 and 2): Provide approved galvanized steel welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 3000 mm, with prefabricated corner and tee units, and complying with requirements indicated below:
1. Width: Fabricate joint reinforcement in units with widths of approximately 50 mm less than nominal

- width of walls and partitions as required to provide mortar coverage of not less than 16 mm on joint faces exposed to exterior and 12 mm elsewhere.
2. Wire Size: 4 mm diameter
 3. Type: Ladder design, single side rods with perpendicular cross rods spaced not more than 400 mm centres.

4.2.4 MISCELLANEOUS MASONRY ACCESSORIES

- A. Reinforcing Bars: Deformed steel to BS 4449.
- B. Premoulded Control Joint Strips: Material designed to fit standard sash block and to maintain lateral stability in masonry wall; sizes and configuration as required and approved.
- C. Bond Breaker Strips: Asphalt-saturated organic roofing felt.
- D. Weepholes: Medium density polyethylene plastic tubing, outside diameter and length as required.
- E. Compressible Joint Fillers:

“Flexcell” joint filler obtainable from Expandite Ltd or other equal and approved shall be used where specified on drawings or requested by the Engineer.
 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.
- F. Damp-proof courses:

Damp-proof courses for walls shall be of a woven hessian base thoroughly saturated with bitumen to BS 6398 type A or as otherwise directed by the Engineer.
- G. Steel Lintels: Galvanised Steel Lintels shall be as “Catnic” or other equal and approved and shall be used strictly in accordance with the manufacturer’s instructions.
- H. Mortar Plasticiser: “Febmix Admix” mortar plasticiser obtained from Feb Ltd or other equal and approved, complying with the requirements of CYS EN 934-3, shall be used strictly in accordance with the manufacturer’s instructions.
- I. Extruded Polystyrene Thermal Insulation Boards: “Wallmate” thermal insulation boards obtained from DOW Ltd or other equal and approved shall be used strictly in accordance with the manufacturer’s instructions.

4.3 EXECUTION

4.3.1 INSTALLATION, GENERAL

- A. All masonry units shall be carefully unloaded and stacked on level standings. They must be adequately protected from the weather, contamination and also physical damage. No damaged units 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.
- B. All wall faces to receive in-situ finishing or cement and sand backings shall be hacked and the joints raked out as necessary to produce an adequate key.
- C. 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.
- D. 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 Engineer.
- E. Movement joints shall be formed at the places and in the manner indicated on the drawings.

- F. In periods of adverse 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.
- G. Build chases and recesses as shown or required for the work of other trades. Provide not less than 200 mm of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.
- H. Leave openings for equipment to be installed prior to completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.
- I. The Contractor shall ensure that the finished walling is not damaged by subsequent operations.
- J. Do not use frozen materials or lay on frozen surfaces.
- K. Other Air temperature requirements: Do not lay bricks/blocks:
 - 1. In cement gauged mortars when at or below 3°C and falling or unless it is at least 1°C and rising.
 - 2. In hydraulic lime:sand mortars when at or below 5°C and falling or below 3°C and rising.
 - 3. In thin joint mortar glue when outside the limits set by the mortar manufacturer.
- L. The temperature of the walling during curing shall be above freezing until hardened.
- M. 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 Engineer.

4.3.2 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 6 mm in 3000 mm, or 9 mm in a storey height not to exceed 6000 mm, nor 12 mm in 12000 mm or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 6 mm in any storey or 6000 mm maximum, nor 12 mm in 12000 or more. For vertical alignment of head joints do not exceed plus or minus 6 mm in 3000 mm, 12 mm maximum.
- B. Variation from Level: For bed joints and joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 6 mm in any bay or 6000 mm maximum, nor 12 mm in 12000 mm or more. For top surface of bearing walls do not exceed 3 mm between adjacent floor elements in 3000 mm or 1.5 mm within width of a single unit.
- C. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 12 mm in any bay or 6000 mm maximum, nor 19 mm in 12000 mm or more.
- D. Variation in Cross-Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 6mm nor plus 12 mm.
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 3 mm, with a maximum thickness limited to 12 mm. Do not exceed head joint thickness indicated by more than plus or minus 3 mm.

4.3.3 LAYING MASONRY WALLS

- A. Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to accurately locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.
- B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.
- C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical

joint in each course centred on units in courses above and below. Lay concealed masonry with all units in a width in running bond or bonded by lapping not less than 50 mm. Bond and interlock each course of each width at corners. Do not use units with less than nominal 100 mm horizontal face dimensions at corners or jambs.

- D. Stopping and Resuming Work: Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.
- E. Built-in Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.
 - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 2. Where built-in items are to be embedded in cores of hollow, concrete masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
 - 3. Fill cores in hollow concrete masonry units with grout 3 courses under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

4.3.4 MORTAR BEDDING AND JOINTING

- A. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 9 mm joints.
- B. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials, unless otherwise indicated.
- C. Rake out joints on faces of blockwork which are to be rendered or plastered, to a depth of 10 mm, as the work proceeds.
- D. Tool exposed joints slightly concave using a jointer larger than joint thickness, unless otherwise indicated, as the work proceeds.
- E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
- F. Collar Joints: After each course is laid, fill the vertical longitudinal joint between widths solidly and with mortar for the following masonry work:
 - 1. Non-loadbearing interior walls or partitions where metal ties or horizontal reinforcing are required for structural bonding and nominal thickness of wall or partition is required to meet code requirements for height-to-thickness ratio.

4.3.5 NON-LOAD BEARING WALLS

- A. Hollow concrete blocks and clay bricks, shall be used for non-load bearing walling as indicated on the drawings.
- B. Only blocks with a minimum compressive strength of 7N/mm² shall be used for non-load bearing walls.
- C. 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.
- D. 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.
- E. On the vertical joints, the blockwork or brickwork shall be fixed to load bearing walls by the use of stainless steel wall ties to CYS EN 845-1, passing through the joint filler and spaced vertically at 400 mm centres.
- F. 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 mineral wool or "Flexcell" or equal and approved compressible material to the approval of the Engineer.

- G. Metal lathing to CYS EN 13658 Parts 1 and 2, of 300 mm width, or fibre glass mesh of exterior grade and 115gr/m² weight, of 300mm width to be used when non-load bearing blockwork / brickwork is jointed with a concrete member.
- H. This lathing to be nailed to both faces of the member by stainless steel nails before plaster is applied and without damaging the blocks.
- I. A glass fibre 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 Engineer. Such glass fibre shall be of minimum weight of 115 gr/m² raw net and mesh width of 10x10mm.

4.3.6 CAVITY WALLS

- A. Where both skins of cavity walls are built in blockwork or brickwork, the skins shall be tied together with stainless steel wall ties to CYS EN 845-1, 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.
- B. 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 walls ties to CYS EN 845-1, spaced every 800 mm horizontally.
- C. The cavities of hollow blocks and cavities of cavity walls shall be kept clear of mortar and other droppings.
- D. Where required, cavity wall insulation shall be 50 mm thick extruded polystyrene slabs of minimum density of 32 Kg/m² or as otherwise indicated on the drawings and of an approved manufacturer.
- E. 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.

4.3.6.1 Protection of Cavities

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

4.3.7 R.C. LINTELS AND CAPPING BEAMS

- A. 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/mm² in 28 days.
- B. Precast concrete lintels shall be in accordance with CYS EN 845-2 with a minimum bearing length of 150 mm.
- C. When the total height of the blockwork or brickwork is greater than 3 metres, a continuous capping beam shall be provided at door or window head level, connecting all the walls. This beam shall be of the same thickness as the wall and reinforced as per the detail drawings or as instructed by the Engineer.

4.3.8 ANCHORING MASONRY WORK

- A. General: Provide anchor devices of types indicated and required.
- B. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 1. Anchor masonry to structural concrete members with metal ties (cast into concrete) embedded in masonry joints.
 2. Space ties as required, but not more than 600 mm centres vertically and 1000 mm centres horizontally.

4.3.9 CONTROL AND EXPANSION JOINTS

- A. General: Provide vertical and horizontal expansion, control and isolation joints in masonry where necessary and required. Build-in items as the masonry work progress.

4.3.10 LINTELS

- A. Install steel lintels where indicated.
- B. Provide cast in place reinforced concrete lintels, minimum 200 mm deep x full width of wall. Temporarily support lintels.
- C. Provide minimum lintel bearing of 200 mm at each jamb, unless otherwise indicated.

4.3.11 EXPOSED MASONRY: REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units; to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings and adjacent work to provide a neat, uniform appearance, prepared for application of sealants.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean masonry if required, as follows:
1. Remove large mortar particles by hand with non-metallic scrapers or chisels.
 2. Test cleaning methods on sample wall panel; leave 1/2 panel un-cleaned for comparison purposes. Obtain Engineer's approval of cleaning method and sample before proceeding with cleaning of masonry.
 3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with masking agent, polyethylene film or waterproof masking tape.
- D. Protection: Provide final protection and maintain conditions in a manner acceptable to the Engineer, which ensures unit masonry work being without damage and deterioration.

5.0 EXTERIOR STONework**5.1 GENERAL****5.1.1 SCOPE OF THE WORKS**

- A. Extent of stonework is indicated on the Drawings.
- B. Types of stonework in this section include:
 - 1. Exterior stone veneers and facings as a rainscreen cladding system.
- C. Interior stone facing and flooring is specified in the Finishes section of the specification.

5.1.2 SYSTEM DESCRIPTION

- A. General: Fabricate and install stonework to withstand normal loads from wind, gravity, movement of building structure, earthquakes, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure.
- B. Provide stonework which is designed, fabricated and installed based on the safety factors applied to minimum physical properties of the different stones indicated.
- C. Provide hand-set stone anchoring system which results in attachments developing the capability to sustain the following forces generated by the supported element (individual member or assembly) acting separately, based on the yield strength of the material:
 - 1. A total of 4 times the dead weight of the element supported, applied vertically downward through the element's centre of gravity, combined with loads caused by thermal movements.
 - 2. A total force of 3 times the dead weight of the element applied horizontally outwards through the centre of gravity of the element, combined with loads caused by thermal movements.

5.1.3 SUBMITTALS

- A. Product Data: Submit technical information and certification demonstrating compliance with specification of each type of stone, stonework accessory and other manufactured products and finishes required including all necessary technical data.
- B. Certification, reports and calculations demonstrating compliance with specification of proposed cladding.
- C. Proposals for connections to and support from the primary support structure (in-situ concrete walls).
- D. Proposals for primary support structure additional to that shown on preliminary design drawings.
- E. Schedule of builders work, special provisions and special attendance by others.

5.1.4 DESIGN INTENT/ RESPONSIBILITY FOR COMPLETION OF DESIGN

- A. All stone is to be from the same source and all fixings selected from a single supplier from their standard range.
- B. In cases where alternative proposals are being considered, they shall not be adopted without the Engineers acceptance of all visual criteria prior to the commencement of the work. Where alternative proposals are made they should be clearly illustrated and identified.
- C. Before ordering materials and commencement of work and within a period to be agreed with the Engineer the Contractor shall submit samples to be approved by the Engineer.

5.1.5 APPLICABLE CODES AND STANDARDS**A. Applicable standards:****1. Cyprus Standards:**

CYS EN 1467	Natural stone – Rough blocks – Requirements
CYS EN 1468	Natural stone – Rough slabs - Requirements
CYS EN 1469	Natural stone products. Slabs for cladding. Requirements
CYS EN 1925	Natural stone test methods – Determination of water absorption coefficient by capillarity.
CYS EN 1926	Natural stone test methods – Determination of uniaxial compressive strength.
CYS EN 1936	Natural stone test methods – Determination of real density and apparent density, and of total and open porosity.
CYS EN 12057	Natural stone products – Modular tiles – Requirements
CYS EN 12370	Natural stone test methods – Determination of resistance to salt crystallisation.
CYS EN 12371	Natural stone test methods – Determination of frost resistance.
CYS EN 12372	Natural stone test methods – Determination of flexural strength under concentrated load.
CYS EN 12407	Natural stone test methods – Petrographic examination.
CYS EN 12440	Natural stone – Denomination criteria.
CYS EN 12670	Natural stone – Terminology.
CYS EN 13161	Natural stone test methods – Determination of flexural strength under constant moment.
CYS EN 13364	Natural stone test methods – Determination of the breaking load at dowel hole.
CYS EN 13373	Natural stone test methods – Determination of geometric characteristics on units.
CYS EN 13755	Natural stone test methods – Determination of water absorption at atmospheric pressure.
CYS EN 13919	Natural stone test methods – Determination of resistance to ageing by SO ₂ action in the presence of humidity.
CYS EN 14066	Natural stone test methods – Determination of resistance to ageing by thermal shock.
CYS EN 14146	Natural stone test methods – Determination of the dynamic modulus of elasticity (by measuring the fundamental resonance frequency).
CYS EN 14147	Natural stone test methods – Determination of resistance to ageing by salt mist.
CYS EN 14157	Natural stone test methods – Determination of the abrasion resistance.
CYS EN 14158	Natural stone test methods – Determination of rupture energy.
CYS EN 14205	Natural stone test methods – Determination of Knoop hardness.

2. British Standards:

BS 6213	Selection of construction sealants. Guide.
BS 6399-2	Loading for buildings. Code of practice for wind loads.
BS 8200	Code of practice for design of non-loadbearing external vertical enclosures of buildings.
BS 8298	Code of practice for design and installation of natural stone cladding and lining.

3. Other European Standards:

DIN 18516-1	Back vented non loadbearing external enclosures of buildings: Requirements and testing.
DIN 18516-3	Cladding for external walls ventilated at rear – Part 3: natural stone; requirements, design.

5.1.6 DELIVERY, STORAGE AND HANDLING**A. Deliver stonework materials to project in undamaged condition.****B. Store and handle stone and related materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage, chipping, or other causes.**

1. Do not use pinch or wrecking bars.

2. Store stone on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stones to distribute weight evenly and to prevent breakage or cracking of stones.

5.1.7 ACCURACY OF ERECTION

- A. Sequencing of stone erection must take into account the accuracy required at each door and window opening. A Method Statement should be produced demonstrating knowledge of this requirement and proposals for ensuring the accuracy required.
- B. Elevation joint widths: Within joint lengths, including continuations across transverse joints, as follows:
 1. Tolerance: Greatest width not to exceed least width by more than 1mm.
 2. Variations: Evenly distribute, with no sudden changes.
 3. Offset in elevation: Between nominally in-line edges across transverse joints not to exceed 10% width of joint.
 4. Offset in plan or section: Between flat faces or adjacent panels across joints not to exceed 10% width of joint.
- C. Finished work: Square, regular, true to line and plane with satisfactory fit at junctions.

5.2 PRODUCTS

5.2.1 MATERIALS, GENERAL

- A. Comply with relevant standards and other requirements indicated, as applicable to each type of material required.
- B. Provide matched blocks from a single quarry for each type, variety, colour and quality of stone required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to the Engineer for aesthetic effect.
- C. Provide stones which are free from vents, cracks, fissures, discoloration or other surface defects which may adversely affect strength, durability or appearance.

5.2.2 STONE TYPES

- A. As indicated on the Drawings and described in the Bills of Quantities.

5.2.3 STONE ANCHORS AND ATTACHMENTS

- A. Provide anchors and attachments of type and size required to support stonework and fabricated from the following metals for conditions and anchors indicated below:
 1. Stainless Steel to CYS EN ISO 3506 grade A4: For anchors in direct contact with stone.
 2. Cast or Malleable Iron: for adjustable inserts embedded in concrete and not in direct contact with stone.
 3. Hot-Dip galvanized Steel: for anchor bolts, nuts and washers; and steel plates, shapes and bars not in direct contact with stone.
- B. Dimensions: Not less than recommended by their manufacturer.
- C. Adjustment capability: Sufficient in three dimensions to accommodate primary support structure and rain screen cladding fabrication / installation tolerance.

5.2.4 STONE FABRICATIONS

- A. General: fabricate stonework in sizes and shapes required to comply with requirements indicated, including details on Drawings and final shop drawings.

- B. Cut and drill sinkages and holes in stones for anchors, fasteners, supports and lifting devices as indicated or needed to set stonework securely in place; shape beds to fit supports.
- C. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by applicable codes or standards or, if none, stone source, for faces, edges, beds and backs.
 - 1. Quirk-mitre corners, unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.
- D. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples.

5.3 **EXECUTION**

5.3.1 **SETTING STONE, GENERAL**

- A. General:
 - 1. Location of joints: Joints must only occur at positions indicated on final detail drawings.
 - 2. Cleanliness: Keep face work clean. Rubbing to remove marks and stains not permitted.
- B. Execute stonework by skilled masons, and stone filters at the site to do necessary field cutting as stones are set.
 - 1. Use power saws to cut stones; for exposed edges, produce edges which are cut straight and true.
- C. Contiguous Work: Provide chases, reveals, reglets, openings and other spaces as required for accommodating contiguous work. Close-up openings in stonework after work is in place with stonework which matches that already set. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework on place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationship and indicated tolerances.
- D. Construction Tolerances: set stones to comply with the following tolerances:
 - 1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 6 mm in 3 m, 10 mm in a story height or 6 m maximum, nor 15 mm in 12 m or more. For external corners, expansion joints and other conspicuous lines, do not exceed 6 mm in any story or 6 mm maximum, nor 15 mm in 12 m or more.
 - 2. Variation from Level: For grades indicated for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 15 mm in any bay or 6 m maximum, nor 20 mm in 12 m or more.
 - 3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 15 mm in any bay or 500 mm maximum, nor 20 mm in 12 m or more.
 - 4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions, do not exceed minus 6 mm nor plus 15 mm.
- E. Protection from other works: Determine the nature and extent of protection from other works which will be required, and the duration this protection will be required.

5.3.2 **ADJUSTING AND CLEANING**

- A. Remove and replace stonework of the following description:
 - 1. Broken, chipped, stained or otherwise damaged stones.
 - 2. Defective joints.
 - 3. Stones and joints not matching approved samples.
 - 4. Stonework not complying with other requirements indicated.
- B. Replace in manner which results in stonework matching approved samples, complying with other requirements and showing no evidence of replacement.

- C. Clean stonework not less than 6 days after completion of work, using water and stiff bristle fibre brushes. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods which could damage stone.

5.3.3 BITUMINOUS PAINT LIQUID DAMP PROOFING

- A. Rubber / bitumen emulsion flexible coating (black):
1. Substrate: In-situ reinforced concrete to the structural engineer's specifications.
 2. Primer: As recommended by the coating manufacturer.
 3. Coating: cold applied modified bitumen / rubber emulsion damp proof membrane.
 4. Product: Brush applied modified bitumen / rubber emulsion.
 - Number of coats: 3.
 - Coverage per coat (minimum): 0.8L/m².
 5. Reinforcement: as recommended by the coating manufacturer.
 6. Accessories: as recommended by the coating manufacturer.
 7. Other requirements:
 - Certified product.
 - All necessary linked products from the manufacturer's standard range to complete the installation.
- B. Execution:
1. Substrates generally:
 - a. Smooth, even textured, clean, dry and frost free.
 - b. Within tolerances for level and surface regularity.
 - c. Vertical and horizontal surfaces: Correctly prepared and free from irregularities.
 - d. Moisture content and stability of substrate: Must not impair integrity of finished tanking / damp proofing.
 2. Preliminary work: Complete including:
 - a. Chases.
 - b. External angles.
 - c. Formation of upstands and kerbs.
 - d. Movement joints.
 - e. Penetrations / Outlets.
 3. Primers:
 - a. Application: Uniform, continuous coverage.
 4. Coating Application:
 - a. Adjacent surfaces exposed to view in finished work: Protect.
 - b. Coatings:
 - Apply in dry atmospheric conditions when primer is completely dry or still tacky as required, in accordance with the recommendations of the coating manufacturer.
 - Uniform, continuous coverage. Do not allow to pool in hollows.
 - Firmly adhered to substrate and free from imperfections.
 - Prevent damage to finished coatings.
 - Penetrations: Impervious.
 - c. Final covering: Apply as soon as possible after coating has hardened.

6.0 METALWORK

6.1 METAL FABRICATIONS**6.1.1 SCOPE OF THE WORKS**

- A. Definition: Metal fabrication includes components and assemblies from ferrous and non-ferrous metal shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.
- B. Extent of metal fabrications is indicated on drawings, and includes but is not necessarily limited to the following:
1. Ladders
 2. Floor drain covers
 3. Water tank access covers
 4. Steel gates
 5. Aluminium handrails and railing systems
 6. Miscellaneous steel pipe railings
 7. Miscellaneous chequer plate fabrications
 8. Miscellaneous galvanised steel gratings
 9. Aluminium doors and windows openings.

6.1.2 SITE CONDITIONS

- A. On-site Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate on-site measurements before fabrications; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

6.1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, anchor details and installation instructions for products used in miscellaneous metal fabrications, including metal finishes, paint products and grout.
- B. Shop Drawings: Submit shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections and details of fabrication, assembly finishing and connection. Show anchorages, accessories and trim. Provide templates for anchor and bolt installation by others.

Where materials or fabrications are indicated or required to comply with certain requirements for design loadings, include structural computations, material properties and other information needed for structural analysis. Samples: Submit 2 sets of representative samples of all materials and finished products as may be requested by the Engineer.

6.2 PRODUCTS**6.2.1 MATERIALS****A. Ferrous Metals**

1. Metal surfaces, general:
For fabrication of miscellaneous metalwork which will be exposed to view, use only materials which are smooth and free of surface blemishes and including pitting, seam marks, roller marks, rolled trade names and roughness. Fasteners are generally of the same metal as the component, with matching coating and finish.
2. Steel long and flat products:

- a. Hot rolled structural steels (excluding structural hollow sections and tubes): To CYS EN 10025-1.
 - b. Fine grain steels, including special steels: To CYS EN 10025-3 and -4.
 - c. Improved atmospheric corrosion resistance: To CYS EN 10025-5.
3. Steel plate, sheet and strip:
 - a. Plates and wide flats, high yield strength steel: To CYS EN 10025-6.
4. Hot rolled steel plate, sheet and strip:
 - a. Flat products, high yield strength for cold forming: To CYS EN 10149-1, -2 and -3.
 - b. Low carbon steel sheet and strip for cold forming: To CYS EN 10111.
 - c. Narrow strip, formable and general engineering purposes: To BS 1449-1.8 and BS 1449 1.14.
5. Cold rolled steel plate, sheet and strip:
 - a. Steel sections: To CYS EN 10162.
 - b. Flat products, high yield strength micro-alloyed steels for cold forming: To CYS EN 10268.
 - c. Low carbon steel flat products for cold forming: To CYS EN 10130 and CYS EN 10131.
 - d. Uncoated mild steel narrow strip for cold forming: To CYS EN 10139 and CYS E 10140.
 - e. Narrow strip, general engineering purposes: To CYS EN 10132-1, -2, and -3.
 - f. Low carbon steel flat products for vitreous enamelling: To CYS EN 10209.
6. Steel coated flat products:
 - a. Hot dip zinc coated low carbon steel sheet and strip for cold forming: To CYS EN 10327 and CYS EN 10143.
 - b. Hot dip zinc coated structural steel sheet and strip: To CYS EN 10143 and CYS EN 10326.
 - c. Hot dip zinc-aluminium (za) coated sheet and strip: To CYS EN 10326 and 10327.
 - d. Hot dip aluminium-zinc (az) coated sheet and strip: To CYS EN 10327.
 - e. Organic coated flat products: To CYS EN 10169-1.
7. Steel structural hollow sections (SHS)
 - a. Non alloy and fine grain steels, hot finished: To CYS EN 10210-1 and -2.
 - b. Non-alloy and fine grain steels, cold formed welded: To CYS EN 10219-2.
 - c. Weather resistant steels, hot finished: To BS 7668.
8. Other steel sections:
 - a. Equal flange tees: To CYS EN 10055.
 - b. Equal and unequal angles: To CYS EN 10056-1 and -2.
 - c. Wire, mild steel for general engineering purposes: To BS 1052.
 - d. Wire and wire products, general: To CYS EN 10218-2.
 - e. Tubes:
 - Cold finished electric resistance welded: To BS 6323-6.
 - Cold finished seamless: To BS 6323-4.
 - Seamless and welded generally: To BS 6323-1.
 - Seamless circular: To CYS EN 10297-1.
 - Seamless cold drawn: To CYS EN 10305-1.
 - Welded and cold sized square and rectangular: To CYS EN 10305-5.
 - Welded circular: To CYS EN 10296-1.
 - Welded cold drawn: To CYS EN 10305-2.
 - Welded cold sized: To CYS EN 10305-3.
9. Stainless steel products:
 - a. Chemical composition and physical properties: To CYS EN 10088-1.
 - b. Sheet, strip and plate: To CYS EN 10088-2.
 - c. Semi-finished products bars, rods and sections: To CYS EN 10088-3.
 - d. Wire: To BS 1554.
 - e. Tubes, welded: To BS 6323-8.
10. Grey iron Castings: To CYS EN 1561.

11. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
12. Concrete inserts: Threaded or wedge type, galvanized ferrous castings, either malleable iron or cast steel. Provide bolts, washers and shims as required, hot-dip galvanized.

B. Aluminium

1. Aluminium alloy products:
 - a. Designations:
 - Designation system, chemical composition and forms: To CYS EN 573-1 to -4.
 - Temper designations: To CYS EN 515.
 - b. Sheet, strip and plate: To CYS EN 485-1 to -4.
 - c. Cold drawn rods, bars and tubes: To CYS EN 754-1 and -2.
 - d. Extruded rods, bars, tubes and profiles: To CYS EN 755-1 and -2.
 - e. Drawn wire: To CYS EN 1301-1, -2 and -3.
 - f. Rivet, bolt and screw stock: To BS 1473.
 - g. Structural sections: To BS 1161.
2. Fasteners for Aluminium: Use fasteners made of same basic metal as fastened metal except use galvanized fasteners for exterior aluminium units, unless otherwise indicated. Do not use metals which are corrosive or incompatible with metals joined.

C. Copper

1. Copper alloy products:
 - a. Sheet, strip, plate and circles for general purposes: To CYS EN 1652.
 - b. Sheet and strip for building purposes: To CYS EN 1172.
 - c. Rods: To CYS EN 12163.
 - d. Profiles and rectangular bars: To CYS EN 12167.
 - e. Wire: To CYS EN 12166.
 - f. Tubes: To CYS EN 12449.

D. Grout

1. Non-Shrink Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non corrosive, non-gaseous grout. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified and required.

E. Fasteners

1. General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.
2. Bolts and Nuts: Regular-hexagon head type.
3. Lag Bolts: Square head type.
4. Machine Screws: Cadmium plated steel.
5. Wood Screws: Flat head carbon steel.
6. Plain Washers: Round, carbon steel.
7. Anchorage Devices: Drilled in expansion anchor bolts.
8. Toggle Bolts: Tumble-wing type, class and style as required.
9. Lock Washers: Helical spring type carbon steel.

F. Paint and other finishes

1. Shop Primer for Ferrous Metal: Manufacturer's or fabricator's standard, fast-curing, lead-free, "universal" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field applied topcoats despite prolonged exposure.
2. Galvanizing Repair Paint: High zinc dust content paint for re-galvanizing welds in galvanized steel.
3. Bituminous Paint: Cold applied asphaltic mastic.

4. Zinc Chromate Primer.
5. Zinc and cadmium plating of iron and steel surfaces:
 - a. Zinc plating: To CYS EN 12329.
 - b. Cadmium plating: To CYS EN 12330.
6. Chromium plating:
 - a. Standard: To CYS EN 12540.
7. Galvanising:
 - a. Standard: To CYS EN ISO 1461.
 - b. Vent and drain holes:
 - Location: To be approved.
 - Sealing after galvanizing: Required. Submit proposals.
8. Vitreous Enamelling:
 - a. Standard: To BS 3830.

6.2.2 **ANODISING**

- A. Anodic coating:
 1. Selected anodizer: Submit details before commencement of anodizing.
- B. Working procedures:
 1. Requirement: Comply with BS 3987 for anodic coatings on wrought aluminium.
- C. Anodizer requirements:
 1. Processing: To CYS EN 12373, subject to a local coating thickness of not less than 20 micrometres.
 2. Currently certified to CYS EN ISO 9001.
 3. Each anodizer to use only one plant.
- D. Guarantees:
 1. Anodizer guarantees:
 - a. Submit sample copies before commencement of anodising.
 - b. Submit signed project specific copies on completion of work.
- E. Control samples:
 1. Sequence: Prior to ordering materials for the works, obtain approval of appearance for:
 - a. Anodic coated samples: Showing colour and texture variation.
 - b. Fabrication samples: Showing joint assembly, how anodic coating is affected and how cut metal edges are protected.
- F. Component design:
 1. Condition of components to be anodised:
 - a. To comply with relevant recommendations of BS 4479-1, and -5.
 - b. Of suitable size to fit plant capacity.
- G. Pre-treatment:
 1. Condition of components to be anodised:
 2. Free from corrosion and damage.
 3. Suitable for and compatible with the pre-treatment and anodizing process.
 4. Process: In accordance with the specification requirements for the finish
- H. Extent of anodic coatings:
 1. Application: To visible component surfaces, and concealed surfaces requiring protection. Coated surfaces will be deemed 'significant surfaces' for relevant BS 3987 performance requirements.
- I. Application of anodic coatings:
 1. Surfaces to receive anodic coatings: Clean.
 2. Jig points: To be agreed. Not on visible areas of anodic coated components.
 3. Use of touch-up paint: Not acceptable.

- J. Performance and appearance of anodic coatings:
1. Standard: To BS 3987.
 2. Visual inspection after anodizing: Significant surfaces to be free from visible coating/ defects when viewed from a distance of not less than 5 m for external and 3 m for internal applications.
- K. Fabrications:
1. Units may be assembled:
 - a. Before anodizing, subject to satisfactory drainage.
 - b. From components anodized after cutting to size.
 - c. Where approved, from components anodized before cutting to size.
- L. Fabrication damage repair/ replacement:
1. Inspection: Check all components before delivery to site for damage to anodic coatings. Submit proposals for repair or replacement.
- M. Protection:
1. Anodic coated surfaces of components: Protect from damage during handling and installation, or by subsequent site operations.
 2. Protective coverings: Must be:
 - a. Resistant to weather conditions.
 - b. Partially removable to suit building in and access to fixing points.
 3. Protective tapes in contact with anodizing: Must be:
 - a. Low tack, self-adhesive and light in colour.
 - b. Applied and removed in accordance with tape and anodizers recommendations.
 4. Inspection of protection: Carry out monthly. Promptly repair any deterioration or deficiency.
- N. Site damage repair/ replacement:
1. Damage to anodic coatings: Rectify immediately damage caused during handling and installation, or by subsequent site operations. Submit proposals for extensive repair or replacement.
- O. Documentation:
1. Submit the following information for each batch of anodic coated components:
 - a. Supplier.
 - b. Trade name.
 - c. Colour (if required).
 - d. Batch and reference number.
 - e. Statutory requirements.
- P. Completion:
1. Cleaning and maintenance of anodic coated surfaces: Carry out in accordance with procedures detailed in the anodiser's guarantees.

6.2.3 **POWDER COATINGS**

- A. Powder Coating Materials:
1. Selected manufacturer: Submit details before commencement of powder coating.
- B. Working Procedures:
1. Requirement: Comply with:
 - a. BS 6496 for aluminium alloy backgrounds.
 - b. British Coatings Federation: Code of safe practice - Application of thermosetting powder coatings by electrostatic spraying.
 - c. Powder coating manufacturer's guarantee.
- C. Powder Coating Applicators:
1. Applicator requirements:

- a. Approved by powder coating manufacturer.
- b. Currently certified to CYS EN ISO 9001.
- c. Comply with quality procedures, guarantee conditions, standards and tests required by powder coating manufacturer.
- d. Each applicator to use only one plant.
- 2. Selected applicator: Submit details before commencement of powder coating.

D. Guarantees:

- 1. Powder coating manufacturer and applicator guarantees:
 - a. Submit sample copies before commencement of powder coating.
 - b. Submit signed project specific copies on completion of work.

E. Control Samples:

- 1. Sequence: Prior to ordering materials for the works, obtain approval of appearance for:
 - a. Powder coated samples: Of various grades and forms of background metal to be used, showing any colour, texture and gloss variation.
 - b. Fabrication samples: Showing joint assembly, how powder coating is affected and how any cut metal edges are protected.
- 2. Samples to include the following information:
 - a. Product reference.
 - b. Colour.
 - c. Reference number.
 - d. Name.
 - e. Gloss level.

F. Independent Inspection at Plant:

- 1. Requirement: Contractors/ Subcontractors of the following designated components must commission the Engineer to carry out acceptance inspections to confirm that powder coating application complies with this specification.
 - a. Designated components: All components specified.
- 2. Acceptance inspections: Carry out for each variation of colour and finish of each component work package at applicator's plant prior to any fabrication of units, in accordance with the following:
 - a. Where three or more production runs are required for application of coatings, not less than three acceptance inspections must be carried out in accordance with BS 6001-1, general inspection level 2, with an acceptance quality limit of 1%.
 - b. Where less than three production runs are required for application of coatings, one acceptance inspection must be carried out in accordance with BS 6001-2, with a limiting quality of 5% where the probability of acceptance is 10%.
- 3. Components failing inspection: Reprocess or replace and re-inspect.

G. Component Design:

- 1. Condition of components to be powder coated:
 - a. To comply with relevant recommendations of BS 4479-1, -3, and -4.
 - b. Of suitable size to fit plant capacity.
 - c. Of suitable thickness to withstand oven curing.

H. Pre-treatment:

- 1. Condition of components to be powder coated:
 - a. Free from corrosion and damage.
 - b. Free from impurities including soil, grease, and oil.
 - c. Suitable for and compatible with the pre-treatment and powder coating process.
- 2. Process: Clean, conversion coat, condition, rinse in demineralised water, drain and dry components in accordance with the powder coating manufacturer's requirements and the pre-treatment Subcontractor's recommendations.

I. Extent of Powder Coatings:

- 1. Application: To visible component surfaces, and concealed surfaces requiring protection. Coated

surfaces will be deemed 'significant surfaces' for relevant BS 6496/ CYS EN 13438 performance requirements.

- J. Application of Powder Coatings:
1. Surfaces to receive powder coatings: Free from dust or powder deposits.
 2. Completion of powder coatings: Within 48 hours of pre-treatment of components.
 3. Jig points: Not visible on coated components.
 4. Curing: Controlled to attain metal temperatures and hold periods recommended by powder coating manufacturer.
 5. Stripping and recoating of components: Only acceptable by prior agreement of powder coating manufacturer. Stripping, pre-treatment and powder coating are to be in accordance with manufacturer's requirements.
 6. Over-coating of components: Not acceptable.
- K. Performance and Appearance of Powder Coatings:
1. Standard: To BS 6496/ CYS EN 13438.
- L. Aluminium Alloy Fabrications:
1. Units may be assembled:
 - a. Before powder coating.
 - b. From components powder coated after cutting to size.
 - c. Where approved, from components powder coated before cutting to size.
 2. Exposure of uncoated background metal: Not acceptable.
 3. Assembly sealants: Compatible with powder coatings. Obtain approval of colour if sealants are visible after fabrication.
- M. Fixings:
1. Exposed metal fixings: Powder coat together with components, or coat with matching repair paint system applied in accordance with the powder coating manufacturer's recommendations.
- N. Fabrication Damage Repair/ Replacement:
1. Inspection: Check all components before delivery to site for damage to powder coatings. Submit proposals for repair or replacement.
- O. Protection:
1. Powder coated surfaces of components: Protect from damage during handling and installation, or by subsequent site operations.
 2. Protective coverings: Must be:
 - a. Resistant to weather conditions.
 - b. Partially removable to suit building in and access to fixing points.
 3. Protective tapes in contact with powder coatings: Must be:
 - a. Low tack, self-adhesive and light in colour.
 - b. Applied and removed in accordance with tape and powder coating manufacturers' recommendations. Do not use solvents to remove residues as these are detrimental to the coating.
 4. Inspection of protection: Carry out monthly. Promptly repair any deterioration or deficiency.
- P. Site Damage Repair/ Replacement:
1. Damage to powder coatings: Rectify immediately damage caused during handling and installation, or by subsequent site operations. Submit proposals for extensive repair or replacement.
- Q. Documentation:
1. Submit the following information for each batch of powder coated components:

- a. Subcontractor.
- b. Trade name.
- c. Colour.
- d. Type of powder.
- e. Method of application.
- f. Batch and reference number.
- g. Statutory requirements.

R. Completion:

1. Cleaning and maintenance of powder coatings: Carry out in accordance with procedures detailed in powder coating manufacturer and applicator guarantees.

6.2.4 **FABRICATION, GENERAL**

A. **Workmanship:**

1. Use materials of size thickness and shapes indicated or, if not indicated, as required to produce strength, durability and performance requirements for use intended in finished product. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
2. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 0.8 mm unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
3. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent bulking, opening up of joints, and over stressing of welds and fasteners.
 - a. Temperature Change (Range): 40 deg C.
4. Shear and punch metals clearly and accurately. Remove burrs.
5. Weld corners and seams continuously, complying with relevant referenced standards. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.
6. Form exposed connections with hairline joints, flush and smooth using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts.
7. Provide for anchorage of type indicated or required, co-ordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
8. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws and similar items.
9. Galvanizing: Provide a zinc coating for those items indicated or specified to be galvanized.
10. Fabricate joints which will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

B. **Finishes:**

1. General: Comply with standards and recommendations relative to application and designations of metal finishes. Finish metal fabrications after assembly.
2. Steel and Iron finishes:
 - a. Galvanizing: For those items indicated for galvanizing, apply zinc-coating by the hot-dip process compliance with relative standard requirements.
 - b. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum standard requirements for surface preparation specifications and environmental exposure conditions of installed metal fabrications.
 - c. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete or masonry, unless otherwise indicated. Comply with standard requirements for shop painting.
3. Aluminium Finishes:
 - a. Clear Anodized Finish: Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I: clear film thicker than 25 microns complying with relevant standard requirements.

6.2.5 **MISCELLANEOUS METAL FABRICATIONS**

A. Railings and Handrails

1. Fabricate railings and handrails to comply with requirements indicated for design, dimensions, spacing, materials, finishes and details. Provide railings and handrails members formed of metal shapes, sizes and wall thickness indicated, but not less than that required supporting design loadings. Comply with requirements of BS 6180.
2. Handrail and balustrade fixing:
The fixing methods used to connect handrail and balustrade assemblies to their backgrounds shall be designed to resist the loads given above. The Contractor will be required to submit all relevant calculations for review by the Engineer. Where loading criteria requirements overlap, satisfy the more onerous criterion.
3. Interconnect railings and handrail members by welding or with internal connectors, at fabricator's option, unless otherwise indicated.

6.3 EXECUTION**6.3.1 INSTALLATION****A. General:**

1. Cutting, Fitting and Placement:
 - a. Perform cutting drilling and fittings required for installation of miscellaneous metal fabrications.
 - b. Set work accurately in location, alignment and elevation, plus, level, true and free of rack, measured from established lines and levels.
 - c. Provide temporary bracing or anchors in formwork for items which are to be built into concrete masonry or similar construction.
2. Installation generally:
 - a. Fit exposed connections accurately together to form tight hairline joints.
 - b. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of transport size limitations.
 - c. Grind exposed joints smooth and touch-up shop paint coat.
 - d. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed site connections.

6.3.2 ADJUST AND CLEAN

- A. Touch-up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. For galvanised surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with CYS EN ISO 1461.

7.0 WOODWORK**7.1 ROUGH CARPENTRY****7.1.1 SCOPE OF THE WORKS**

A. Types of work in this section include but are not limited to rough carpentry for:

1. Wood grounds, nailers, and blocking.
2. Wood framing and furring.
3. Sheathing.

B. Joinery and architectural woodwork is specified elsewhere.

7.1.2 DEFINITIONS

A. Rough carpentry includes carpentry work not specified as part of other sections and which is generally not exposed, except as otherwise indicated.

7.1.3 PRODUCT HANDLING

A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack timber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

1. For timber and plywood pressure treated with waterborne chemicals, sticker between each course to provide air circulation.

7.1.4 SITE CONDITIONS

A. Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow attachment of other work.

7.2 PRODUCTS**7.2.1 TIMBER, GENERAL**

A. Timber Standards:

1. Fabrication:
 - a. Standard: To BS 1186-2.
 - b. Sections: Accurate in profile and length, and free from twist and bowing. Formed out of solid unless shown otherwise.
 - c. Machined surfaces: Smooth and free from tearing, wooliness, chip bruising and other machining defects.
 - d. Joints: Tight and close fitting.
 - e. Assembled components: Rigid. Free from distortion.
 - f. Screws: Provide pilot holes.
 - g. Screws of 8 gauge (4 mm diameter) or more and screws into hardwood: Provide clearance holes.
 - h. Countersink screws: Heads sunk at least 2 mm below surfaces visible in completed work.
 - i. Adhesives: Compatible with wood preservatives applied and end uses of timber.
2. Cross Section Dimensions of Timber:
 - a. General: Dimensions on drawings are finished sizes.
 - b. Maximum permitted deviations from finished sizes:
 - Softwood sections: To CYS EN 1313-1:
Clause 6 for sawn sections.
Clause NA.2 for further processed sections.
 - Hardwood sections: To CYS EN 1313-2:
Clause 6 for sawn sections.
Clause NA.3 for further processed sections.

3. Preservative Treated Wood:
 - a. Cutting and machining: Completed as far as possible before treatment.
 - b. Extensively processed timber: Retreat timber sawn lengthways, thickened, planed, ploughed, etc.
 - c. Surfaces exposed by minor cutting and/ or drilling: Treat with two flood coats of a solution recommended by main treatment solution manufacturer.
4. Moisture Content:
 - a. Wood and wood based products: Maintained within range specified for the component during manufacture and storage.
5. Laminated Plastics Veneered Boards/ Panels:
 - a. Fabrication: To British Laminated Plastics Fabricators Association Ltd (BLF) fabricating standards.
 - b. Balancing veneer: From decorative veneer manufacturer and of similar composition. Applied to reverse side of core.
 - c. Finished components: Free from defects, including bow, twist, scratches, chipping, cracks, pimpling, indentations, glue marks, staining and variations in colour and pattern.
 - d. Joints visible in completed work: Tight butted, true and flush.
6. Wood Veneered Boards/ Panels:
 - a. Core material and veneers: Conditioned before bonding.
 - b. Setting out: Veneer features and grain pattern aligned regularly and symmetrically unless instructed otherwise.
 - c. Balancing veneer: Applied to reverse side of core material.
 - d. Moisture and temperature movement characteristics: As facing veneer.
 - e. Veneer edges: Tight butted and flush, with no gaps.
 - f. Tolerance of veneer thickness (maximum): ± 0.5 mm.
 - g. Finished components: Free from defects, including bow, twist, scratches, chipping, splits, blebs, indentations, glue marks and staining.
 - h. Surface finish: Fine, smooth, free from sanding marks.
7. Finishing:
 - a. Surfaces: Smooth, even and suitable to receive finishes.
 - b. Arrises: Eased unless shown otherwise on drawings.
 - c. End grain in external components: Sealed with primer or sealer as section M60 and allowed to dry before assembly.

B. Timber Types:

1. General Timber: Douglas Fir, Longleaf Pine, European Redwoods.
2. Blocking Timber: Russia Whitewood "SHUH" or other equal approved.

C. Grade Stamps: Factory-mark each piece of timber with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade species, moisture content at time of surfacing, and mill.

1. For exposed timber apply grade stamps to ends or back of each piece, or omit grade stamps entirely and issue certificate of grade compliance from inspection agency in lieu of grade stamp.

D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by Cyprus/ British Standards, for moisture content specified for each use.

1. Provide dressed timber, unless otherwise indicated.
2. Provide seasoned timber with 19 percent maximum moisture content at time of dressing and shipment for sizes 50 mm or less in nominal thickness, unless otherwise indicated.
3. Provide timber with 15 percent maximum moisture content at time of dressing and shipment for sizes 50 mm or less in nominal thickness, unless otherwise indicated.

7.2.2 MISCELLANEOUS MATERIALS

- A. Fasteners and Anchorages:** Provide size, type, material and finish as indicated and as recommended by applicable standards, for nails, staples, screws, bolts, nuts, washers and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommended nails.

1. Where rough carpentry work is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating.

B. Building Paper: asphalt saturated felt, non-perforated, 7 kg type.

7.3 EXECUTION

7.3.1 INSTALLATION GENERAL

- A. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
- B. Set carpentry work to required levels and lines, with members plumb and true and cut and fitted.
- C. Securely attach carpentry work to substrate by anchoring and fastening as shown and as required by recognized standards.
- D. Countersink nail heads on exposed carpentry work and fill holes.
- E. Use common wire nails, except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite sides will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

7.3.2 WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS

- A. Provide wherever shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
- B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.
- C. Provide permanent grounds of dressed, preservative treated, key-bevelled timber not less than 37.5 mm wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

7.3.3 WOOD FURRING

- A. Install plumb and level with closure strips at edges and opening. Shim with wood as required tolerance of finished work.
 1. Fire stop furred spaces on walls at each floor level and at ceiling line of top storey, with wood blocking or non-combustible material, accurately fitted to close furred spaces.
- B. Furring to receive Plywood Panelling: Unless otherwise indicated, provide 25 mm x 75 mm furring at 600 mm, horizontally and vertically. Select furring for freedom from knots capable of producing bent-over nails and resulting damage to panelling.

8.0 THERMAL AND MOISTURE PROTECTION**8.1 WATERPROOFING AT AND BELOW GROUND LEVEL****8.1.1 GENERAL****8.1.1.1 SCOPE OF THE WORKS**

- A. Extent of each type of waterproofing work is indicated on the drawings.
- B. Types of waterproofing specified in this section include the following:
 - 1. Below slab polyethylene sheet DPM.
 - 2. Liquid applied tanking – Waterproofing / DPM to below ground RC walls and columns.
 - 3. Flexible sheet tanking – Self-adhesive waterproof membrane to RC walls.

8.1.1.2 APPLICABLE CODES AND STANDARDS

- A. Applicable standards:

All Cyprus standards pertaining to these works including:

CYS EN 13967	Flexible sheets for waterproofing. Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet. Definitions and characteristics.
CYS EN 13969	Flexible sheets for waterproofing. Bitumen damp proof sheets including bitumen basement tanking sheets. Definitions and characteristics.
CYS EN 14909	Flexible sheets for waterproofing. Plastic and rubber damp proof courses. Definitions and characteristics.
CYS EN 14967	Flexible sheets for waterproofing. Bitumen damp proof courses. Definitions and characteristics.

- B. British Standards:
 - BS 8102 Code of practice for protection of structures against water from the ground.

8.1.1.3 QUALITY ASSURANCE

- A. Codes and Standards: conform and comply with CYS, BS or other alternative equivalent codes and standards which establish minimum qualitative and quantitative standards for the types of waterproofing materials and installations indicated.
- B. Manufacturer: Obtain primary waterproofing materials of each type required from a single manufacturer, approved by the Engineer, to greatest extent possible. Provide secondary materials only as recommended by manufacturer of primary materials.

Manufacturers are required to demonstrate at least 10 years successful experience in the application of proposed waterproofing membrane systems in circumstances, conditions and locations similar to those of the project.

- C. Installer: Perform waterproofing installations by skilled operators or specialist contractor experienced and regularly engaged in this type of work.

8.1.1.4 SUBMITTALS

- A. Product Data: Submit product data, installation, instructions and general recommendations from waterproofing materials manufacturer, for types of waterproofing required. Include data substantiating that materials comply with requirements, and recommendations for protective courses.
- B. Samples: submit samples of each type of sheet membrane indicated and protective course.
- C. Shop Drawings: Show typical sheet layout and seams configurations; details at perimeter, junctions of vertical and horizontal planes, and special conditions.

8.1.1.5 SITE CONDITIONS

- A. Substrate: Proceed with work only after substrate construction, openings, and penetrating work have been completed.
- B. Weather: Proceed with waterproofing and associated work only when existing and forecasted weather conditions will permit work to be performed in accordance with manufacturers' recommendations and warranty requirements.

8.1.1.6 SPECIAL PROJECT WARRANTY

- A. Provide written warranty in a form acceptable to the Engineer, agreeing to repair and/or replace waterproofing which leaks or otherwise fails to perform as required during the warranty period due to defective materials or workmanship. Warranty includes responsibility for removal and replacement of all other work which conceals waterproofing.

Warranty period shall be 5 years after date of substantial completion taking-over.

8.1.2 PRODUCTS**8.1.2.1 MATERIALS**

- A. General: Provide sheet waterproofing materials recognised to be generic to the types indicated and complying with required performances. Other similar materials certified in writing to be equal to or better than specified in every significant respect may be used if approved by the Engineer.

8.1.2.2 BELOW SLAB POLYETHYLENE SHEET DAMP PROOF MEMBRANE

- A. Chlorinated polyethylene formed into uniform flexible sheets minimum 1200 gauge loose laid.
 - 1. Applications: Damp Proof Membrane (DPM): Under concrete slabs cast on ground, granular or base at grade elevations.
 - 2. Substrate: sand blinded hardcore.
 - 3. Preparation: in accordance with the DPM manufacturers documented instructions, submit copy prior to installation.
 - 4. Thickness/ Gauge: 0.3mm.
 - 5. Joints: Clean and dry membrane surfaces beyond full width of joint.
 - 6. Surface to be joined: Clean and dry.
 - 7. Laps: minimum 150 mm.
 - 8. Sealing: Continuous mastic strip between overlaps or double sided adhesive tape as recommended by membrane manufacturer.
 - 9. Accessories: As recommended by the DPM manufacturer.
 - 10. Other requirements:
 - a. Certified product.
 - b. All necessary linked products from the manufacturers standard range to complete the installation.
- B. Workmanship generally:
 - 1. Condition of substrate: Clean and even textured, free from voids and sharp protrusions.
 - 2. Air and surface temperature: Do not apply sheets if below minimum recommended by membrane manufacturer.
 - 3. Condition of membrane at completion:
 - a. Neat, smooth and fully supported, dressed well into abutments and around intrusions.
 - b. Completely impervious and continuous.
 - c. Undamaged. Prevent puncturing during following work.
 - 4. Permanent overlying construction: Cover membrane as soon as possible.

- C. Inspection:
1. Give notice: Before covering any part of membrane with overlying construction.
- D. Cold applied bonding compounds:
1. Type and application: As recommended for the purpose by the membrane manufacturer.
- E. Angles in bonded damp proof membrane/ tanking:
1. Preformed rot proof fillet to internal angles:
 - a. Size (minimum): 50 x 50mm.
 - b. Bedding: Bitumen mastic or bonding compound.
 2. Reinforcing strip to all angles:
 - a. Material: As damp proofing membrane.
 - b. Width (minimum): 300mm.
 - c. Timing: Apply before main sheeting.
 3. Dressing of main sheeting onto adjacent surfaces (minimum): 100mm.
- F. Junctions with projecting DPCs/ cavity trays:
1. Condition of adjoining surfaces: Clean and dry.
 2. Project dpcs / cavity trays: Lap and fully bond / seal with sheeting.
 - a. Laps (minimum): 150mm.
 - b. Bonding / Sealing: Taped.
- G. Junctions with flush DPCs/ cavity trays:
1. Preparation of adjacent dpcs / cavity trays:
 - a. Expose edge where concealed.
 - b. Adjoining surfaces: Clean and dry.
 2. Joints: Bond / Seal sheeting to wall.
 - a. Dressing of sheeting beyond dpc / cavity tray (minimum): 50mm.
 - b. Bonding / Sealing: Taped.
- H. Pipes, ducts, cables, etc.:
1. Preformed collars: as recommended by the DPM manufacturer from their standard range to suit the context. Submit proposals for approval prior to installation.
 2. Sealing: Fully bond to penetrations and sheeting.
 3. Completed junctions: Impervious.

8.1.2.3 **BITUMINOUS PAINT DAMP PROOFING**

- A. Cold applied liquid damp proofing comprising rubber / bitumen emulsion flexible coating (black).
1. Applications: To below ground concrete walls generally where described on the Drawings.
 2. Substrate: In-situ reinforced concrete to the structural engineer's specifications.
 3. Primer: As recommended by the coating manufacturer.
 4. Coating: cold applied modified bitumen / rubber emulsion damp proof membrane.
 5. Product: Brush applied modified bitumen / rubber emulsion:
 - a. Number of coats: 3.
 - b. Coverage per coat (minimum): 0.8L/m².
 6. Reinforcement: as recommended by the coating manufacturer.
 7. Accessories: as recommended by the coating manufacturer
 8. Other requirements:
 - a. Certified product.
 - b. All necessary linked products from the manufacturers standard range to complete the installation.
- B. Suitability of Substrate:
1. Substrates generally:
 - a. Smooth, even textured, clean, dry and frost free.
 - b. Within tolerances for level and surface regularity.
 - c. Vertical and horizontal surfaces: Correctly prepared and free from irregularities.

- d. Moisture content and stability of substrate: Must not impair integrity of finished tanking / damp proofing.
- 2. Preliminary work: Complete including:
 - a. Chases.
 - b. External angles.
 - c. Formation of upstands and kerbs.
 - d. Movement joints.
 - e. Penetrations / Outlets
- C. Primers:
 - 1. Application: Uniform, continuous coverage.
- D. Coating application:
 - 1. Adjacent surfaces exposed to view in finished work: Protect.
 - 2. Coatings:
 - a. Apply in dry atmospheric conditions when primer is completely dry or still tacky as required, in accordance with the recommendations of the coating manufacturer.
 - b. Uniform, continuous coverage. Do not allow to pool in hollows.
 - c. Firmly adhered to substrate and free from imperfections.
 - d. Prevent damage to finished coatings.
 - e. Penetrations: Impervious.
 - f. Final covering: Apply as soon as possible after coating has hardened.
- E. Cold applied coatings:
 - 1. Thinning: Only as recommended by manufacturer.
 - 2. Successive coats:
 - a. Allow to dry before applying next.
 - b. Apply at right angles as previous.
- F. Bituminous coatings:
 - 1. Surface treatment: As recommended by the coating manufacturer.
 - 2. Air and surface temperatures (minimum): 5°C.
 - 3. Weather conditions: Do not apply if there is a risk of rain during application and drying unless effective temporary cover is provided over working area.
- G. Protection of coating:
 - 1. Surface: Clean and free from contaminants.
 - 2. Board: Bituminous fibre board or as recommended by DPM supplier.
 - 3. Thickness: As recommended by manufacturer for purpose.
 - 4. Placement: Bed into membrane or apply double-sided adhesive tape, as recommended by manufacturer.
 - a. Edge overlap (minimum): 75mm.
 - b. Perimeter treatment: Seal as recommended by manufacturer.
 - 5. Contact: Secure. Full and continuous with coating.
- H. Backfilling:
 - 1. Timing: Carry out as soon as possible after tanking and protection are complete.

8.1.2.4 BITUMINOUS SHEET WATERPROOFING

- A. Two-ply self-adhesive waterproof membrane of polyethylene film top layer and bitumen polymer adhesive bottom layer, formed into uniform flexible sheets. HDPE film laminated to a 1.5mm layer of modified bitumen polymer.
 - 1. Thickness/ Gauge: 1.5 mm.
 - 2. Joints: Clean and dry membrane surfaces beyond full width of joint.
 - 3. Surface to be joined: Clean and dry.
 - 4. Laps: minimum 150 mm.
 - 5. Sealing: As recommended by the membrane manufacturer.
 - 6. Accessories: As recommended by the membrane manufacturer.

7. Other requirements:
 - a. Certified product.
 - b. All necessary linked products from the manufacturer's standard range to complete the installation.
 - c. All necessary protection, reinforcement and trims as required to complete the installation
- B. Applications:
 1. Basement Tanking: Membrane waterproofing to underside/outside surfaces of underground concrete slabs and walls enclosing basement structures.
 2. Planter Linings: Membrane waterproofing to inside of concrete planters and the like, as indicated.
- C. Miscellaneous Materials:
 1. Adhesives: Provide types of adhesive compound and tapes recommended by waterproofing sheet manufacturer, for bonding to substrate (if required), for waterproof sealing of seams in membrane, and for waterproof sealing of joints between membrane and flashings, adjoining surfaces and projections through membrane.
 2. Primers: Provide type of concrete primer recommended by manufacturer of sheet waterproofing material for applications required.
 3. Coatings: Provide type of coating recommended by waterproofing sheet manufacturer, for improvement of weathering resistance on exposed areas of membrane, including areas extended as flashing (if any). Provide black coating except as otherwise indicated.
 4. Flashing Materials: Except as otherwise indicated, provide types of flexible sheet material for flashing as recommended by waterproofing sheet manufacturer.
 5. Protection Course: Provide type recommended by waterproofing sheet manufacturer, unless otherwise indicated or acceptable to the Engineer, include adhesives recommended by the manufacturer.
- D. Preparation:
 1. Prior to installation of waterproofing and associated work, meet at project site with installer of each component of associated work, inspection and testing agency representatives (if any), and installers of work requiring coordination with waterproofing work. Review material selections and procedures to be followed in performing work.
 2. On concrete walls, immediately before placement of waterproofing sheet, grind surface lightly with terrazzo grinder or similar device, to ensure removal of projections which might penetrate sheet. Clean deck of loose material.
 3. Apply primer to concrete (and masonry where applicable) surfaces at rate recommended by manufacturer of primary waterproofing materials. Prime only area which will be covered by waterproof membrane in same working day; re-prime areas not covered by membrane within 24 hours.
- E. Installation:
 1. Comply with manufacturer's instructions for handling and installation of sheet waterproofing materials including air and surface temperatures.
 2. Coordinate installation of waterproofing materials and associated work to provide complete system complying with combined recommendations of manufacturers and installers involved in work. Schedule installation to minimize period of exposure of sheet waterproofing materials.
 3. Extend waterproofing sheet and flashings as shown to provide complete membrane over area indicated to be waterproofed. Seal to projections through membrane and seal seams. Bond to vertical surfaces and also, where shown or recommended by manufacturer, bond to horizontal surfaces.
 4. Coat exposed areas of sheet and flashing materials. Comply with sheet manufacturer's recommendations for application and cure of coating.
 5. Install protection course of type indicated over completed membrane, complying with manufacturer's recommendations for both waterproofing sheet and protection course materials.
- F. Performance Requirements:
 1. It is required that waterproof membranes are watertight and do not deteriorate in excess of limitations published by the manufacturer.
 2. In-place Testing: Before completed membranes on horizontal surfaces are covered by protection course or other work, test for leaks with 50 mm depth of water maintained for 24 hours. Repair any leaks revealed by examination of substructure and repeat test until no leakage is observed.

- G. Protection:
1. Institute required procedures for protection of completed membrane during installation of work over membrane and throughout remainder of construction period. Do not allow traffic of any type on unprotected membrane.
 2. Inspection: Give notice before covering any part of membrane with overlying construction.

8.2 MEMBRANE ROOFING

8.2.1 GENERAL

8.2.1.1 SCOPE OF THE WORKS

- A. The extent of membrane roofing is indicated on drawings, and includes single-ply membrane roofing systems.
- B. Types of roofing systems specified in this section utilizing single ply roofing membranes include the following:
1. Single layer reinforced bitumen membrane inverted roof covering.
- C. The following membrane inverted roofing related items are also specified in this section:
1. Concrete roof screeds.
 2. Thermal insulation and roof finishes.

8.2.1.3 APPLICABLE CODES AND STANDARDS

- A. Applicable standards:
1. All Cyprus standards pertaining to these works including:

CYS EN 495-5	Flexible sheets for waterproofing. Determination of foldability at low temperature. Plastic and rubber sheets for roof waterproofing.
CYS EN 1107-1	Flexible sheets for waterproofing. Determination of dimensional stability. Bitumen sheets for roof waterproofing.
CYS EN 1107-2	Flexible sheets for waterproofing. Determination of dimensional stability. Plastic and rubber sheets for roof waterproofing.
CYS EN 1108	Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of form stability under cyclical temperature changes.
CYS EN 1109	Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of flexibility at low temperature.
CYS EN 1110	Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of flow resistance at elevated temperature.
CYS EN 1296	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roofing. Method of artificial ageing by long term exposure to elevated temperature.
CYS EN 1297	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Method of artificial ageing by long term exposure to the combination of UV radiation, elevated temperature and water.
CYS EN 1339	Concrete paving flags. Requirements and test methods.
CYS EN 1548	Flexible sheets for waterproofing. Plastic and rubber sheets for roof waterproofing. Method for exposure to bitumen.
CYS EN 1844	Flexible sheets for waterproofing. Determination of resistance to ozone. Plastic and rubber sheets for roof waterproofing.
CYS EN 1847	Flexible sheets for waterproofing. Plastic and rubber sheets for roof waterproofing. Methods for exposure to liquid chemicals including water.
CYS EN 1848-1	Flexible sheets for waterproofing. Determination of length, width and straightness. Bitumen sheets for roof waterproofing.
CYS EN 1848-2	Flexible sheets for waterproofing. Determination of length, width and straightness. Plastic and rubber sheets for roof waterproofing.
CYS EN 1849-1	Flexible sheets for waterproofing. Determination of thickness and mass per unit area. Bitumen sheets for roof waterproofing.

CYS EN 1849-2	Flexible sheets for waterproofing. Determination of thickness and mass per unit area. Plastic and rubber sheets for roof waterproofing.
CYS EN 1850-1	Flexible sheets for waterproofing. Determination of visible defects. Bitumen sheets for roof waterproofing.
CYS EN 1850-2	Flexible sheets for waterproofing. Determination of visible defects. Plastic and rubber sheets for roof waterproofing.
CYS EN 1928	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of watertightness.
CYS EN 1931	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of water vapour transmission properties.
CYS EN 12039	Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of adhesion of granules.
CYS EN 12310-1	Flexible sheets for waterproofing. Determination of resistance to tearing (nail shank). Bitumen sheets for roof waterproofing.
CYS EN 12310-2	Flexible sheets for waterproofing. Determination of resistance to tearing (nail shank). Plastic and rubber sheets for roof waterproofing.
CYS EN 12311-1	Flexible sheets for waterproofing. Determination of tensile properties. Bitumen sheets for roof waterproofing.
CYS EN 12311-2	Flexible sheets for waterproofing. Determination of tensile properties. Plastic and rubber sheets for roof waterproofing.
CYS EN 12316-1	Flexible sheets for waterproofing. Determination of peel resistance of joints. Bitumen sheets for roof waterproofing.
CYS EN 12316-2	Flexible sheets for waterproofing. Determination of peel resistance of joints. Plastic and rubber sheets for roof waterproofing.
CYS EN 12317-1	Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of shear resistance of joints.
CYS EN 12317-2	Flexible sheets for waterproofing. Plastic and rubber sheets for roof waterproofing.
CYS EN 12691	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of resistance to impact.
CYS EN 12730	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of resistance to static loading.
CYS EN 13111	Flexible sheets for waterproofing. Underlays for discontinuous roofing and walls. Determination of resistance to water penetration.
CYS EN 13162	Thermal insulation products for buildings. Factory made mineral wool (MW) products. Specification.
CYS EN 13164	Thermal insulation products for buildings. Factory made products of extruded polystyrene foam (XPS). Specification.
CYS EN 13165	Thermal insulation products for buildings. Factory made rigid polyurethane foam (PUR) products. Specification.
CYS EN 13166	Thermal insulation products for buildings. Factory made products of phenolic foam (PF). Specification.
CYS EN 13167	Thermal insulation products for buildings. Factory made cellular glass (CG) products. Specification.
CYS EN 13168	Thermal insulation products for buildings. Factory made wood wool (WW) products. Specification.
CYS EN 13169	Thermal insulation products for buildings. Factory made products of expanded perlite (EPB). Specification.
CYS EN 13170	Thermal insulation products for buildings. Factory made products of expanded cork (ICB). Specification.
CYS EN 13416	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Rules for sampling.
CYS EN 13583	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of hail resistance.
CYS EN 13707	Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definition and characteristics.
CYS EN 13859-1	Flexible sheets for waterproofing. Definitions and characteristics of underlays. Underlays of discontinuous roofing.
CYS EN 13897	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing – Determination of watertightness after stretching at low temperature.

CYS EN 13948	Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of resistance to root penetration.
CYS EN 13956	Flexible sheets for waterproofing. Plastic and rubber sheets for roof waterproofing. Definitions and characteristics.
CYS EN 13970	Flexible sheets for waterproofing. Bitumen water vapour control layers. Definitions and characteristics.
CYS EN 13984	Flexible sheets for waterproofing. Plastic and rubber vapour control layers. Definitions and characteristics.
CYS EN ISO 10319	Geotextiles. Wide-width tensile test.
CYS EN ISO 11058	Geotextiles and geotextile-related products. Determination of water permeability characteristics normal to the plane, without load.
CYS EN ISO 12956	Geotextiles and geotextile-related products. Determination of the characteristic opening size.

2. British Standards:
- | | |
|-----------|---|
| BS 476 | Fire tests on building materials and structures. Classification and method of test for external fire exposure to roofs. |
| BS 5250 | Code of practice for control of condensation in buildings. |
| BS 6203 | Guide to fire characteristics and fire performance of expanded polystyrene materials (EPS and XPS) used in building applications. |
| BS 6229 | Flat roofs with continuously supported coverings. Code of practice. |
| BS 8217 | Reinforced bitumen membranes for roofing. Code of practice. |
| BS 8218 | Code of practice for mastic asphalt roofing. |
| CP 143-5 | Code of practice for sheet roof and wall coverings. Part 5: Zinc. |
| CP 143-12 | Code of practice for sheet roof and wall coverings. Part 12: Copper |
| CP 143-15 | Code of practice for sheet roof and wall coverings. Part 15: Aluminium. |

8.2.1.4 **SITE CONDITIONS**

- A. Weather: Proceed with roofing work when existing and forecasted weather conditions permit work to be performed in accordance with manufacturers' recommendations and warranty requirements.
- B. Substrate Conditions: Do not begin roofing installation until substrates have been inspected and are determined to be in satisfactory condition.

8.2.1.5 **WARRANTY**

- A. Special Project Warranty: Submit two executed copies of "Roofing Warranty" in a form acceptable to the Engineer, undertaking to repair and/or replace all or any part of the roofing system which leaks or otherwise fails to perform as required during the warranty period due to defective materials or workmanship including pavers, protection course, thermal insulation, membrane roofing, roof screed, accessories, flashings, etc.

Period of Warranty: 10 years after date of substantial completion/taking over.

8.2.2 **PRODUCTS**

8.2.2.1 **SINGLE LAYER REINFORCED BITUMEN MEMBRANE INVERTED ROOF COVERING**

- A. Standard: To BS 6229.
- B. Substrate: Concrete screed laid to falls or reinforced concrete deck laid to falls.
- Preparation: Fully in accordance with the waterproof membrane manufacturer's recommendations.
- C. Primer:
- Apply strictly in accordance with waterproof membrane manufacturer's recommendations.

- D. Waterproof covering:
1. Standard: Refer to Section 9.2.1.4.
 2. Description: Dimensionally stable single layer membrane to comprise HDPE film and rubber/bitumen compound. Material selection to be specifically recommended by manufacturer for use in hot climates.
 3. Attachment: Adhesive or self-adhesive.
 4. Flashings and detail work: To detail, to approval.
- E. Thermal Insulation:
1. Standard: To CYS EN 13164.
 2. Extruded polystyrene foamed boards:
 - a. To CYS EN 13164.
 - b. Minimum density: 30 kgm^{-3} .
 - c. Compressive strength: 300 kPa.
 - d. Thickness: As indicated on drawings.
- F. Filter Layer:
1. Standard: To CYS EN ISO 10319, CYS EN ISO 11058, and CYS EN ISO 12956.
 2. Description: Non-woven polyethylene geotextile.
 3. Application: As a separating and filtering layer between the extruded polystyrene foam boards and a gravel ballast layer.
- G. Surface protection/ Securement:
- Either:
1. Nominal 600 x 600mm by 50mm thick concrete paving slabs laid dry on proprietary spacers to CYS EN 1339.
 - Or,
 2. Ballast: Selected, well washed, well-rounded gravel of nominal diameter 20mm to 40mm hard, strong and durable with no sharp protrusions. Layer thickness: 50-100mm.
- H. Accessories:
1. As recommended by the waterproof membrane manufacturer. Provide all necessary linked products to complete the installation.
- I. Other requirements:
1. Submit full technical data for the Engineer's approval prior to order and detail design.
 2. Co-ordinate with all interfacing suppliers and contractors works.

8.2.2.3 OTHER AUXILIARY MATERIALS

- A. Flashing Material: Manufacturer's standard or recommended system compatible with flexible sheet membrane.
- B. Roof Screed (lightweight): Lightweight insulating concrete roof screed formed from ordinary Portland cement and aggregate conforming to CYS EN 13055-1, such as vermiculite, Alveolitic etc., of an exfoliated micaceous mineral aggregate, incombustible and chemically inert. Screed to have minimum thickness of 50mm at rainwater outlets shall be laid to falls as indicated on the drawings and shall be constructed strictly in accordance with manufacturer's specification.
- C. Roof Screed (ordinary): Ordinary roof screeds shall be of concrete grade C20, of water/cement ratio 0.5, with minimum thickness of 50mm at rainwater outlets and shall be laid to falls as indicated on the drawings.

8.2.3 INVERTED ROOF INSTALLATION

8.2.3.1 PREPARATION OF SUBSTRATE

- A. Clean substrate of dust, debris, and other substances detrimental to roofing system work. Remove sharp projections.

- B. Verify that penetrations, expansion joints, and blockings are in place and secured and that roof drains are properly clamped into position.
- C. Install flashings and accessory items as indicated, and as recommended by manufacturer if not indicated.
- D. Mask to prevent compounds from entering and clogging drains and conductors and from spilling or migrating on to surfaces of other work.

8.2.3.2 ROOF SCREED INSTALLATION

- A. Lightweight screeds: Comply with lightweight aggregate manufacturer's instructions for mixing and handling of the lightweight screed.
- B. Lay the screed to thicknesses and drainage falls required to provide an efficient drainage system. Minimum screed thickness 40 mm.
- C. Lay the screed in bays of maximum 9 m². Each bay shall be formed between stop boards of the correct height and falls. Furnish the surface of the screed with a wood float to true and accurate falls and cross falls up to the stop boards.
- D. Leave a gap of 10 mm between each screed bay for the full depth of screed. Allow screed to cure thoroughly to attain maximum shrinkage. Make good any cracks resulting. Fill gaps between bays with cold bitumen finished perfectly with surrounding work.

8.2.3.3 MEMBRANE INSTALLATION

- A. Direction of laying: Unrolled up the slope.
- B. Where practicable install so that water drains over and not into laps.
- C. Side and end laps: To be dimensioned and sealed in accordance with the manufacturer's requirements.
- D. Head and side laps: Offset.
- E. Completed coverings: Firmly attached, fully sealed, smooth, weatherproof and free draining.
- F. Torch-on bonding of reinforced bitumen membranes:
 - 1. Bond: Full over whole surface, with no air pockets.
 - 2. Excess compound at laps of top layer/ capsheet: Leave as continuous bead.
- G. Welded jointing of reinforced bitumen membranes:
 - 1. Side and end joints: Lap to dimensions required by membrane manufacturer.
 - a. Preparation: Clean and dry surfaces for full width of joint.
 - b. Sealing: Hot air welded.
- H. Skirtings and upstands:
 - 1. Angle fillets: Fix by bitumen bonding if required.
 - 2. Venting first layer of bitumen membrane: Stop at angle fillet. Fully bond in bitumen for 300 mm strip around perimeters. Overlap onto upstand with strips of BS 747, type 3B bitumen membrane, fully bonded.
 - 3. Other layers of bitumen membrane: Carry in staggered formation up upstand, with each layer fully bonded. Where practicable, carry top layer over top of upstand.
 - 4. Upstands:
 - a. At ends of rolls: Form with bitumen membrane carried up without using separate strip.
 - b. Elsewhere: Form with matching strips of bitumen membrane, maintaining laps, or equivalent solution proposed in the supplier's approved system.

8.2.3.4 LAYING ROOF INSULATION

- A. Condition of substrate: Clean.
- B. Setting out: Loose lay with staggered joints. Minimize cutting and avoid small cut pieces at perimeters and penetrations.
 - 1. Joints: Butt together.
- C. Projections, upstands, rainwater outlets, etc.: Cut insulation cleanly and fit closely around.
- D. Completion:
 - 1. Boards must be in good condition, well-fitting and stable.
 - 2. Cover as soon as practicable to prevent wind uplift, flotation and ultra-violet degradation.

8.2.3.6 FIELD QUALITY CONTROL

- A. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.
- B. Flood to minimum depth of 50 mm with clean water. After 48 hours, inspect for leaks.
- C. If leaking is found, remove water, repair leaking areas with new waterproofing materials as directed by the Engineer and repeat flood test. Repair any damage to building.
- D. When area is proven watertight, drain water and remove dam.

8.2.3.7 PROTECTION OF ROOFING

- A. Upon completion of roofing (including associated work), institute appropriate procedures for surveillance and protection of roofing from chemicals, traffic and adjacent or high level working during the remainder of the construction period. At the end of the construction period, or at a time when remaining construction will in no way affect or endanger roofing, make a final inspection of the roofing and submit a written report to the Engineer, describing the nature and extent of any deterioration or damage found.
- B. Repair or replace (as required) deteriorated or defective work found at the time of final inspection to a condition free of damage and deterioration at the time of final handing over and in accordance with the requirements of specified warranty.

8.3 FLASHING AND SHEET METAL**8.3.1 GENERAL****8.3.1.1 SUMMARY**

- A. The extent of flashing and sheet metal is indicated on drawings and may include the following:
 - 1. Metal counter flashing and base flashing (if any).
 - 2. Metal wall flashing and expansion joints.
 - 3. Exposed metal trim/fascia units.
 - 4. Miscellaneous sheet metal accessories.
 - 5. Elastic roof/wall expansion joint systems.
- B. Roofing accessories installed integral with roofing are specified in "Membrane Roofing".

8.3.1.2 PROJECT CONDITIONS

- A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

8.3.2 PRODUCTS**8.3.2.2 SHEET METAL FLASHING AND TRIM MATERIALS**

- A. Sheet Aluminium standard: CYS EN 485, CYS EN 515 and CYS EN 573; flashings and cappings SWg as indicated on Drawings.

8.3.2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Materials and Accessories:

1. Bituminous Coating: Solvent-type bituminous mastic, nominally free of sulphur, compounded for 0.4 mm dry film thickness per coat.
2. Mastic Sealant: Polysobutylene: non-hardening, non-skinning, non-drying, non-migrating sealant.
3. Elastomeric Sealant: Generic type recommended by manufacturer of metal and fabricator of components being sealed.

- B. Sealant Joints: Where movable, non-expansion type joints are indicated or required for proper performance of work, form metal to provide for proper installation of elastomeric sealant, in compliance with standards.

- C. Separations: Provide for separation of metal from non-compatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating or other permanent separation as recommended by manufacturer/fabricator.

8.3.3 EXECUTION**8.3.3.1 INSTALLATION REQUIREMENTS**

- A. General: Except as otherwise indicated, comply with manufacturer's installation instructions and recommendations. Anchor units of work securely in place by methods indicated or required, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

8.3.3.2 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.
- B. Protection: Upon completion of flashing and sheet metal work institute appropriate procedure for surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering at time of final hand over.

9.1 METAL DOORS, WINDOWS AND FRAMES**9.1.1 GENERAL****9.1.1.1 SCOPE OF THE WORKS**

- A. Extent of metal doors, windows and frames is indicated on drawings and schedules.
- B. This section includes purpose made pressed steel doors, windows and frames.
- C. Door ironmongery installation is specified elsewhere.
- D. Painting is specified elsewhere.
- E. Sound Control Door Assemblies are specified elsewhere.

9.1.1.2 CROSS REFERENCES/ DRAWINGS

- A. This specification is to be read with all other relevant product documentation including:
1. The door schedule.
 2. The ironmongery schedule.
 3. The latest revisions of the detail drawings.
 4. The acoustic report.

9.1.1.3 DELIVERY, STORAGE, AND HANDLING

- A. Handling of products: All products shall be carefully handled at works, during transportation and storage and on site to prevent damage. Any damaged or defective products shall be removed from the site and replaced at no additional cost.
- B. Identification of products: Mark or tag to facilitate identification during assembly, handling, storage and installation. Do not mark surfaces visible in the completed installation.
- C. Protection of products: All products are to be suitably protected and crated to prevent damage during transportation and storage. The protection shall be such that they are not subjected to dampness.
- D. Storage of products: Do not deliver to site components that cannot be installed immediately or placed in clean, dry, floored and covered storage. Stacking shall be on level bearers, separated with spacers to prevent damage by and to projecting ironmongery, beads, etc. and in order to promote air circulation. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Products such as doors shall be stored in such a way that they are not liable to distortion caused by undue weight in stacking.

9.1.1.4 FABRICATION, GENERAL

- A. Site dimensions:
1. Procedure: Before starting work on designated items take site dimensions, record on shop drawings and use to ensure accurate fabrication.

9.1.1.4 FABRICATION, GENERAL

- B. Dimensions shall conform to the detail drawings.
- C. Metal Frames:
1. Provide metal frames for doors, transoms, side-lights, borrowed lights, windows and other openings, of size and profile as indicated on drawings.
 2. Prepare metal frames to receive mortised and concealed finish ironmongery, including cut-outs, reinforcing, drilling and tapping in accordance with final Door and Ironmongery Schedules and templates provided by ironmongery supplier. Provide cover bases at the back of all hardware cut outs.
 3. Reinforce metal frames to receive surface-applied ironmongery. Drilling and tapping for surface-applied door ironmongery may be done at project site.
 4. Locate ironmongery as shown on final approved shop drawings.
 5. Door frames are to extend below finished floor level for fixing to concrete slab.

9.1.2 EXECUTION**9.1.2.1 INSTALLATION**

- A. Install hollow metal units and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.
- B. In situ welding will not be permitted.
- C. Door/ Window Installation:

1. Timing: After associated rooms have been made weathertight and the work of wet trades is finished and dried out.
2. Installing Frames:
 - a. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
3. Door Installation:
 - a. Fit hollow metal steel doors accurately in their respective frames, within the following clearances:
 - Jambs and head: 3mm.
 - Meeting edges, pair of doors: 3mm.
 - Bottom, the undercut height to be as indicated on the shop drawings.
 - b. Refer to finish ironmongery as indicated on the shop drawings or ironmongery schedule for finish ironmongery installation.

9.1.2.2 ADJUST AND CLEAN

- A. Final adjustment: Check and readjust all operating finish ironmongery items in hollow metal work prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors, windows or frames which are warped, bowed or otherwise damaged or defective.
- B. Protective coverings: Remove only where necessary to facilitate installation and from surfaces that will be inaccessible on completion.
- C. General Quality of finished work:
 1. Any parts of the installation which are indented, distorted, out of alignment, visible welds not ground flush, or defective in any way shall be rejected and replaced at no additional cost or made good to the satisfaction of the Engineer.
 2. Any damage to the corrosion inhibiting coatings shall be made good immediately on completion of the frame fixing. Immediately after erection, sand smooth any rusted or damaged areas of the prime coat of paint and apply touch-up of a compatible air drying primer paint.

9.1.2.3 IRONMONGERY INSTALLATION

- A. Preparation: Prepare hollow steel units to receive mortised and concealed ironmongery, including cut outs, reinforcing, drilling and topping in accordance with final ironmongery schedule and templates provided by the ironmongery supplier.
- B. Assembly and fixing: Accurately, as shown on final shop drawings, using fasteners with matching finish supplied by ironmongery manufacturer.
- C. Adjacent surfaces: Undamaged.
- D. Completion: Check, adjust and lubricate as necessary to ensure correct functioning.
- E. Location of hinges:
 1. Primary hinges: Where not specified otherwise, positioned with centre lines 250mm from top and bottom of door leaf.
 2. Third hinge: Where specified, positioned 2/3 of door height above FFL.
 3. Hinges for fire resisting doors: Positioned in accordance with door leaf manufacturer's recommendations.
- F. Installation of Emergency Exit Devices:
 1. Standard: Unless specified otherwise, install panic bolts/latches in accordance with CYS EN 1125.

2. Compatibility: Glass/plastics, surround materials, sealers, primers and paints/clear finishes to be used together to be compatible. Avoid contact between glazing panes/units and alkaline materials such as cement and lime.
3. Protection: Keep materials dry until fixed.
4. Edges: Generally undamaged. Shells and chips not more than 2mm deep and extending not more than 5mm across the surface are acceptable if ground out.

9.2 WOODEN DOORS, WINDOWS AND FRAMES

9.2.1 GENERAL

9.2.1.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect wooden doors and windows during transit, storage and handling to prevent damage, soiling and deterioration. Comply with manufacturer's recommendations and instructions, unless otherwise indicated.
- B. Package doors and windows at factory prior to shipping, using Polyvinyl or plastic wrap.
- C. Stack doors and windows horizontally on no less than three level bearers at no more than one metre centres.

9.2.2 EXECUTION

9.2.2.1 INSPECTION

- A. Examine door and window frames and verify that frames are correct size and type and have been installed as required for proper hanging of corresponding doors. Do not proceed with installation until unsatisfactory conditions have been corrected.

9.2.2.2 INSTALLATION

- A. Condition doors and windows to average prevailing humidity in installation area prior to hanging.
- B. Fit doors and windows into previously installed door and window frames and install door ironmongery:
 1. Clearance: For non-rated doors provide clearance of 3 mm at jambs and heads; 3 mm at meeting stiles for pairs of doors; and 6 mm from bottom of door to top of decorative floor finish or covering. Where threshold is indicated or scheduled, provide 5 mm clearance from bottom of door to top of threshold.
 2. For fire-rated doors, provide clearances complying with BS 476.
- C. Shop-Finished Doors: Restore finish on edges of shop finished doors before installation, if fitting or machining is required at the job site.

9.2.2.3 ADJUST AND CLEAN

- A. Final Check:
 1. Replace doors and windows damaged during installation or which are warped, bowed or otherwise unacceptable.
 2. Rehang or replace doors which do not swing freely or operate smoothly and satisfactorily.
- B. Protection: Provide protection and maintain conditions in a manner acceptable to the Engineer, which will ensure doors, windows and ironmongery are undamaged at time of Taking Over.

9.3 ALUMINIUM DOORS AND WINDOWS AND CURTAIN WALLS

9.3.1 GENERAL

9.3.1.1 SCOPE OF THE WORKS

- A. Extent of aluminium doors and windows is indicated on drawings and schedules.

- B. Types required for the project include or as specified on drawings:
1. Exterior aluminium doors and screens.
 2. Interior aluminium doors and screens.
 3. Exterior and interior aluminium windows and curtain walling.
 4. Aluminium Louvres.
- C. Glass and glazing is specified elsewhere.
- D. Sundry metalwork, anodising, sealants and adhesives are specified elsewhere.
- E. Lock cylinders are specified in the Door Ironmongery section of the Specification.

9.3.1.2 **SYSTEM DESCRIPTION**

- A. Performance Requirements: Provide aluminium assemblies that have been designed and fabricated to comply with the following specified performance characteristics. Compliance may be demonstrated by testing manufacturer's corresponding stock systems according to methods indicated.
- B. Weather Performances:
1. Deflection under Dead Loads: Framing members parallel to the aluminium assembly plane must not:
 - a. Reduce glass bite to less than 75% of design dimension.
 - b. Reduce edge clearance to less than 3mm between members and immediately adjacent glazing units, panel/ facing units or other fixed units.
 - c. Reduce clearance to less than 2mm between members and movable components such as doors and windows.
 2. Air Permeability:
 - a. Requirement: All fixed areas shall be of class 2 as defined by CYS EN 12152. Permissible air leakage rates of $1.5\text{m}^3/\text{hr}/\text{m}^2$ for fixed lights and $2.0\text{m}^3/\text{hr}/\text{lin.m}$ for opening lights must not be exceeded when the aluminium assembly is subjected to a peak positive test pressure of 300Pa. Maximum air leakage based on linear meter of fixed joint: $0.5\text{m}^3/\text{m.h}$ at 300Pa.
 3. Water Permeability:
 - a. Requirement: All glazed facades and skylights shall be of class R7 as defined by CYS EN 12154. Moisture must not penetrate to internal surfaces or into cavities not designed to be wetted when the aluminum assembly is tested to the requirements of CYS EN 12155.
 4. General Movement:
 - a. Requirement: The aluminum assembly must accommodate anticipated building movements as follows:
 - Structural movement: To be advised by the structural engineer.
 - Thermal movement: The aluminum assembly shall be designed to allow for expansion and contraction of the component parts at an ambient temperature of 38 °C without causing buckling, opening of joints, overstressing of fasteners, or other harmful effects.
 - b. Seismic Criteria: Refer to Section 1.9 G of this Specification.
- C. Thermal and Solar Performances:
1. Thermal Properties:
 - a. Requirement: Thermal transmittance (U value) for glazed panels in façades types to be $1.7\text{kW}/\text{m}^2/^\circ\text{C}$, thermal transmittance (U value) for composite insulated panels to be $0.5\text{kW}/\text{m}^2/^\circ\text{C}$, and thermal transmittance (U value) for sky lights to be $1.7\text{kW}/\text{m}^2/^\circ\text{C}$ unless otherwise stated on the drawings.
 - b. Framing sections to be thermally broken
 2. Solar and Light Control: Glass panes/ units in aluminum assemblies must have:
 - a. Total solar energy transmission of normal incident solar radiation (max): 0.40.

- b. Total light transmission (min): 50%.
- c. Daylight reflectance: 15%.

9.3.1.2 **SYSTEM DESCRIPTION**

- 3. Thermal Stress in Glazing:
 - a. Glazed units to have adequate resistance to thermal stress generated by orientation, shading, solar control and construction.
- 4. Avoidance of Condensation: Notional psychrometric conditions under which condensation must not form on building interior surfaces of framing members or any part of infill panels/ facings are:
 - a. External summer: 37 °C DB, 24.4 °C WB.
 - b. External winter: 3 °C, 90% humidity.
 - c. Internal summer: 25 °C, 55%RH.
 - d. Internal winter: 20 °C, RH = NC

D. Safety Performance:

- 1. Finished surfaces of aluminium assemblies: Accessible internal and external areas must not:
 - a. Have irregularities capable of inflicting personal injury.
 - b. Release irritant or staining substances.

E. Applicable Codes and Standards:

- 1. Cyprus Standards:
 - CYS EN 485 Aluminium and aluminium alloys. Sheet, strip and plate.
 - CYS EN 515 Aluminium and aluminium alloys. Wrought products. Temper designations.
 - CYS EN 573 Aluminium and aluminium alloys. Chemical composition and form of wrought products.
 - CYS EN 755 Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles.
 - CYS EN 1063 Glass in building. Security glazing.
 - CYS EN 1991-1-1 Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight and imposed loads for buildings.
 - CYS EN 1998-1 Eurocode 8: Design of structures for earthquake resistance.
 - CYS EN 12020 Aluminium and aluminium alloys. Extruded precision profiles in alloys EN AW-6060 and EN AW-6063.
 - CYS EN 12152 Curtain walling – Air permeability – Performance requirements and classification.
 - CYS EN 12153 Curtain walling – Air permeability – Test method.
 - CYS EN 12154 Curtain walling – Watertightness – Performance requirements and classification.
 - CYS EN 12155 Curtain walling – Watertightness – Laboratory test under static pressure.
 - CYS EN 12179 Curtain walling – Resistance to wind load – Test method.
 - CYS EN 12400 Windows and pedestrian doors - Mechanical durability - Requirements and classification.
 - CYS EN 12600 Glass in building – Pendulum test – Impact test method and classification for flat glass.
 - CYS EN 13051 Curtain walling – Watertightness – Site test.
 - CYS EN 13116 Curtain walling – Resistance to wind load – Performance requirements.
 - CYS EN 13119 Curtain walling – Terminology.
 - CYS EN 13501-1 Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests.
 - CYS EN 13501-2 Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services.
 - CYS EN 13830 Curtain walling – Product standard
 - CYS EN 13947 Thermal performances of curtain walling – Calculation of thermal transmittance – Simplified method.
 - CYS EN 14019 Curtain walling – Impact resistance – Performance requirements
 - CYS EN ISO 140-3 Acoustics – Measurement of sound insulation in buildings and of building elements – Part 3: Laboratory measurements of airborne sound insulation of building elements (ISO 140-3:1995).
 - CYS EN ISO 717-1 Acoustics – Rating of sound insulation in buildings and of building elements – Part 1:

CYS EN ISO 1461	Airborne sound insulation (ISO 717-1:1996). Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.
2.	British Standards:
BS 952	Glass for glazing.
BS 952-1	Glass for glazing. Classification.
BS 4255-1	Specification for non-cellular gaskets.
BS 4315-2	Methods of test for resistance to air and water penetration. Permeable walling constructions (water penetration).
BS 4842	Specification for liquid organic coatings for application to aluminium alloy extrusions, sheet and preformed sections for external Engineerural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with liquid organic coatings.
BS 4873	Aluminium alloy windows.
BS 5368	Methods of testing windows.
BS 5368-1	Air permeability test.
BS 5713	Specification for hermetically sealed flat double glazing units.
BS 6213	Selection of construction sealants. Guide.
BS 6375	Performance of windows.
BS 6496	Specification for powder organic coatings for application and stoving to Aluminium alloy extrusions, sheets and preformed sections for external Engineerural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings.
BS 8118	Structural use of aluminium.
BS 8118-2	Specification for materials, workmanship and protection.
BS 8213	Windows, doors and roof lights.
BS 8220	Guide for security of buildings against crime.

9.3.1.3 **PROJECT CONDITIONS**

- A. On-site Measurements: Check openings by on-site measurement before fabrication to ensure proper fitting of work. Coordinate fabrication schedule with construction progress to avoid delay in the work.

9.4 **PRODUCTS**

9.4.1 **FABRICATION**

- A. General: Sizes of door, frame and window units, and profile requirements are indicated on drawings. Variable dimensions are indicated, with maximum and minimum dimensions required to achieve design requirements and coordination with other work.
- B. Prefabrication: Before transportation to the project site, complete fabrication, assembly, finishing, ironmongery application, and other work to the greatest extent possible. Disassemble components only as necessary for shipment and installation.
1. Preglaze door, and window units to greatest extent possible.
 2. Do not drill and tap for surface-mounted ironmongery items until time of installation at project site.
 3. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces. For ironmongery, perform these operations prior to application of finishes.
- C. Identification of Products: Mark or tag to facilitate identification during assembly, handling, storage and installation. Do not mark surfaces visible in the completed installation.

9.4.2 **EXECUTION**

9.4.2.1 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations for installation.
- B. Fixing anchor installation:
 - 1. Site drilling or cutting into structure: Submit proposals for positions other than shown on detailed drawings.
 - 2. Concrete supporting structure: edge fixing distances not less than recommended by fixing manufacturers.

9.4.2.2 CLEANING

- A. General: At the completion of the installation, the work shall be cleaned to remove mastic smears and other foreign materials.
- B. Aluminium Surfaces: Before final acceptance, exposed-to-view aluminium surfaces shall be washed with clean water and soap and rinsed with clean water inside and out, exercising care to avoid damage to the coatings.
- C. Clean glass surfaces after installation. Remove excess glazing and sealant compounds, dirt and other substances from aluminium surfaces.

9.4.2.3 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that aluminium doors, screens and windows will be without damage or deterioration, other than normal weathering, at time of Substantial Completion.

9.5 GLASS AND GLAZING**9.5.1 GENERAL****9.5.1.1 SCOPE OF THE WORKS**

- A. Extent of glass and glazing work is indicated on drawings and schedules.
- B. Work in this section includes glass and glazing for:
 - 1. Aluminium doors and screens
 - 2. Aluminium windows and curtain walling
 - 3. Wooden doors and windows

- C. Mirror glass units are specified elsewhere.

9.5.1.2 APPLICABLE CODES AND STANDARDS

- A. To BS 952: Glass for glazing, BS 6262: Glazing for buildings and relevant parts of:

CYS EN 356	Glass in building. Security glazing. Testing and classification of resistance against manual attack.
CYS EN 357	Glass in building. Fire resistant glazed elements with transparent or translucent glass products. Classification of fire resistance.
CYS EN 410	Glass in building. Determination of luminous and solar characteristics of glazing.
CYS EN 572	Glass in building. Basic soda lime silicate glass products.
CYS EN 673	Glass in building. Determination of thermal transmittance (U value). Calculation method.
CYS EN 674	Glass in building. Determination of thermal transmittance (U value). Guarded hot plate method.
CYS EN 675	Glass in building. Determination of thermal transmittance (U value). Heat flow meter

	method.
CYS EN 1063	Glass in building. Security glazing. Testing and classification of resistance against bullet attack.
CYS EN 1096	Glass in building. Coated glass.
CYS EN 1279	Glass in building. Insulating glass units.
CYS EN 1288	Glass in building. Determination of the bending strength of glass.
CYS EN 1748-1	Glass in building. Special basic products. Borosilicate glasses.
CYS EN 1748-2	Glass in building. Special basic products. Glass ceramics.
CYS EN 1863	Glass in buildings. Heat strengthened soda lime silicate glass.
CYS EN 12150	Glass in building. Thermally toughened soda lime silicate safety glass
CYS EN 12337	Glass in building. Chemically strengthened soda lime silicate glass.
CYS EN 12600	Glass in building. Pendulum test. Impact test method and classification for flat glass.
CYS EN 12758	Glass in building. Glazing and airborne sound insulation. Product descriptions and determination of properties.
CYS EN 12898	Glass in building. Determination of the emissivity.
CYS EN 13022	Glass in building. Structural sealant glazing.
CYS EN 13024	Glass in building. Thermally toughened borosilicate safety glass.
CYS EN 13541	Glass in building. Security glazing. Testing and classification of resistance against explosion pressure.
CYS EN 14178	Glass in building. Basic alkaline earth silicate glass products.
CYS EN 14179	Glass in building. Heat-soaked thermally-toughened soda lime silicate safety glass.
CYS EN 14321	Glass in building. Thermally toughened alkaline earth silicate safety glass.
CYS EN 14449	Glass in building. Laminated glass and laminated safety glass. Evaluation of conformity/product standard.
CYS EN 15434	Glass in building. Product standard for structural and/or ultraviolet resistant sealant (for use with structural sealant glazing and/or insulating glass units with exposed seals).
CYS EN ISO 12543	Glass in building. Laminated glass and laminated safety glass.
CYS EN ISO 14438	Glass in building. Determination of energy balance value. Calculation method.

9.5.1.3 **DELIVERY, STORAGE, AND HANDLING**

- A. Protect glass and glazing materials during delivery, storage and handling to comply with manufacturer's directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes.

9.5.2 **PRODUCTS**

9.5.2.1 **GLASS PRODUCTS, GENERAL**

- A. Primary Glass Standard: Provide primary glass which complies with specific referenced standard requirements, including those indicated by reference to type, class, quality, and, if applicable, form, finish, mesh and pattern.
- B. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses indicated or, if not otherwise indicated, as recommended by glass manufacturer for application indicated.

9.5.2.2 **PRIMARY GLASS PRODUCTS**

- A. Clear Float Glass: Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), to BS 952: Section I: Part 3.
- B. Tinted Float Glass: Type I (transparent glass, flat), Class 2 (tinted heat absorbing and light reducing), Quality q3 (glazing select).
- C. Wired Glass: Type II (patterned and wired glass, flat), Class 1 (translucent), Quality q8 (glazing): complying with resistance requirements: 6 mm thick: of form and mesh pattern indicated below:
1. Polished Wire Glass: Form 1 (wired, polished both sides), Mesh m2 (square).

9.5.3 EXECUTION**9.5.3.1 PREPARATION**

- A. Clean glazing channels and other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

9.5.3.2 GLAZING, GENERAL

- A. Comply with combined printed recommendations of glass manufacturers, of manufacturers of sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those of referenced glazing standards.
- B. Protect glass from edge damage during handling and installation; use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass with flares or bevels along one horizontal edge which would occur in vicinity of setting blocks so that these are located at top of opening; Remove from project and dispose of glass units with edge damage or other imperfections of kind that, when installed, weakens glass and impairs performance and appearance.
- C. Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.
- D. Provide compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep systems and from adhering to joints back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.

9.5.3.3 PROTECTION AND CLEANING

- A. Protect exterior glass from breakage immediately upon installation by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove non- permanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove immediately by method recommended by glass manufacturer.
- C. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

10.0 FINISHES**10.1 PLASTERING/ RENDERING****10.1.1 GENERAL****10.1.1.1 SCOPE OF THE WORKS**

- A. Extent of plastering/ rendering is indicated on drawings and schedules.
 B. Types of work include:

1. Metal lathing
2. Portland cement rendering
3. Gypsum plastering to blockwork/brickwork walling
4. Gypsum plaster skim coat to plasterboard.

10.1.1.2 APPLICABLE CODES AND STANDARDS

- A. Cyprus Standards:
- | | |
|-----------------|--|
| CYS EN 197-1 | Cement. Composition, specifications and conformity criteria for common cements. |
| CYS EN 459 | Building lime. |
| CYS EN 520 | Gypsum plasterboards. Definitions, requirements and test methods. |
| CYS EN 998-1 | Specification for mortar for masonry. Rendering and plastering mortar. |
| CYS EN 13139 | Aggregates for mortar. |
| CYS EN 13279 | Gypsum binders and gypsum plasters. |
| CYS EN 13658-1 | Metal lath and beads. Definitions, requirements and test methods. Internal plastering. |
| CYS EN 13658-2 | Metal lath and beads. Definitions, requirements and test methods. External rendering. |
| CYS EN 13914-1 | Design, preparation and application of external rendering and internal plastering. External rendering. |
| CYS EN 13914-2 | Design, preparation and application of external rendering and internal plastering. Design considerations and essential principles for internal plastering. |
| PD CEN/TR 15123 | Design, preparation and application of internal polymer plastering systems. |
- B. British Standards:
- | | |
|-----------|--|
| BS 4027 | Specification for sulfate-resisting Portland cement. |
| BS 6100-9 | Building and civil engineering. Vocabulary. Work with concrete and plaster. |
| BS 8481 | Design, preparation and application of internal gypsum, cement, cement and lime plastering systems. Specification. |

10.1.1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for cementitious materials, gypsum materials, lath, metal support components, and accessories.
- B. Material Certificates: Submit producer's certificate for each kind of plaster aggregate indicated evidencing that the materials comply with requirements.

10.1.1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer.
- B. Store materials inside under cover and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

10.1.1.5 SITE CONDITIONS

- A. Environmental Requirements, General: Comply with requirements of referenced plaster application standards and recommendation of plaster manufacturer for environmental conditions before, during, and after application of plaster.

- B. Ventilation: Ventilate building spaces as required to remove water in excess of that required for hydration of plaster. Begin ventilation immediately after plaster is applied and continue until it is set.
- C. Protect contiguous work from soiling, spattering, moisture deterioration and other harmful effects which might result from plastering.
- D. Provide good temporary lighting in internal areas using lamps with suitable reflectors mounted on telescopic tripods for float finishing stages.

10.1.2 PRODUCTS

10.1.2.1 LATH

- A. Expanded Metal Lath: Fabricate expanded metal lath from galvanised steel sheet to produce lath complying with CYS EN 13658 for type, configuration and other characteristics indicated below, with uncoated steel sheet painted after fabrication into lath.

- 1. Diamond Mesh Lath: Comply with the following requirements:
Configuration: Flat
Weight: 1.60 Kg/m²

10.1.2.2 ACCESSORIES FOR CEMENT RENDER

- A. General: Comply with material provisions of CYS EN 13658 and CYS EN 13914-1; coordinate depth of accessories with thicknesses and number of coats required.
- B. Metal Corner Reinforcement: Expanded large mesh diamond mesh lath fabricated from tight coat galvanised sheet steel to comply with CYS EN 13914-1, with weight 2.25 Kg/m² and formed to reinforce external corners of Portland cement render on exterior exposures while allowing full render encasement.
- C. Metal Corner Beads: Small nose corner beads fabricated from tight coat galvanised sheet steel, synthetic coated fitted with PVC strip.
- D. Casing Beads: Square-edged style, with expanded flanges and removable protective tape, of the following material:

Material: Zinc-coated (galvanized) steel with PVC strip.

Two-piece type: Pair of casing beads with back flanges formed to provide slip joint action, adjustable for joint widths from 3 mm to 15 mm, with PVC edging.

10.1.2.3 CEMENT RENDER MATERIALS

- A. Ready-to-use Cement Gauged Mortars:
 - 1. Time and temperature limitations: Use within limits prescribed by mortar manufacturer.
 - 2. Re-tempering: Restore workability with water only within prescribed time limits.
- B. Cements for mortars:
 - 1. Cement: To CYS EN 197-1 and CE marked. Types:
 - a. Portland cement, CEM I.
 - b. Portland slag cement, CEM II/S.
 - c. Portland fly ash cement, CEM II/V or W.
 - 2. White cement: To CYS EN 197-1 and CE marked.
 - a. Type: Portland cement, CEM I.
 - b. Strength Class: 52.5.
 - 3. Sulphate resisting Portland cement: To BS 4027 and Kitemarked.
 - a. Strength class: 42.5.
 - 4. Masonry cement: To CYS EN 998-1 and Kitemarked.
 - a. Class: MC 12.5 (with air entraining agent).

- C. Sand for Cement Gauged Mortars: to CYS EN 13139.
 - 1. Standard: To CYS EN 13139.
 - a. Grading: 0/2 or 0/4 (CP or MP); category 2 fines.
 - 2. Colour and texture: Consistent. Obtain from one source.
- D. Lime: Special hydrated lime for finishing purposes to CYS EN 459-1.
- E. Chloride content of mortars:
 - 1. Content (maximum): 0.1% by dry mass.

10.1.2.4 GYPSUM PLASTER MATERIALS

- A. Lightweight Gypsum Plaster to Blockwork/ Brickwork walls:
 - 1. Undercoats: To CYS EN 13279.
 - a. Thickness (excluding dubbing out and keys): 10mm.
 - 2. Final coat: Finish plaster to CYS EN 13279.
 - a. Thickness: 3mm.
 - b. Finish: Smooth.
 - 3. Accessories: Beads and stops as clause 11.1.2.5.
- B. Gypsum Plaster Skim Coat on Plasterboard:
 - 1. Plasterboard: Gypsum wall board.
 - 2. Plaster: Board finish/ finish plaster to CYS EN 13279.
 - a. Thickness: 3mm.
 - b. Finish: Smooth.
 - 3. Accessories: None.

10.1.2.5 BACKINGS/ BEADS/ JOINTS

- A. Additional Framing Supports for Backings:
 - 1. Framing: Accurately position and securely fix to give full support to fixtures, fittings and service outlets.
 - 2. Support to board edges and perimeters: As recommended by board manufacturer to suit type and performance of board.
- B. Gypsum Plasterboard Backings:
 - 1. Type: To CYS EN 520.
 - a. Core density (minimum): 650 kg/m³.
 - 2. Exposed surface and edge profiles: Suitable to receive specified plaster finish.
- C. Joints in Plasterboard Backings:
 - 1. Ceilings:
 - a. Bound edges: At right angles to supports and with ends staggered in adjacent rows.
 - b. Two layer boarding: Stagger joints between layers.
 - 2. Partitions/ walls:
 - a. Vertical joints: Centre on studs. Stagger joints on opposite sides of studs. Two layer boarding: Stagger joints between layers.
 - b. Horizontal joints: Two layer boarding: Stagger joints between layers by at least 600 mm. Support edges of outer layer.
 - 3. Joint widths (maximum): 3 mm.
- D. Beads/ Stops for Internal Use:
 - 1. Material: Galvanised steel to BS 6452-1.
- E. Beads/ Stops Generally:
 - 1. Location: External angles and stop ends, except where specified otherwise.
 - 2. Corners: Neat mitres at return angles.

3. Fixing: Secure, using longest possible lengths, plumb, square and true to line and level, ensuring full contact of wings with substrate.
 - a. Beads/ stops for external render: Fix mechanically.
4. Finishing: After coatings have been applied remove surplus material, while still wet, from surfaces of beads/ stops exposed to view.

F. Crack Control at Junctions between Dissimilar Solid Substrates:

1. Locations: Where defined movement joints are not required. Where dissimilar solid substrate materials are in same plane and rigidly bonded or tied together. For example in corridor areas where block-work abuts reinforced concrete columns.
2. Crack control materials:
 - a. Isolating layer: Building paper to BS 1521.
 - b. Metal lathing: Galvanized steel to CYS EN 13658-1.
3. Installation: Fix metal lathing over isolating layer. Stagger fixings along both edges of lathing.
4. Width of installation over single junctions:
 - a. Isolating layer: 150 mm.
 - b. Lathing: 300 mm.
5. Width of installation across face of dissimilar substrate material (column, beam, etc. With face width not greater than 450 mm):
 - a. Isolating layer: 25 mm (minimum) beyond junctions with adjacent substrate.
 - b. Lathing: 100 mm (minimum) beyond edges of isolating layer.

G. Movement Joints Generally:

1. Installation: Centred over joint in substrate.
2. Fixing: In accordance with manufacturer's recommendations.

H. Plasterboard Joints:

1. Joints and angles (except where coincident with metal beads): Reinforce with continuous lengths of jointing tape.

I. Plastering over conduits/ service chases:

1. General: Prevent cracking over conduits and other services.
2. Services chased into substrate: Isolate from coating by covering with galvanized metal lathing, fixed at staggered centres along both edges.

10.1.2.6 MISCELLANEOUS MATERIALS

- A. Water for Mixing and Finishing Plaster: Drinkable, free of substances capable of affecting plaster set or of damaging plaster, lath or accessories.
- B. Bonding Agent for cement render.
 1. General: Apply evenly to substrate to achieve effective bond of plaster/ render coat. Protect adjacent surfaces.
- C. Plasticiser: Manufacturer's standard product, subject to compliance with requirements and approval of the Engineer may be used in accordance with manufacturer's recommendations and instructions.

10.1.2.7 CEMENT RENDER MIXES AND COMPOSITIONS

- A. General: Comply with CYS EN 13914-1 for Portland cement render base and finish coat mixes as applicable to render bases, materials and other requirements indicated.
- B. Portland Cement Render Base Mixes and Compositions: Proportion materials for respective base coats in parts by volume for cementitious materials and in parts by volume per sum of cementitious materials for aggregates to comply with the following requirements for each method of application and render base indicated. Adjust mix proportions below within limits specified to attain workability.

1. Three-Coat Work over Metal Lath: Base coats as indicated below:
Scratch Coat: 1 part Portland cement, $\frac{1}{2}$ part lime, 4 parts sand.
Brown Coat: 1 part Portland cement, $\frac{1}{2}$ part lime, 4 parts sand.
 2. Two-Coat Work over Concrete Unit Masonry: Base coats as indicated below.
Base coats: 1 part Portland cement, $\frac{1}{2}$ part lime, 4 parts sand.
- C. At Contractor's option, provide one of the following:
1. Job-Mixed Portland Cement Plaster Finish Coats: Proportion materials for finish coats in parts by volume for cementitious materials and parts by volume per sum of cementitious materials for aggregates to comply with the following requirements:
 - a. 1 part Portland cement, $\frac{3}{4}$ - $1\frac{1}{2}$ parts lime, 3 parts sand.
 2. Factory-Prepared Portland Cement Finish Coats: Add water only; comply with finish coat manufacturer's directions.
- D. Mixing: Mechanically mix cementitious and aggregate materials for renders to comply with applicable referenced application standard and with recommendations of render manufacturer.
1. Render mortars (site-made):
 - a. Batching: By volume. Use clean and accurate gauge boxes or buckets.
 - b. Mix proportions: Based on damp sand. Adjust for dry sand.
 - c. Lime: sand: Mix thoroughly. Allow to stand, without drying out, for at least 16 hours before using.
 2. Mixes: Of uniform consistence and free from lumps. Do not re-temper or reconstitute mixes.
 3. Contamination: Prevent intermixing with other materials.
- E. Cold Weather:
1. General: Do not use frozen materials or apply coatings on frozen or frost bound substrates.
 2. External work: Avoid when air temperature is at or below 5°C and falling or below 3°C and rising. Maintain temperature of work above freezing until coatings have fully hardened.
 3. Internal work: Take precautions to enable internal coating work to proceed without detriment when air temperature is below 3°C.

10.1.3 **EXECUTION**

10.1.3.1 **METAL LATHING**

- A. Install expanded metal lath for the following applications where render base coats are required. Provide appropriate type, configuration and weight of metal lath selected from materials indicated which comply with referenced lathing installation standards.
1. At junctions and joints between differing materials and forms of construction, and at all chases and other places where making good occurs.
 - a. Install minimum 150 mm wide strip of lath, fixed to substrate on both edges at minimum 600 mm centres.

10.1.3.2 **INSTALLATION OF RENDERING ACCESSORIES**

- A. General: Comply with referenced lathing and furring installation standards for provision and location of render accessories of type indicated. Mitre or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during rendering.
- B. Accessories for Portland cement render:
1. Corner Bead: Install at external corners.
 2. Casing Beads: Install at termination of render work unless otherwise indicated.
 3. Control joints: Install control joints at location indicated, or if not indicated, at locations complying with the following criteria and approved by the Engineer.
 - (a) Where an expansion or control joint occurs in surface of construction directly behind render membrane.
 - (b) Where distance between control joints in render surfaces exceed 5.5 m in either direction.
 - (c) Where area within Portland cement panels exceed 10 m².

- (d) Where Portland cement render panels sizes or dimensions change, extend joints full width or height of render membrane.

10.1.3.3 RENDER APPLICATION, GENERAL

- A. Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced render application standards for conditioning of monolithic surfaces.
- B. Tolerances: Do not deviate more than 3 mm in 1.8 m from true plane in finished render surfaces, as measured by a 1.8 m straightedge placed at any location on surface.
- C. Grout hollow metal frames, bases and similar work occurring in plastered areas, with base coat render material and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout 150 mm lengths at each anchorage.
- D. Sequence Plaster application with the installation and protection of other work, so that neither will be damaged by the installation of the other.
- E. Suitability of substrates:
 - 1. Soundness: Free from loose areas and significant cracks and gaps.
 - 2. Cutting, chasing, making good, fixing of conduits and services outlets and the like: Completed.
 - 3. Tolerances: Permitting specified flatness/ regularity of finished coatings.
 - 4. Cleanliness: Free from dirt, dust, efflorescence and mould, and other contaminants incompatible with coatings.
- F. Raking out for key:
 - 1. Joints in existing masonry: Rake out to a depth of 13 mm (minimum).
 - a. Dust and debris: Remove from joints.
- G. Roughening for key:
 - 1. Substrates: Roughen thoroughly and evenly.
 - a. Depth of surface removal: Minimum necessary to provide an effective key.
- H. Spatterdash key:
 - 1. Materials:
 - a. Cement: To CYS EN 197-1 and CE marked.
 - b. Sand: Clean, coarse.
 - c. Admixture: As recommended by plaster manufacturer.
 - 2. Mix proportions (cement: sand): 1:1.5-2.
 - 3. Consistency: Thick slurry, well stirred.
 - 4. Application: Throw onto dampened background and leave rough.
 - a. Thickness: 3-5 mm.
 - 5. Curing: Controlled to achieve a firm bond to substrate.
- I. Apply thicknesses and number of coats of render as indicated; or as required by reference standards.
- J. Concealed Render: Where render application will be concealed above suspended ceilings and similar locations, finish-coat may be omitted; where used as a base for adhesive application of tile and similar finishes, omit finish-coat and coordinate thickness with overall dimension as shown, and comply with tolerances specified.

10.1.3.4 PORTLAND CEMENT RENDER APPLICATION

- A. Portland Cement Render Application Standard: Apply Portland cement render materials, compositions, and mixes to comply with CYS EN 13914-1.
- B. Number of Coats: Apply Portland cement render, of composition indicated, to comply with the following requirements:
 - 1. Use three-coat work over metal lath.

2. Use two-coat work over the following render bases:
 - (a) Concrete unit masonry.
 - (b) Concrete cast-in-place or precast when surface complies with CYS EN 13914-1 for plaster bonded direct to solid base.
 3. Finish Coat: Floated finish unless otherwise indicated; match approved sample.
- C. Thickness:
1. Thickness of external render shall be 25 mm, 3 coat application over metal lath, having smooth wood float finish.
 2. Thickness of internal render shall be 15 mm, 2 coat application, having smooth steel float finish.
- D. Moist cure Portland cement render base and finish coats to comply with CYS EN 13914-1, including recommendations for time between coats and curing.

10.1.3.5 **GYPSUM PLASTER APPLICATION**

- A. Application Generally:
1. Application of coatings: Firmly and in one continuous operation between angles and joints.
 2. Achieve good adhesion.
 3. Appearance of finished surfaces: Even and consistent. Free from rippling, hollows, ridges, cracks and crazing.
 - a. Accuracy: Finish to a true plane, to correct line and level, with angles and corners to a right angle unless specified otherwise, and with walls and reveals plumb and square.
 4. Drying out: Prevent excessively rapid or localised drying out.
- B. Flatness/ Surface Regularity:
1. Sudden irregularities: Not permitted.
 2. Deviation of plaster surface: Measure from underside of a straight edge placed anywhere on surface.
 - a. Permissible deviation (maximum) for plaster not less than 13 mm thick: 3 mm in any consecutive length of 1800 mm.
- C. Dubbing Out:
1. General: Correct substrate inaccuracies.
 2. New smooth, dense concrete and similar surfaces: Dubbing out prohibited unless total plaster thickness is within range recommended by plaster manufacturer.
 3. Thickness of any one coat (maximum): 10 mm.
 4. Mix: As undercoat.
 5. Application: Achieve firm bond. Allow each coat to set sufficiently before the next is applied. Cross scratch surface of each coat.
- D. Undercoats Generally:
1. General: Rule to an even surface. Cross scratch to provide a key for the next coat.
 2. Undercoats on metal lathing: Work well into interstices to obtain maximum key.
 3. Undercoats gauged with Portland cement: Do not apply next coat until drying shrinkage is substantially complete.
- E. Thin Coat Plaster:
1. Preparation for plasters less than 2 mm thick: Fill holes, scratches and voids with finishing plaster.
- F. Smooth Finish:
1. Appearance: A tight, matt, smooth surface with no hollows, abrupt changes of level or trowel marks. Avoid water brush, excessive trowelling and over polishing.
- G. Wood Float Finish:
1. Appearance: An even overall texture. Finish with a dry wood float as soon as wet sheen has disappeared.

10.1.3.6 CUTTING AND PATCHING

- A. Cut, patch, point-up and repair render as necessary to accommodate other work and to restore cracks, dents and imperfections. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, dry-outs, efflorescence sweat-outs and similar defects, and where bond to the substrate has failed.
- B. Sand smooth trowelled finishes lightly to remove trowel marks and arrises.

10.1.3.7 CLEANING AND PROTECTION

- A. Remove temporary protection and enclosure of other work. Promptly remove render from door frames, windows, and other surfaces which are not to be rendered. Repair floors, walls and other surfaces which have been stained, marred or otherwise damaged during the rendering work, remove unused materials, containers and equipment and clean floors of render debris.
- B. Provide final protection and maintain conditions, in a manner acceptable to the Engineer, which ensures plaster work being without damage or deterioration at time of taking-over.

10.2 CERAMIC WALL AND FLOOR TILING**10.2.1 GENERAL****10.2.1.1 SCOPE OF THE WORKS**

- A. Definition: Tile includes ceramic surfacing units made from clay or other ceramic materials.
- B. Extent of tile works is indicated on drawings and schedules.
- C. Types of tile work in this section include the following:
 - 1. Ceramic floor tiles and skirtings.
 - 2. Glazed ceramic wall tiles.
- D. Portland cement render scratch coat is specified in the Plastering/ Rendering section of the specification.
- E. Sealing expansion and other joints in tile work with elastomeric joint sealers are specified in the Joint Sealers section of this specification.

10.2.1.2 QUALITY ASSURANCE

- A. Source of Materials: Provide materials obtained from one source acceptable to the Engineer for each type and colour of tile, grout and setting materials.
- B. Field-Constructed Mock-Up: Before installing tiles, erect mock-ups for each form of construction and finish required to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated and selected for final work.
 - 1. Locate mock-ups on site in location directed by the Engineer.
 - 2. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 3. Obtain Engineer's approval of mock-ups before start of final work.
 - 4. Retain and maintain mock-ups during construction in undisturbed condition as a standard for judging completed work.
 - a. Accepted mock-ups in undisturbed condition at time of taking over may become part of completed work.

10.2.1.3 APPLICABLE CODES AND STANDARDS

- A. Cyprus Standards:

CYS EN 87	Ceramic floor and wall tiles. Definitions, classification, characteristics and marking.
CYS EN 101	Ceramic Tiles. Determination of scratch hardness of surface according to Mohs.
CYS EN 154	Ceramic tiles. Determination of resistance to abrasion. Glazed tiles.

	CYS EN 1308	Adhesives for tiles. Determination of slip.
	CYS EN 1323	Adhesives for tiles. Concrete slabs for tests.
	CYS EN 1324	Adhesives for tiles. Determination of shear adhesion strength of dispersion adhesives.
	CYS EN 1346	Adhesives for tiles. Determination of open time.
	CYS EN 1347	Adhesives for tiles. Determination of wetting capability.
	CYS EN 1348	Adhesives for tiles. Determination of tensile adhesion strength for cementitious adhesives.
	CYS EN 12002	Adhesives for tiles. Determination of transverse deformation for cementitious adhesives and grouts.
	CYS EN 12003	Adhesives for tiles. Determination of shear adhesion strength of reaction resin adhesives.
	CYS EN 12004	Adhesives for tiles. Requirements, evaluation of conformity, classification and designation.
	CYS EN 12808	Adhesives and grouts for tiles.
	CYS EN 13888	Grouts for tiles. Definitions and specifications.
	CYS EN 14411	Ceramic tiles. Definitions, classification, characteristics and marking.
	CYS EN 14891	Liquid applied water impermeable products for use beneath ceramic tiling bonded with adhesives. Requirements, test methods, evaluation of conformity, classification and designation.
	CYS EN ISO 10545	Ceramic tiles. (various tests).
	CEN/TR 13548	General rules for the design and installation of ceramic tiling.
B.	British Standards:	
	BS 5385	Wall and floor tiling. Codes of practice.
	BS 7976	Pendulum Testers.
C.	Other Standards:	
	DIN 51097	Testing of floor coverings; determination of the anti-slip properties; wet-loaded barefoot areas; walking method; ramp test German National Standard 1992.
	DIN 51130	Testing of floor coverings; determination of the anti-slip properties; workrooms and fields of activities with slip danger; walking method; ramp test German National Standard 2004.

10.2.1.4 **SUBMITTALS**

- A. Product Data: Submit manufacturer's technical information and installation instructions for materials required, except built materials.
- B. Samples for initial selection purposes: Submit manufacturer's charts consisting of actual tiles or sections of tile showing selected range of colours. Include samples of grout and accessories involving colour selection.
- C. Samples for verification purposes: Submit the following:
 1. Samples for each type of tile and for each colour and texture required, not less than 300 mm square, on plywood or hardboard backing and grouted.
 2. Full size samples for each type of trim, accessory and for each colour.
 3. Samples of metal edge strip.
- D. Certification: Furnish master grade certificates for each shipment and type of tile, signed by tile manufacturer.

10.2.1.5 **PRODUCT HANDLING**

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Prevent damage or contamination to materials by water, freezing, foreign matter or other causes.

10.2.1.6 **SITE CONDITIONS**

- A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

10.2.1.7 EXTRA MATERIALS

- A. Deliver extra materials to Employer. Furnish extra materials that match products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.

Tile and trim units: furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, colour, pattern, and size.

10.2.2 PRODUCTS**10.2.2.1 PRODUCTS, GENERAL**

- A. Standard for Ceramic Tile: To CYS EN 14411.
- B. Standard for Tile Installation Materials: Comply with standard referenced with installation products and materials indicated or with CYS EN 14411.
- C. Colours, Textures and Patterns: For tile and other products requiring selection of colours, surface textures or other appearance characteristics, provide products to match characteristics indicated or, if not otherwise indicated, as selected by the Engineer from manufacturer's standard range.

Provide tile trim and accessories which match colour and finish of adjoining flat tile.

10.2.2.2 TILE PRODUCTS

- A. Ceramic Floor Tiles: Provide factory-mounted flat tile complying with CYS EN 14411: Part (as indicated).
1. Wear Surface: Smooth, non-slip (unless otherwise described on drawings).
 2. Nominal Facial Dimension: as indicated.
 3. Nominal thickness: as indicated or 10 mm if not.
 4. Face: Plain with square edges.
- B. Glazed Ceramic Wall Tiles: complying with CYS EN 14411: Part (as indicated)
1. Wearing Surface: Smooth
 2. Nominal Facial Dimensions: as indicated
 3. Nominal Thickness: as indicated.
 4. Face: Plain with cushion edges.
- C. Skirting:
- Coved skirting with rounded top edge: To match floor tiles; height as indicated, or 100 mm if not.
- D. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with following requirements:
1. Size: As indicated, coordinate with sizes and coursing of adjoining flat tile, where applicable.
 2. Shapes: As follows, selected from manufacturer's standard shapes.
 - a. Skirting: Coved with square top edge, unless otherwise indicated.
Provide external and internal corner angles as required.
 - b. External Corners: Rounded, unless otherwise indicated.
 - c. Internal Corners: Field-buttet square corners.

10.2.2.3 SETTING MATERIALS

- A. Thin-set Portland Cement Mortar: Where thin-set Portland cement mortar applications are indicated, use the following unless otherwise recommended by manufacturer or required by the Engineer:
1. Latex-Portland cement mortar.
 2. Epoxy mortar
 3. Organic adhesive

10.2.2.4 GROUTING MATERIALS

- A. Grout: Proprietary product recommended by tile manufacturer.
 - 1. Type/ classification: To CYS EN 13888 CG2.
 - 2. Colour: To match tiling as closely as possible.
- B. Commercial Portland Cement Grout: Proprietary pre-blended compound composed of Portland cement.
- C. Latex Portland Cement Grout: Proprietary pre-blended compound of Portland cement selected and graded aggregates, colour pigments and chemical additives gauged with latex additive to comply with manufacturer's direction and additives formulated for the type of tile installed.
 - 1. Use latex additive in grout which is compatible with latex additive in latex-Portland cement mortar.

10.2.2.5 MISCELLANEOUS MATERIALS

- A. Sealants: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that comply with requirements of CYS EN ISO 11600 for type, grade and use.
 - 1. Colours: Provide colours of exposed sealants to match colours of grout in tile adjoining sealed joints unless otherwise indicated.
- B. Metal Edge Strips: Stainless steel, 3 mm wide at top edge with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.
- C. Tile Cleaner: Product specifically acceptable to tile manufacturer and grout manufacturer for application indicated.

10.2.2.6 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

10.2.3 EXECUTION**10.2.3.1 EXAMINATION**

- A. Examine substrates and areas where tile will be installed, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compound which are incompatible with bedding.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tiling.
 - 3. Plasterboard backgrounds: Verify that boards are dry, securely fixed and rigid with no protruding fixings and face to receive decorative finish exposed.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

10.2.3.2 INSTALLATION, GENERAL

- A. Tile Installation Standards: Comply with applicable parts of BS 5385, Code of Practice for Wall Tiling and CYS EN 14411.
- B. Installation Guidelines: Comply with British Ceramic Tile Council recommendations.
- C. Stippling for Key:
 - 1. Stipple mix:
 - a) Cement: Portland to CYS EN 197-1 type CEM 1/42.5.
 - b) Sand: Clean coarse.
 - c) Proportions (cement: sand): 1-1.5:2.

- d) Admixture: None.
2. Application/ finish: Brush applied to a deep close texture.
3. Curing/ drying: Keep damp until hardened. Dry out to provide securely bonded finish.
- D. Fixing Generally:
 1. Colour/ shade: Unintended variations within tiles for use in each area/ room are not permitted.
 2. Adhesive: Compatible with background/ base. Prime if recommended by adhesive manufacturer.
 3. Cut tiles: Neat and accurate.
 4. Fixing: Provide adhesion over entire background/ base and tile backs.
 5. Final appearance: Before bedding material sets, make adjustments necessary to give true, regular appearance to tiles and joints when viewed under final lighting conditions.
 6. Surplus bedding material: Clean from joints and face of tiles without disturbing tiles.
- E. Extend tile work into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.
- F. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish or build-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures and other penetrations so that plates, collars or covers overlap tile.
- G. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, skirting, walls and trim are same size. Layout tile work and centre tile fields in both directions in each space or on each wall area. Adjust to minimise tile cutting. Provide uniform joint width, unless otherwise shown.
 1. For tile mounted in sheets make joints between tile sheets same width as joints within tile sheets so that extent of each sheet is not apparent in finished work.
- H. Flatness/ regularity of tiling:
 1. Sudden irregularities: Not permitted.
 2. Deviation of surface: Measure from underside of a 2m straightedge placed anywhere on surface. The straightedge should not be obstructed by the tiles and no gap should be greater than 3mm.
- I. Level of tiling across joints:
 1. Deviation (maximum) between the surfaces either side of any type of joint:
 - a) 1mm for joints less than 6mm wide.
 - b) 2mm for joints 6mm or greater in width.
- J. Crack Control Reinforcement:
 1. Type: To BS 4483: Steel fabric for the reinforcement of concrete. Specification.
 2. Installation: Place centrally in depth of bed. Lap not less than 100mm and securely tie together with steel wire.
 3. Corners: Avoid a four layer build at corners.
- K. Expansion Joints: Locate expansion joints and other sealant filled joints, including control, contraction and isolation joints, where indicated, or if not indicated, at spacing and locations recommended by the manufacturers and approved by Engineer.
 1. Prepare joints and apply sealants to comply with requirements of referenced standards and sealant manufacturer.
- L. Sealant/ Neoprene Movement Joints with Metal Edgings:
 1. Edging material: Stainless steel/ anodised aluminium.
 - a) Size: As indicated on drawings.
 - b) Bedding: Bed in 1:3 cement: sand.
 2. Installation: Centre over joints in base. Set to exact finished level of floor.
 - a) Fixing to base: Plugged and screwed with stainless steel screws.
 3. Joint width: 10-15mm.
 4. Sealant: Silicone/ Neoprene.
 - a) Colour: Black or as otherwise confirmed by Engineer.

- M. Grouting:
1. Sequence: Grout when adhesive has set sufficient to prevent disturbance of tiles.
 2. Grout tile to comply with referenced installation standards, using grout materials indicated. At showers, tubs and similar wet areas, install cementitious backer units and seal joints to comply with manufacturer's instructions for type of application indicated.
 3. Joints: 6mm deep (or depth of tile if less). Free from dust and debris.
 4. Grouting: Fill joints completely, tool to profile, clean off surface. Leave free from blemishes.
 - a) Profile: Flush with general tiling surface.
 5. Polishing: When grout is hard, polish tiling with a dry cloth.

10.2.3.3 FLOOR INSTALLATION METHODS

- A. Ceramic Floor Tile and Base: Install tile to comply with requirements indicated below for setting bed methods.
1. Portland Cement Mortar
 - a. Bond Coat: Portland cement paste on plastic bed; or thin-set Portland cement on cured bed, at Contractor's option.
 - b. Concrete Subfloors, Interior
 - c. Grout: Latex-Portland cement
 2. Organic Adhesive
 - a. Concrete Subfloors, Interior
 - b. Grout: Latex-Portland cement.
- B. The pre-wetted ceramic floor tiles shall be laid on screeds as described in section 11.8 of a true and level nature, which have been 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 Engineer's approval.
- C. 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, the double gluing technique shall be used.
- D. Grouting of 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 debris. Movement joints shall be provided as directed by the Engineer.

10.2.3.4 WALL TILE INSTALLATION METHODS

- A. Install types of tile designated for wall application to comply with requirements indicated below for setting bed methods, related to subsurface wall conditions, and grout types:
1. Organic Adhesive.
 - a. Solid Backing, Interior
 - b. Grout: Latex-Portland cement, with waterproofer.

10.2.3.5 CLEANING AND PROTECTION

- A. Cleaning: Upon completion of placement of grouting, clean all ceramic tile surfaces so they are free from foreign matter.
1. Unglazed tiles may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.
- B. Finish Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded or otherwise defective tile work.
- C. Protection: When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage and wear.

1. Prohibit foot and wheel traffic from using tiled floor for at least 7 days after grouting is completed.
2. Before final inspection, remove protective coverings and rinse neutral cleaning from tile surface.

10.3 PRECAST TERRAZZO

10.3.1 GENERAL

10.3.1.1 SCOPE OF THE WORKS

- A. Types of precast terrazzo work include:
 1. Precast terrazzo tile flooring.
- B. The Contractor shall engineer and design all precast terrazzo tile assemblies and installations, including under bed reinforcement, control joint and cold joint locations, and all other details and junctures with other materials and systems, to provide precast terrazzo tiling free from cracks, spalling, and other defects.

10.3.1.2 SUBMITTALS

- A. Product Data: Manufacturer's technical information and installation instructions for each type of precast terrazzo tile, accessory item, and materials.
- B. Samples: Submit four full size unit samples for each pattern, colour and type of precast terrazzo tile required, including grout colours. Submit 200 mm long samples of each type of accessory item.
 1. Resubmit samples as required to obtain the Engineer's approval

10.3.1.3 QUALITY ASSURANCE

- A. Precast Terrazzo Tiles: Provide precast terrazzo tile products obtained from a single source acceptable to the Engineer.
- B. Setting and Grouting Materials: Provide materials obtained from one source for each type and colour of grout and setting materials.
- C. Standards: Unless otherwise approved by the Engineer comply with specified provisions and recommendations of International recognised associations.
 1. Cyprus Standards:

CYS EN 197-1	Cement. Composition, specifications and conformity criteria for common cements.
CYS EN 12620	Aggregates for concrete.
CYS EN 12878	Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test.
CYS EN 13748-1	Terrazzo tiles. Terrazzo tiles for internal use.
CYS EN 13748-2	Terrazzo tiles. Terrazzo tiles for external use.
- D. Manufacturer's Instructions: In addition to specified requirements, comply with precast terrazzo manufacturer's instructions and recommendations for substrates preparation, materials storage, mixing and application, finishing, and curing.

10.3.1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store materials in original package containers with any seals unbroken and labels intact until time of use.

10.3.2 PRODUCTS

10.3.2.1 PRECAST TERRAZZO TILE PRODUCTS

Provide precast terrazzo tiles conforming to the following characteristic requirements:

1. Dimensional Tolerances: Face: + or - 1 mm
2. Warpage: Along any edge on either diagonal +/- 1.5%
3. Wedging: Not to exceed 1.0%
4. Water Absorption:
 - Tile Face: 10%
 - Whole Tile: 66% maximum
5. Breaking Strength: 1.72 MPa
6. Mohs Hardness : 4-5 depending on aggregates used
7. Impact Resistance: Very high resistance to damage by impact
8. Precast Terrazzo Tile Production: Tile shall be produced from a manufacturing system which includes the following:
 - a. Mechanically vibrated in the moulds.
 - b. Hydraulically pressed by 13.80 MPa.
 - c. Curing totally immersing in water for at least 24 hours, after the initial set was taken place, or
 - d. Steam curing with 100% humidity for 14 hours at 150 degrees F.
9. The face layer of terrazzo tile shall have a minimum depth of 10 mm and shall include minimum 70% coverage of the tile face with marble aggregate.

10.3.2.2 SETTING MATERIALS

- A. Portland Cement Mortar Installation Materials: Provide materials complying with CYS EN 197-1.

10.3.2.3 GROUTING MATERIALS

- A. Latex-Portland Cement Grout, Colours to match matrix of each area of tile.

10.3.2.4 ACCESSORIES

- A. Divider Strips: White zinc alloy. Width as required or as indicated.
- B. Cleaner: Liquid, natural chemical cleaner, of formulation recommended by sealer manufacturer of type of precast terrazzo tiles used.
- C. Interior Floor Sealer: Colourless, slip and stain resistant penetrating sealer with Ph factor between 7 and 8, which does not affect colour or physical properties of precast terrazzo tiles surface.

10.3.2.5 TERRAZZO FORMULATIONS

- A. Aggregate: Provide natural, sound, crushed marble chips, irregular in size and roughly cuboid in shape without excessive flats or flakes, obtained from a source or supplier acceptable to the Engineer. 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.
1. Samples: Propose and submit samples of marble chippings for approval of size / colour gradation and composition, by the Engineer.
 2. Facing: Marble chippings shall be of sizes from 10mm to 25mm (quality A) and from 3mm to 6mm (quality B), 1:2 nominal mix using coloured cement. The facing shall provide a minimum wearing thickness of 10mm after grinding. The marble chippings shall be evenly distributed and the face of the work shall be free from projections, depressions, flakes and crazing.
- B. Base Layer: Ordinary Portland cement and aggregate mix in parts proportion of 1:4 by volume complying with CYS EN 12620.
- C. Face matrix: White Portland cement to CYS EN 197-1.
1. Use one brand of cement throughout, unless otherwise acceptable to the Engineer.
- D. Pigments: To comply with CYS EN 12878: Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test.
1. The overall colour of precast terrazzo tiling shall be uniform in any one delivery.

- E. Sizes: Terrazzo tiles shall be square with flat tops and of rectangular cross section.
1. Tiles: 400 x 400 x 35mm nominal size with an allowance for joints.
 2. Skirtings: 400 x 80mm high x 15mm thick produced in the same manner as for tiles and with chamfered top edges.
 3. Precast Terrazzo tread and riser units: To dimensions and profiles shown on drawings and incorporating non-slip carborundum or aluminium inserts as detailed.

10.3.3 EXECUTION

10.3.3.1 PREPARATION

- A. Clean and prepare substrate. Examine substrates to verify that surfaces are within required tolerances.
- B. Prior to precast terrazzo tile installation, remove dust, curing compounds, oil and other foreign substances from substrates.

10.3.3.2 INSTALLATION, GENERAL

- A. Place precast terrazzo tiles around obstructions to achieve continuous colour, pattern and finish.
- B. Install divider strips and accessories in accordance with patterns indicated on drawings.
- C. Install control joint strips in patterns as required or as indicated on drawings, except not to exceed 9000 mm centres maximum.
- D. Straightness and flatness tolerance: 3 mm in a 3000 mm span.

10.3.3.3 INSTALLATION

- A. Install precast terrazzo tile in accordance with referenced standards for tile installation methods.
- B. Jointing Pattern: Lay precast terrazzo in pattern shown. Align joints when adjoining tiles on floor, base, and walls. Provide uniform minimum joint widths.
- C. Expansion and Control Joints: Provide openings for joints in locations as required. Comply with recommendations in referenced standards.
- D. Cutting: Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.
- E. Install mortar beds in accordance with CYS EN 197-1. Install square edged precast terrazzo tile on cured mortar beds with latex-Portland cement mortar (1:3-4) minimum 15mm thick in accordance with CYS.
- F. Grout joints with latex Portland cement grout of matching colour. Care shall be taken to fill all joints completely. Surplus grout shall immediately be removed from the face of the work and surrounding surfaces and all work shall be carefully cleaned.

10.3.3.4 GRINDING AND POLISHING

- A. Surfacing: Delay final fine grinding and finishing until heavy trade work is completed and construction traffic through the area is restricted. Finish by fine grinding with abrasive grit of size required to match/ achieve a surface finish to approved sample.

10.3.3.5 CLEANING, SEALING, AND PROTECTION

- A. Clean precast terrazzo units after installation, grouting and fine grinding operations are completed, complying with sealer manufacturer's instructions.

- B. Apply sealer to cleaned precast terrazzo units surfaces to comply with sealer manufacturer's instructions.
- C. Protect precast terrazzo units from damage and wear during construction operation.

10.3.3.6 FINAL CLEANING

- A. Clean precast terrazzo units as recommended by manufacturer of sealer and machine buff if required by the Engineer, when building is ready for taking-over.

10.4 SUSPENDED CEILINGS

10.4.1 GENERAL

10.4.1.1 SCOPE OF THE WORKS

- A. Extent of each type of suspended ceiling is shown on the drawings and schedules.
- B. Types of ceilings specified in this section include (but are not limited to) the following:
 1. Plasterboard Ceilings.
 2. Demountable Suspended Ceilings:
 - a. Mineral fibre tile/ panel ceilings exposed or concealed suspension.
 - b. Aluminium snap-in linear strip ceilings with sound absorption blanket.
 - c. Steel lay-in pan ceilings with sound absorption blanket.
 - d. Decorative hardwood boarding.

10.4.1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product specifications and installation instructions for each type of tile/ panel unit and suspension system required, including certified laboratory test reports and other data as necessary to show compliance with these specifications.
 1. Include manufacturer's recommendations for cleaning, including precautions against materials and methods which may be detrimental to finishes and acoustical performances.
- B. Coordination Drawings: Submit reflected ceiling plans, for installation purposes, drawn accurately to scale and coordinated with related mechanical, electrical and other work above, penetrating, or connected to acoustical ceiling. Show ceiling suspension members, method of anchorage to building structure of hangers, size and location of initial access modules for acoustical tile ceilings (if any), and ceiling-mounted work including light fixtures, diffusers, grilles, and special mouldings.
 1. Scale: 1:20.
 2. Scale: 1:100
- C. Samples for Verification Purposes: Submit the following:
 1. Full size sample panels of each ceiling type, pattern and colour.
 2. Set of 300 mm long samples of exposed runners and mouldings for each colour and system type required.
 3. Set of concealed suspension members.

10.4.1.3 QUALITY ASSURANCE

- A. Coordination of Work: Coordinate layout and installation of suspended ceiling units and suspension system components with other work supported by, or penetrating through ceilings, including light fixtures, HVAC equipment, fire-suppression system components (if any), and partition systems (if any), etc.

10.4.1.4 APPLICABLE CODES AND STANDARDS

- A. Applicable standards:
 1. Cyprus Standards:

CYS EN 520	Gypsum plasterboards. Definitions, requirements and test methods.
CYS EN 1998-1	Eurocode 8: Design of structures for earthquake resistance.

CYS EN 13658-1	Metal lath and beads. Definitions, requirements and test methods. Internal plastering.
CYS EN 13964	Suspended ceilings. Requirements and test methods.
CYS EN 14246	Gypsum elements for suspended ceilings. Definitions, requirements and test methods.
CYS EN ISO 354	Acoustics. Measurement of sound absorption in a reverberation room.

2. British Standards:
BS 8212 Code of practice for dry lining and partitioning using gypsum plasterboard.

10.4.1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver suspended units in manufacturer's original unopened packages, fully identified with type, finish, performance data, and compliance labels. Handle and store in accordance with manufacturer's instructions and recommendations.
- B. Before installing suspended ceiling units, permit them to reach room temperature and stabilized moisture content.
- C. Handle suspended ceiling units carefully to avoid chipping edges or damaging units in any way.

10.4.1.6 SITE CONDITIONS

- A. Space Enclosure: Do not install interior suspended ceilings until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

10.4.2 PRODUCTS

10.4.2.1 PLASTERBOARD SUSPENDED CEILINGS

- A. Structural soffits: Reinforced concrete structural slabs and beams.
- B. Grid type: Single layer. As CYS EN 520.
- C. Suspension system: As recommended by the board manufacturer to complete the ceiling system and achieve specified performance.
1. Extent of system: Include all hangers, fixings, main runners, cross members, primary channels, perimeter trims, splines, noggings, clips, bracing, bridging, etc. necessary to complete the ceiling system and achieve specified performance.
 2. Top fixings: Anchor bolts fixed in RC slab soffit.
 3. Hangers: Rigid galvanised steel angle.
 4. Grid type: Galvanised steel channel primary and secondary members.
 - a. Finish: Galvanised.
 - b. Colour: Not applicable.
- D. Access units: Required. Generally panels to be 450 x 450mm sealed panels in beaded frames in a colour to match the adjacent ceiling.
- E. Integrated services fittings: Recessed down lights, recessed loudspeakers, fire detection and alarm devices.
- F. Other requirements: Moisture resistant boards, required in washroom areas. Perforated gypsum boards, required as shown and where necessary to achieve acoustic performance stated in the acoustic report (if any).
- G. Structural Performance for Board Suspended Ceilings:
1. Loads: The ceiling system must safely support all anticipated loads, including services fittings:
 - a. Uniform distributed loads: Self-weight of boards and support system.
 - b. Point loads: Light fittings, fire detection and alarm fittings, loudspeakers.
 - c. Additional loads/ pressures to be sustained by ceiling system: Earthquake movement.

2. Deflection (maximum) between points of support:
 - a. Span less than 1200 mm: Span/400.
 - b. Span 1200–1800 mm: Span/500.
 - c. Span over 1800 mm: Span/600.
 3. Test standard: To CYS EN 13964.
- H. Fire Performance for Board Suspended Ceilings:
1. Ceiling system intended for fire protection: Generally no, except where shown on drawings.
 2. Surface spread of flame ratings:
 - a. Ceiling soffits surfaces: Euroclass B.
 - b. Ceiling void surfaces: Euroclass B.
 3. Fire resistance:
 - a. Ceiling resistance, to BS 476-22 (integrity/ insulation): 60/0.
 - b. Other protection: Not applicable.
 4. Test reports or assessments: Include details of performance related to the particular elements of construction.
 - a. Ceilings with integrated luminaires: Test/ assess with luminaires in place.
- I. Acoustic Performance for Board Suspended Ceilings:
1. Sound absorption:
 - a. Sound absorption coefficient, as (minimum) to CYS EN ISO 354: Refer to Acoustic Report (if any).
- J. Compliance with Performance Requirements:
1. Testing/ Assessment: Submit accredited laboratory reports for the following:
 - a. Fire performance as Clause 11.4.2.1.I.
 - b. Acoustic performance as Clause 11.4.2.1.J.
 2. Materials, components and details: As used in testing/ assessment reports. If discrepancies arise, give notice.
- K. Additional Supports:
1. Framing: Accurately position and securely fix to give full support to:
 - a. Fixtures, fittings and service outlets. Mark framing positions clearly and accurately on linings.
 - b. Board edges and panel perimeters, as recommended by board manufacturer to suit type and performance of lining.
 - c. Bracing for seismic resistance.
- L. Control Samples:
1. General: Refer to section 11.4.1.2.C.
- M. Gypsum Plasterboard:
1. Type: To CYS EN 520.
 - a. Core density (minimum): 650 kg/m³.
 2. Exposed surface and edge profiles: Suitable to receive specified finish.
- N. Gypsum Plasterboard (Moisture Resistant) for use in Washrooms:
1. Type: To CYS EN 520.
 - a. Core density (minimum): 710 kg/m³.
 - b. Core: Moisture resistant.
 - c. Paper facings: Moisture resistant.
 2. Exposed surface and edge profiles: Suitable to receive specified finish.
- O. Perforated Gypsum Boards:
1. Type: Perforated fibre reinforced gypsum.
 2. Thickness: 12.5mm.
 3. Sizes: 900x2700mm.
 4. Edge profile: Tapered on all four edges.
 5. Fillets/ cover strips: Not applicable.
 6. Finish: Smooth for painting.

7. Colour: White.
8. Other requirements: None.

P. Installation Generally:

1. Sequence: Where appropriate, fix boards to ceilings before dry lined walls and partitions.
2. Orientation of boards: Fix with bound edges at right angles to supports and with ends staggered in adjacent rows.

Q. Sealing Gaps and Air Paths:

1. Location of sealant: To perimeter abutments and around openings.
 - a. Pressurized shafts and ducts: At board-to-board and board-to-metal frame junctions.
2. Application: To clean, dry and dust free surfaces as a continuous bead with no gaps.
 - a. Gaps greater than 6 mm between floor and underside of plasterboard: After sealing, fill with jointing compound.

R. Joints Between Boards:

1. Tapered edged plasterboards:
 - a. Bound edges: Lightly butted.
 - b. Cut/ Unbound edges: 3 mm gap.
2. Square edged plasterboards: 3 mm gap.
3. Square edged fibre reinforced gypsum boards: 5 mm gap.

S. Long Joints:

1. Joints: Centre on studs.

T. Cross Joints:

1. Two layer boarding: Stagger joints between layers by at least 600 mm.
2. Edges of boards: Support using additional framing.
 - a. Two layer boarding: Support edges of outer layer.

U. Fixing Plasterboard to Metal Framing:

1. Ceilings: Fix securely and firmly at centres recommended by system manufacturer.
2. Position of screws from edges of boards (minimum): 10 mm.
 - a. Screw heads: Set in a depression. Do not break paper or gypsum core.

V. Level of Ceiling Across Joints:

1. Sudden irregularities: Not permitted.
2. Joint deviations: Measure from faces of adjacent boards using methods and straightedges (450 mm long with feet/ pads) to BS 8212, clause 3.3.5.
 - a. Tapered edge joints: Permissible deviation (maximum) across joints when measured with feet resting on boards: 3mm.
 - b. External angles: Permissible deviation (maximum) for both faces: 4 mm.
 - c. Internal angles: Permissible deviation (maximum) for both faces: 5 mm.

W. Seamless Jointing to Plasterboards:

1. Cut edges of boards: Lightly sand to remove paper burrs
2. Filling and taping: Fill joints, gaps and internal angles with jointing compound and cover with continuous lengths of paper tape, fully bedded.
3. Protection of edges/ corners: Reinforce external angles, stop ends, etc. with specified edge/ angle bead.
4. Finishing: Apply jointing compound. Feather out each application beyond previous application to give a flush, smooth, seamless surface.
5. Nail/ Screw depressions: Fill with jointing compound to give a flush surface.
6. Minor imperfections: Remove by light sanding.

X. Rigid Beads/ Stops:

1. Type: Galvanized steel to CYS EN 13658-1.

- Y. Installing Beads/ Stops:
1. Cutting: Neatly using mitres at return angles.
 2. Fixing: Securely using longest possible lengths, plumb, square and true to line and level, ensuring full contact of wings with substrate.
 3. Finishing: After joint compounds/ plasters have been applied, remove surplus material while still wet from surfaces of beads exposed to view.

10.4.2.2 DEMOUNTABLE SUSPENDED CEILING UNITS, GENERAL

- A. Standard for Suspended Ceiling Units: Provide manufacturer's standard units of configuration indicated which are prepared for mounting method designated and which comply with CYS or equivalent alternative standard requirements, acceptable to the Engineer, including those indicated by reference to type, form, pattern, grade, light reflectance coefficient, edge detail, joint detail (if any) and acoustic report (if any).
- B. Colours, Textures, and Patterns: Provide products to match appearance characteristics indicated or, if not otherwise indicated, as selected by the Engineer from manufacturer's standard colours, surface textures, and patterns available for acoustical ceiling units and exposed metal suspension system members of quality designated.
- C. Sound Absorption (Acoustical) Pads or Blanket: Provide manufacturer's standard sound absorptive pads or blanket, of thickness indicated, installed over metal grid or suspension components, and wrapped in or laid on black PVC sheet.

10.4.2.3 DEMOUNTABLE SUSPENDED CEILING TYPES

- A. Mineral fibre Composition Tiles/ Panels; Water felted, with standard washable finish: Manufacturer's standard plain texture and perforated pattern designs to be selected by Engineer, with other characteristics as follows:
- a. Colour/Light Reflectance: White/LR 1 (75% and over).
 - b. Grade: NRC 65 – 75.
 - c. STC Range: 40 – 44.
 - d. Edge Detail: Tegular, or as otherwise described in drawings and finishes schedule.
 - e. Size: 600 mm x 600 mm x 19 mm.
- B. Aluminium Snap-in Linear Metal Panels: Provide manufacturer's standard 100 mm wide unit as referenced. Colour to be selected by Engineer.
- C. Steel Lay-in Panels: Provide manufacturer's standard 600 mm x 600 mm units as referenced. Finish to be selected by Engineer.
- D. Decorative Hardwood Board Ceiling: Construct, install and finish as indicated and detailed on drawings.
1. Materials and workmanship: Comply with relevant requirements specified for Joinery and architectural Woodwork.
- E. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to the following:

10.4.2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Standard for Metal Suspension Systems: Provide manufacturer's standard metal suspension systems of type, structural classification and finish indicated which comply with applicable CYS or equivalent alternative requirements and approved by the Engineer.
- B. Finishes and Colours: Provide manufacturer's standard factory - applied finish for type of system indicated. For exposed suspension members and accessories with painted finish, provide colour indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's full range of standard colours.
- C. Miscellaneous Materials: (All to comply with relevant CYS).
1. Attachment Devices: Type recommended by suspension system manufacturer for attachment or anchorage of ceiling hangers to structure, sized for 5 times design load indicated.

- a. Concrete Inserts: Inserts formed from hot-dipped galvanized sheet steel and designed for attachment to concrete forms and for embedment in concrete, with holes or loops for attachment at hanger wires.
2. Hanger Wire: Galvanized carbon steel wire, soft temper, pre-stretched, Class 1 coating, sized so that stress at 3-times hanger design load, will be less than yield stress of wire, but provide not less than 12 gage (2.7 mm).
3. Edge Mouldings and Trim: Metal or extruded plastic of types and profiles indicated or, if not indicated, provide manufacturer's standard moulding for edges and penetrations of ceiling which fits with type of edge detail and suspension system indicated.
 - a. For lay-in tiles/ panels with reveal edge details, provide stepped edge moulding which forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - b. For circular penetrations of ceiling, provide edge mouldings fabricated to diameter required to fit penetration exactly.
 - c. For narrow faced suspension systems, provide suspension system manufacturer's standard edge mouldings which match width and configuration of exposed runners.
4. Hold-Down Clips for Non-Fire-Rated Ceilings: For interior ceilings composed of lay-in panels weighing less than 4.9 Kg/M², provide hold-down clips spaced 600 mm centres on all cross tees.
5. Impact Clips: Where required provide manufacturer's standard impact clip system design to absorb impact forces against lay-in panels as recommended by panel manufacturer.
6. Acoustical Sealant: Resilient, non-staining, non-shrinking, non-hardening, non-skinning, non-drying, non-sag sealant intended for interior sealing of concealed construction joints.

10.4.3 EXECUTION

10.4.3.1 PREPARATION

- A. Coordination: Furnish layouts for inserts, clips, or other supports required to be installed by other trades for support of acoustical ceilings.
 1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.
- B. Pre-Installation : Prior to start of suspended ceiling installation, meet at project site with installers of related work, including lighting, ductwork, and similar work in ceiling plenum. Review areas of potential interference and resolve conflicts before proceeding with work. Co-ordinate ceiling layout with layout of other work which penetrates or is supported by ceiling in each space of project.
- C. Plan each layout to balance border widths at opposite edges of each ceiling area. Avoid use of less-than-half width units wherever possible. Comply with Engineer's approved reflected ceiling plans to greatest extent possible.

10.4.3.2 INSTALLATION

- A. General: Install materials in accordance with manufacturer's printed instructions, and to comply with governing regulations, as indicated, and industry standards applicable to work.
- B. Arrange tiles/ panels and orient directionally-patterned tiles/ panels (if any) in manner shown by reflected ceiling plans.
- C. Install suspension systems to comply with CYS, with hangers supported only from building structural members. Locate hangers not less than 150 mm from each end and spaced 1200 mm along each carrying channel or direct-hung runner, unless otherwise indicated, levelling to tolerance of 3 mm in 3600 mm.
 1. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail with age or elevated temperatures.
 2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum which are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, counters playing or other equally effective means.

3. Bracing General: Secure, with additional bracing and stiffening to give a stable ceiling system resistant to design loads and pressures including seismic restraint.
 4. Top Fixing:
 - a. Building structure: Verify suitability.
 - b. Structural soffit: In situ reinforced concrete and pre-cast concrete panels.
 - Suitability to receive specified fixings: Contractor to evaluate and obtain approval of proposed fixing methods from Engineer before commencing installation.
 - c. Fixing to:
 - Concrete: Drill and insert suitable expanding anchors.
 - Aerated concrete: Fix through from the top of concrete units and provide a system of primary support channels.
 - Structural steel: Drill, or use suitable proprietary clips/ adaptors.
 - Hollow structural members: Submit fixing proposals.
 - d. Cartridge or powder activated methods: Do not use.
 5. Installing Hangers:
 - a. Wire hangers: Straighten and tension before use.
 - b. Installation: Install vertical or near vertical, without bends or kinks. Do not allow hangers to press against fittings, services, or insulation covering ducts/ pipes.
 - c. Obstructions: Where obstructions prevent vertical installation, either brace diagonal hangers against lateral movement, or hang ceiling system on an appropriate rigid sub-grid bridging across obstructions and supported to prevent lateral movement.
 - d. Extra hangers: Provide as necessary to carry additional loads.
 - e. Fixing:
 - Wire hangers: Not acceptable.
 - Angle/ strap hangers: Do not use rivets for top fixing.
 - f. Spacings: To be determined by Contractor.
- D. Install edge trims of type indicated at perimeter of suspended ceiling area and at locations where necessary to conceal edges of tiles/ panels.
1. Jointing: Neat and accurate, without lipping or twisting.
 - a. External and internal corners: Mitre joints generally. Overlap joints at internal corners are Not acceptable.
 - b. Intermediate butt joints: Minimize. Use longest available lengths of trim. Align adjacent lengths.
 2. Fixing: Fix firmly to perimeter wall, edge battens or other building structure.
 - a. Fasteners: Non-ferrous or stainless steel screws.
 - b. Fixing centres: 300mm and not more than 75 mm from ends, levelling-with ceiling suspension system to tolerance of 3 mm in 3600 mm.
- E. Exposed Grids:
1. Grid fixings: Angle hangers.
 2. Main runners: Install level. Do not kink or bend hangers.
 - a. Spliced joints: Stagger.
 - b. Wire hangers passing through main runners: Use sharp bends and tightly wrapped loops.
 - c. Angle/ strap hangers: Do not use rivets for bottom fixing.
 - d. Angular displacement of long axis of one runner in relation to next runner in line with it: Not visually apparent.
 3. Cross members supported by main runners or other cross members: Install perpendicular to intersecting runners.
 4. Cross tees: Flat and coplanar with flanges of main runners after panel insertion.
 - a. Cross tees over 600 mm long, cut and resting on perimeter trim: Provide an additional hanger.
 5. Holding down clips: Locate to manufacturer's recommendations.
 - a. Fire protecting/ resisting ceiling systems: Use clip type featured in the fire test/ assessment.
- F. Concealed Grids:
1. Grid fixings: Angle hangers.
 2. Main runners: Install level. Do not kink or bend hangers.
 - a. Spliced joints: Stagger.
 - b. Wire hangers passing wrapped around primary channel: twice wrapped. Loops tightly formed.

- c. Angle/ strap hangers: Do not use rivets for bottom fixing.
- 3. Splines: Locate between infill units to assist levelling of adjacent unit.
- 4. Spring-tee grids: Do not omit primary channel.
- G. Install acoustical tiles/ panels in coordination with suspension system, with edges concealed by support of suspension members.
 - 1. Install hold-down clips in areas indicated, and in areas where required by governing regulations or for fire-resistance ratings; space as recommended by tile/ panel manufacturer, unless otherwise indicated or required.
 - 2. General:
 - a. Perimeter tiles/ panels: Trimmed, as necessary, to fully fill space between last grid member and perimeter trim. Prevent subsequent movement.
 - b. Deeply textured infill units: Minimize variations in apparent texture and colour. In particular, avoid patchiness.
 - 3. Concealed grids: Install tiles/ panels uniformly, straight and aligned. Avoid dimension creep.
 - a. Tiles/ panels around recessed luminaires and similar openings: Prevent movement and displacement.
- H. Scribe and cut metal panels for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling.
- I. Install snap-in tiles/ panels in coordination with suspension system and any exposed runner mouldings.
- J. Install metal acoustical tiles/ panels in coordination with suspension system, with edges concealed by support of suspension members.
- K. Install sound attenuation pads or blanket in areas indicated by approved reflected ceiling plans or room finish schedules. Lay directly on ceiling system in manner directed by the manufacturer in co-ordination with the ceiling installation. Cut or fold pads in cut perimeter infill units to full unit size. Reseal cut pads.
- L. Upstands and Bulkheads:
 - 1. Vertical ceiling systems: Support and brace to provide alignment and stability.
 - 2. High upstands: Provide support at base of upstand.
- M. Openings in Ceiling Materials:
 - 1. General: Neat and accurate. To suit sizes and edge details of fittings. Do not distort ceiling system.
- N. Integrated Services:
 - 1. General: Position services accurately, support adequately. Align and level in relation to the ceiling and suspension system. Do not diminish performance of ceiling system.
 - 2. Small fittings: Support with rigid backing boards or other suitable means. Do not damage or distort the ceiling.
 - a. Surface spread of flame rating of additional supporting material: Not less than ceiling material.
 - 3. Services outlets:
 - a. Supported by ceiling system: Provide additional hangers.
 - b. Independently supported: Provide flanges to support ceiling system.
- O. Ceiling Mounted Luminaires:
 - 1. Support: Independent.
 - a. Independently supported luminaires: Suspension adjusted to line and level of ceiling.
 - b. Ceiling supported luminaires: Modifications and/ or extra support required: Not applicable.
 - 2. Surface mounted luminaires: Units installed so that in event of a fire the designed grid expansion provision is not affected.
 - 3. Modular fluorescent recessed luminaires: Compatible with ceiling module. Extension boxes must not foul ceiling system.

4. Recessed rows of luminaires: Provide flanges for support of grid and infill units, unless mounted above grid flanges. Retain in position with lateral restraint.
5. Fire protecting/ resisting ceiling systems: Luminaires must not diminish protection integrity of ceiling system.
6. Access: Provide access for maintenance of luminaires.

P. Trunking:

1. Recessed trunking: Provide flanges for support of grid and infill units, unless mounted above grid flanges. Retain in position with lateral restraint.

Q. Mechanical Services:

1. Fan coil units:
 - a. Inlet/ Outlet grilles: Trim ceiling grid and infill units to suit.
 - b. Space beneath: Sufficient for ceiling system components.
 - c. Suspension and connections: Permit accurate setting out and levelling of fan coil units.
2. Air grilles and diffusers:
 - a. Setting out: Accurate and level.
 - b. Linear air diffusers: Retain in place with lateral restraint. Provide flanges for support of grid and infill units.
 - c. Grille/ Diffuser ceiling joints: Provide smudge rings and edge seals.
3. Smoke detectors and PA speakers:
 - a. Ceiling tiles/ panels: Scribe and trim to suit.
 - b. Independent suspension: Required.
 - c. Flexible connections: Required.
4. Sprinkler heads: Carefully set out and level.
 - a. To allow for seismic movement, form larger hole in tile/ panel than diameter of sprinkler pipework. Cover with suitable flange.

R. Electrical Continuity and Earth Bonding:

1. Substantial conductive parts of the ceiling system: Electrically continuous and fully earth bonded to carry prospective earth fault currents.
 - a. Standard: To BS 7671.
2. Sequence: Complete earth bonding as soon as possible after completion of each independent area of suspension system.
3. Testing: After completion of the ceiling system, associated services and fittings, test conductive parts of suspension system required to carry earth fault current, or used as bonding connections. Give notice before testing.
 - a. Electrical continuity: Measure from various distant conductive points of ceiling system and to earth bar in distribution board serving the area.
 - b. Test current: Sufficient to indicate probable electrical performance under fault conditions.
 - c. Test instrument: Type providing a pulse of about 25A at safe voltage for safe duration, and indicating resistance in ranges 0–2 ohms and 0–20 ohms.
 - d. Resistance of measuring conductors: Deduce from test instrument readings.
 - e. Test readings: Record and certify. Add results to resistance of other parts of the path forming the earth fault loop.

S. General: Completed ceiling should present, over the whole of its surface exposed to the room below, a continuous and even surface, jointed (where applicable) at regular intervals.

1. Infill and access units, integrated services: Fitted correctly and aligned.
2. Edge/ perimeter infill units size (minimum): Half standard width or length.
3. Corner infill units size (minimum): Half standard width and length.
4. Grid: Position to suit infill unit sizes. Allow for permitted deviations from nominal sizes of infill unit.
5. Infill joints and exposed suspension members: Straight, aligned and parallel to walls, unless specified otherwise.
6. Suitability of construction: Give notice where building elements and features to which the ceiling systems relate are not square, straight or level.

10.4.3.3 PROTECTION

- A. Loading: Do not apply loads for which the suspension system is not designed.
- B. Ceiling materials: When necessary, remove and replace correctly using special tools and clean gloves, etc. as appropriate.

10.4.3.4 CLEANING

- A. Clean exposed surfaces of suspended ceilings, including trim, edge mouldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented or bent units.
- B. Institute required protection for suspended ceilings, including temperature and humidity limitations and dust control, so that work will be without damage and deterioration at time of Substantial Completion.

10.5 INTERIOR STONework**10.5.1 GENERAL****10.5.1.1 SCOPE OF THE WORKS**

- A. Extent of interior stonework is indicated on drawings and in schedules.
- B. Interior stonework includes (but is not limited to) the following:
 1. Marble/ Granite tile flooring including stair treads and risers.
 2. Marble/ Granite skirtings and thresholds.
 3. Marble/ Granite cladding facing to walls and columns.
 4. Marble/ Granite partitions to WC cubicles and urinals.
- C. Stonework incorporated into joinery and architectural woodwork is specified in the appropriate section.
- D. Sealing joints in interior stonework is specified in the Joint Sealers section.

10.5.1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for each type of stone, stonework accessory and other manufactured product required.
- B. Samples: Submit sets of samples for each colour, grade, finish, type and variety of stone consisting of units not less than 300 mm x 300 mm. Include 2 or more units in each set of samples showing the full range of appearance characteristics to be expected in completed work.

10.5.1.3 QUALITY ASSURANCE

- A. Single Source Responsibility for Stone: Obtain each colour, grade, finish, type and variety of stone from a single source with adequate resources to provide materials of consistent quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the Work.
- B. Standards: Unless otherwise approved by the Engineer, comply with recommendation of:
 1. Cyprus Standards:

CYS EN 1467	Natural stone – Rough blocks – Requirements
CYS EN 1468	Natural stone – Rough slabs - Requirements
CYS EN 1469	Natural stone products. Slabs for cladding. Requirements
CYS EN 1925	Natural stone test methods – Determination of water absorption coefficient by capillarity.
CYS EN 1926	Natural stone test methods – Determination of uniaxial compressive strength.

CYS EN 1936	Natural stone test methods – Determination of real density and apparent density, and of total and open porosity.
CYS EN 12057	Natural stone products – Modular tiles – Requirements.
CYS EN 12058	Natural stone products. Slabs for floors and stairs. Requirements.
CYS EN 12370	Natural stone test methods – Determination of resistance to salt crystallisation.
CYS EN 12371	Natural stone test methods – Determination of frost resistance.

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CYS EN 12372	Natural stone test methods – Determination of flexural strength under concentrated load.
CYS EN 12407	Natural stone test methods – Petrographic examination.
CYS EN 12440	Natural stone – Denomination criteria.
CYS EN 12670	Natural stone – Terminology.
CYS EN 13161	Natural stone test methods – Determination of flexural strength under constant moment.
CYS EN 13364	Natural stone test methods – Determination of the breaking load at dowel hole.
CYS EN 13373	Natural stone test methods – Determination of geometric characteristics on units.
CYS EN 13755	Natural stone test methods – Determination of water absorption at atmospheric pressure.
CYS EN 13919	Natural stone test methods – Determination of resistance to ageing by SO ₂ action in the presence of humidity.
CYS EN 14066	Natural stone test methods – Determination of resistance to ageing by thermal shock.
CYS EN 14146	Natural stone test methods – Determination of the dynamic modulus of elasticity (by measuring the fundamental resonance frequency).
CYS EN 14147	Natural stone test methods – Determination of resistance to ageing by salt mist.
CYS EN 14157	Natural stone test methods – Determination of the abrasion resistance.
CYS EN 14158	Natural stone test methods – Determination of rupture energy.
CYS EN 14205	Natural stone test methods – Determination of Knoop hardness.
CYS EN 14231	Natural stone test methods – Determination of the slip resistance by means of the pendulum tester.
CYS EN 14579	Natural stone test methods – Determination of sound speed propagation.
CYS EN 14580	Natural stone test methods – Determination of static elastic modulus.
CYS EN 14581	Natural stone test methods – Determination of linear thermal expansion coefficient.
CYS EN ISO 3506	Mechanical properties of corrosion-resistant stainless-steel fasteners.

British Standards:

BS 6213	Selection of construction sealants. Guide.
BS 8298	Code of practice for design and installation of natural stone cladding and lining.

10.5.1.4 **DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to project in undamaged condition.
- B. Store and handle stone and related materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage, chipping, or other causes.
 - 1. Do not use pinch or wrecking bars.
 - 2. Lift with wide-belt type slings where possible; do not use wire rope or ropes containing tar or other substances which might cause staining. If required for moving stone, use wood rollers with cushions at end of wood slides.
 - 3. Store stones on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stones to allow air to circulate around, to distribute weight evenly and to prevent breakage or cracking of stones.
 - 4. Store cementitious materials off the ground, under cover and in dry location.

10.5.1.5 **SITE CONDITIONS**

- A. Do not set stone when air temperature or temperature of materials is below 10 deg. C.

10.5.2 PRODUCTS**10.5.2.1 MATERIALS, GENERAL**

- A. Comply with referenced standards and other requirements indicated applicable to each type of material required.
- B. Provide premier quality matched stones obtained from an approved a single quarry for each type, variety, colour and quality of stone required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to the Engineer for aesthetic effect.
- C. Provide stones which are free from vents, cracks, fissures, discoloration or other surface defects which may adversely affect strength or appearance.

10.5.2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: To CYS EN 197-1. Provide grey or white cement as needed to produce mortar colour required.
- B. Hydrated Lime: To CYS EN 459-1
- C. Aggregate: To CYS EN 13139; non-staining and as indicated below:
 - 1. For joints narrower than 6 mm use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent the No. 16 sieve.
 - 2. For pointing mortar use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. White Aggregates: Natural white sand or ground white stone.
- D. Coloured Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in stone mortars.
- E. Latex-Portland Cement Grout: to CYS, of the following composition and requirements:
 - 1. Latex additive (water emulsion) serving as a replacement for part or all of gauging water, added at job site to pre-packaged dry grout mix.
 - 2. Manufacturers standard. Pre-packaged latex Portland cement dry mix grout specified or supplied by latex manufacturer.
 - 3. Provide grout colours approved by the Engineer to match colour of stone.
- F. Water: Clean, non-alkaline and potable.

10.5.2.4 STONE ACCESSORIES

- A. Stone Anchors: Stainless steel, type and size shown or, if not shown, as required and approved by the Engineer for securely anchoring and fastening interior stonework in place.
- B. Setting Buttons: Lead or resilient plastic buttons, non-staining to stone, sized to suit joint thicknesses and bed depths of stonework involved.
- C. Metal Edge Strips: Stainless steel strips, 3 mm wide at top edge, with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.
- D. Cleaner: Provide stone cleaners of proper formulation for kinds of stones, finishes and applications indicated, as recommended by stone producer and, if sealer specified, by sealer manufacturer. Do not use acid-type cleaning agents or other cleaning compounds containing caustic or harsh fillers, except where expressly approved by stone producer for type of condition involved.
- E. Sealer for Floors: Colourless, slip and stain resistant sealer which will not affect colour or physical properties of stone surface, as recommended by sealer manufacturer and by stone producer for application intended.

10.5.2.5 MORTAR AND GROUT MIXES

- A. General: Do not add admixtures including colouring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.
- B. Mixing: Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with CYS or other acceptable standard, as applicable, for mixing time and water content.
- C. Spotting Plaster: Stiff mix of moulding plaster and water.
- D. Setting Mortars and Grout for Flooring: Comply with mixing requirements of referenced CYS or other acceptable standards for materials and installation methods.
- E. Pointing Mortar. Provide pointing mortar mixed to match Engineer's approved sample and complying with requirements indicated above for setting mortar including type and the following:
 - 1. Coloured Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce colour required. Do not exceed pigment-to-cement ratio of 1-to-10, by weight.

10.5.2.6 FABRICATION

- A. General: Fabricate interior stonework in sizes and shapes required to comply with requirements indicated, including details on Drawings and final shop drawings.
- B. Cut and drill sinkages and holes in stones for anchors, fasteners, supports and lifting devices as indicated or needed to set stonework securely in place; shape beds to fit supports.
- C. Cut stones accurately to produce pieces of thickness, size, shape and profiles indicated or required and within fabrication tolerances recommended by applicable stone association or stone source, for faces, edges, beds, and backs.
- D. Contiguous Work: Provide chases, reveals, reglets, openings and similar features as required to accommodate contiguous work. Close-up openings in stonework when other work is in place, with stonework which matches that already set.
- E. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples and field-constructed mock-ups.
- F. Pattern Arrangement: Cut fabricate and arrange marble panels, including veining and other natural markings to form patterns indicated.
- G. Carefully inspect finished stones for compliance with requirements relative to qualities of appearance, material and fabrication; replace defective stones with ones that do comply.
 - 1. Natural variations in appearance are acceptable if installed stones match range of colours and other appearance characteristics represented in approved samples and field-constructed mock-ups.

10.5.3 EXECUTION**10.5.3.1 PREPARATION**

- A. Prior to setting, clean stone surfaces to remove soil, stains and foreign materials. Clean stones by thoroughly scrubbing stones with fibre brushes followed by a thorough drenching with clean water. Use only mild cleaning compounds that contain no caustic or harsh filler or abrasives.

10.5.3.2 SETTING STONE, GENERAL

- A. Execute stonework by skilled tradesmen, and employ skilled stone fitters at the site to perform any necessary field cutting as stones are set.
 - 1. Use power saws to cut stones; produce exposed edges which are cut straight and true.

- B. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework in place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
- C. Construction Tolerances: Set stones to comply with the following tolerances:
1. Variation from Plumb: For lines and surfaces of columns, walls and arises do not exceed 6mm in 3m, 10mm in a story height or 6m maximum, nor 15mm in 12m or more. For external corners, expansion joints and other conspicuous lines, do not exceed 6mm in any story or 6m maximum, nor 15mm in 12m or more.
 2. Variation from Level: For grades indicated, horizontal grooves and other conspicuous lines do not exceed 15mm in any bay or 6mm maximum, nor 20mm in 12m or more.
 3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 15mm in any bay or 500mm maximum, nor 20mm in 12m or more.
 4. Variation in surface plane of flooring: Do not exceed 3mm from level or slope indicated, when tested with 3m straight edge.
 5. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus 6mm nor plus 15mm.
- D. Expansion and Control Joints: Provide for expansion and control joints of widths and at locations indicated, or as required.
1. Sealant for expansion and other joints is specified in Joint Sealers Section.

10.5.3.3 **INSTALLATION OF STONE FLOORING**

- A. Extend flooring into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.
- B. Accurately form intersections and returns: Perform cutting and drilling of stones without marring visible surfaces. Carefully grind cut edges of stones abutting trim, finish or built-in items for straight aligned joints. Fit stones closely to electrical outlets, piping, fixtures and other penetrations so that plates, collars, or covers overlap stones.
- C. Metal Edge Strips: Install at locations indicated or where exposed edge of stone flooring meets carpet, wood, or other flooring which finishes flush with top of stones.
- D. Jointing Pattern for Tile: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout tile work and centre tile fields in both directions in each space or on each wall area.
- E. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise shown.
- F. Match tiles for colour and other appearance characteristics by using tiles in same sequence as manufactured and packaged.
- G. Stone Flooring Set in Portland Cement Mortar Bed:
1. Saturate concrete subfloor with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
 2. Apply slurry of cement grout over surface of concrete subfloor about 15 minutes prior to placing setting bed. Limit area to avoid its drying out prior to placing setting bed. Mix slurry to a consistency similar to that of thick cream and consisting of either neat cement and water, or cement, sand and water. Do not exceed 1.5mm thickness for slurry coat.
 3. Mix setting bed in proportions of 1:2:6 cement/lime/sand to quantity of water to produce a stiff mixture with a moist surface when setting bed is ready to receive stone flooring.
 4. Spread and screed setting bed to uniform thickness indicated to produce subgrade elevations required for accuracy shown. Mix and place only the amount which can be covered with stone prior to initial set. Cut back, bevel edge, remove and discard setting bed material which has reached initial set prior to placing stone.

5. Butter backs of stone flooring units until firmly bedded to proper finished floor elevation indicated. Set and level each stone unit in single operation, prior to initial set of cement bed; do not return to areas already set and disturb stone for levelling purposes.

H. Grouting Stone Flooring:

1. Mix grout consisting of factory prepared colour pigmented grout and liquid latex admixture in proportions recommended by manufacturer.
2. Grout joints in stone flooring units, except at expansion and control joints indicated as required to be filled with sealant. Finish grout flush with finished surface of stone. Fill all gaps and skips to produce a finished joint which is uniform in colour, smooth and without voids, pinholes, or low spots.
3. Remove grout spillage from face of stone as work progresses.
4. Cure grout by maintaining in a moist condition for 7 days.
5. Do not permit traffic on stone flooring during setting of units for at least 24 hours after final grouting of joints.

10.6 CONCRETE FLOOR SCREEDS

10.6.1 GENERAL

10.6.1.1 SCOPE OF THE WORKS

- A. Extent of concrete floor screeds is indicated on drawings and in schedules.
- B. Types of concrete floor screeds include:
 1. Standard concrete screeds with brush-applied finish.
 2. Standard concrete screeds with hardener admixture.

10.6.1.2 QUALITY ASSURANCE

- A. Comply with relevant requirements specified for cast in place concrete.

10.6.1.3 APPLICABLE CODES AND STANDARDS

- A. Cyprus Standards:

CYS EN 197-1	Cement. Composition, specifications and conformity criteria for common cements
CYS EN 12620	Aggregates for concrete.
CYS EN 13318	Screed material and floor screeds. Definitions.
CYS EN 13813	Screed material and floor screeds. Screed material. Properties and requirements.
CYS EN 13892	Methods of test for screed materials.
CYS EN 14016	Binders for magnesite screeds. Caustic magnesia and magnesium chloride.
- B. British Standards:

BS 4550	Methods of Testing Cement.
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10.6.2 PRODUCTS - CEMENT AND AGGREGATES

- A. Portland Cement:
- B. Standard Aggregates:

Fine aggregate, consisting of sand or crushed stone screening, clean, hard, free from deleterious matter. Grade by weight as follows:

3/8" :	100%
No.4 :	95 - 100%
No.8 :	80 - 90%
No.16 :	50 - 75%
No.30 :	30 - 50%
No.50 :	10 - 20%
No.100:	2 - 5%

C. Reinforcement:

DIN 488, welded steel wire fabric.

10.6.2.2 SCREED MIX AND THICKNESS

A. Standard Screed:

Design mix to produce screed material with the following characteristics:

Compressive strength: 25 N/mm² at 28 days

Slump: 20 cm maximum for concrete containing HRWR (super plasticiser) and 7.5 cm maximum for other concrete. Maximum W/C ratio: 0.51

B. Screed Thickness: Provide concrete floor screed thickness indicated on drawings and schedules, or as required.

1. Minimum thickness: 50mm

10.6.2.3 MIXING

A. Provide type mechanical mixer for mixing topping material at project site. Equip batch mixer with a suitable charging hopper, water storage tank, and a water-measuring device. Use only mixers which are capable of mixing aggregates, cement and water into a uniform mix within specified time, and of discharging mix without segregation.

B. Mix each batch of 1.5m³ or less for at least 1^{1/2} minutes after ingredients are in mixer. Increase mixing time 15 seconds for each additional 0.75m³ or fraction thereof.

C. Chemical Hardener: Colourless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 0.24 Kg. of fluosilicate per litre used to increase water and abrasion resistance and the durability of the screed. Such admixture shall provide a highly abrasion resistant surface to concrete floors by the "dry shake" method which ensures the hard wearing surface bonds monolithically to the base concrete.

1. Not to be used on concrete cured by curing compound.

D. Polypropylene Fibre Mesh Reinforcement:

1. "Fibermesh" or other equal and approved 100% polypropylene fibre mesh reinforcement shall be incorporated in to the mix to inhibit plastic cracking.

10.6.3 EXECUTION**10.6.3.1 CONDITION OF SURFACES**

A. Preparation of concrete slab: Remove dirt, loose material, oil, grease, paint or other contaminants, leaving a clean surface.

1. When base slab surface is smooth and unacceptable for good bonding, roughen surface by chipping or scarifying before cleaning.

2. Prior to placing screed mixture, thoroughly dampen slab surface but do not leave standing water. Over dampened surface, apply specified bonding compound. Place screed mix bonding compound has dried.

B. Joints: Mark locations of joints in base slab so that joints in top course will be placed directly over them. Provide movements joints to coincide with the location of the building expansion joints. Provide also constructions joints of PVC extruded strips, or similar approved, as shown on the drawings.

10.6.3.2 PLACING AND COMPACTINGA. Screeds are to be laid in areas not exceeding 9m² 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.

B. Spread screed mixture evenly over prepared base, bring to required level with straight-edge and strike off. After placement, do not work surface further until ready for floating. Begin floating when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power floats. Consolidate surface with power floats or by hand-floating if area is small or inaccessible to power units.

10.6.3.3 TROWEL FINISH

- A. After floating, begin first trowel finish operation using power trowels. Continue trowelling until surface is ready to receive final trowelling. Begin final trowelling when a ringing sound is produced as trowel is moved over surface.
- B. Consolidate concrete surface by final hand-trowelling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 3mm in 3m when tested with 3m straight-edge.

10.6.3.4 CURING AND PROTECTION

- A. 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.
- B. The whole of the screeded area shall be kept covered and wet for 7 days. Protect topping applications and finishes as specified for cast in place concrete. No moisture sensitive floor finish shall be laid unless a reliable moisture test shows that the screed is sufficiently dry to receive covering.

10.6.3.5 PERFORMANCES

- A. Failure of concrete screed to bond to substrate (as evidenced by a hollow sound when tapped), or disintegration or other failure of topping to perform as a floor finish, will be considered failure of materials and workmanship. Repair or replace screed in areas of such failures, as directed.

11.0 PAINTING**11.1 GENERAL****11.1.1 SCOPE OF THE WORKS**

- A. Extent of painting work is indicated on drawings, schedules and herein, and includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.
1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.
- B. Paint exposed surfaces whether or not colours are designated in "schedules" except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If colour or finish is not designated, the Engineer will select from standard manufacturer's colours or finishes available.
1. Painting includes field painting exposed bare and covered pipes and ducts (including colour coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
- C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
1. Prefinished items not to be painted include all factory-finished components such as:
 - a. Prefinished metal fabrications
 - b. Acoustic ceilings
 - c. Joinery and architectural woodwork
 - d. Elevator equipment
 - e. Finished mechanical and electrical equipment
 - f. Light fixtures
 - g. Switchgear
 - h. Distribution cabinets.
 - i. Overhead coiling door
 2. Concealed surfaces not to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
 - a. Foundation spaces
 - b. Furred areas
 - c. Suspended ceilings voids
 - d. Utility tunnels.
 - e. Pipe spaces
 - f. Duct shafts
 - g. Elevator shafts
 3. Finished metal surfaces not to be painted include:
 - a. Anodized aluminium
 - b. Stainless steel
 - c. Chromium plate
 4. Operating parts not to be painted include moving parts of operating equipment such as the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
 5. Labels: Do not paint over regulation or code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Related Sections: Other specification sections contain requirements that relate to painting; and include but are not necessarily limited to.
1. Metal fabrications.
 2. Joinery
 3. Metal door frames.
 4. Wood doors.
 5. Overhead coiling Door.

6. Mechanical and Electrical Engineering Service.

11.1.2 DEFINITIONS

- A. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

11.1.3 SUBMITTALS

- A. Product Data: Manufacturer's technical information, label analysis, and application instructions for each material proposed for use. List each material and cross-reference the specific coating and finish system and application. Identify each material by the manufacturer's catalogue number and general classification.
- B. Samples for verification and approval purposes: Define each separate coat, including block fillers and primers. Use representative colours when preparing samples for review. Resubmit until required sheen, colour, and texture are achieved.
1. Paint samples that are being submitted for Engineer's review shall be applied to 600mm by 600mm panels of the actual substrate to which the paint will be applied, using painting procedures including primers, number of finish coats and painting methods that are proposed for the finished product, showing true colour, texture and sheen.
 2. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.
 3. Submit samples on the following substrates for the Engineer's review of colour and texture only:
 - a. Concrete. Provide two 100mm square samples for each colour and finish.
 - b. Concrete Masonry: Provide two 100mm by 200mm samples of masonry, with mortar joint in the centre, for each finish and colour.
 - c. Painted Wood: Provide two 600mm by 600mm samples of each colour and material on hardboard.
 - d. Stained or Natural Wood: Provide two 100mm by 200mm samples of natural and stained wood finish on actual wood surfaces.
 - e. On actual plastered and other types of wall surfaces to be painted, duplicate paint finishes of prepared samples. Provide full-coat finish samples on at least 10 sq.m. of surface, as directed, until required sheen, colour and texture is obtained; simulate finished lighting conditions for review of in place work by the Engineer.
 - f. Final acceptance of colours will be from these job applied samples.

11.1.4 QUALITY ASSURANCE

- A. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
- B. Applicable Standards:
1. Cyprus Standards:
CYS EN ISO 4624 Paints and varnishes. Pull-off test for adhesion.
 2. British Standards:
BS 3900 Methods of test for paint. Durability tests on paint films.
BS 6150 Painting of buildings. Code of practice.

11.1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Standard Specification number, if applicable.
 4. Manufacturer's stock number and date of manufacture.
 5. Contents by volume, for pigment and vehicle constituents.
 6. Thinning instructions.

7. Application instructions.
8. Colour name and number.

- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7 deg. C. Maintain containers in storage in a clean condition, free of foreign materials and residue.
1. Protect from freezing. Keep storage area neat and orderly. Remove lily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and application.

11.1.6 SITE CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 10 deg C and 32 deg. C.
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 7 deg C and 35 deg C.
- C. Do not apply paint in dust storms, rain, fog, or mist; when the relative humidity exceeds 85 percent, at temperatures less than 3 deg C above the dew point, or to damp or wet surfaces.
1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

11.2.1 PRODUCTS

11.2.2 MATERIALS, GENERAL

- A. Material Quality: Provide only best quality grades for the various types of coatings and paint systems required, as regularly manufactured and recommended by acceptable paint manufacturers. Paint material containers not displaying manufacturer's names and product identification will not be acceptable.
1. Conform to Cyprus/ British Standards or alternative equivalent standards acceptable to the Engineer which establish minimum acceptable qualitative and quantitative requirements for paint materials. Provide written certification from paint manufacturers that materials provided meet or exceed these minimums.
- B. Colour Pigments: Pure, non-fading, applicable types to suit substrates and services indicated.
1. Lead contents in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint by weight.

11.2.3 PREPARATION

- A. General Procedures: Remove, hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- B. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.
1. Provide barrier coats over incompatible primers or remove and re-prime. Notify Engineer in writing any problems anticipated with using the specified finish-coat material with substrates primed by others.
 2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

- a. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
 - b. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, and rinse; allow to dry and vacuum before painting.
 3. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler.
 - a. Prime, stain, or seal wood required to the job-painted immediately upon delivery to job. Prime edges, ends, faces, underside, and backsides of such wood, including cabinets, counters, cases, panelling.
 - b. When transparent finish is required, use spar varnish for back priming.
 - c. Backprime panelling on interior partitions only where masonry, plasters, or other wet wall construction occurs on backside.
 - d. Seal tops, bottoms, and cut-outs of unprimed wood doors with a heavy coat of varnish or equivalent sealer immediately upon delivery to job.
 4. Ferrous Metals: Clean non galvanized ferrous-metal surface that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances by use of solvent or mechanical cleaning methods as recommended by the paint system manufacturer and in accordance with requirements of the Engineer.
 - a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.
 5. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum based solvents so that the surface is free of oil and surface contaminants.
- C. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.
1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 3. Use only thinners approved by the paint manufacturer, and only within recommended limits.
- D. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the colour of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

11.2.4 **APPLICATION**

- A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
- B. Do not paint over dirt, rust, scale, grease, moisture; or any scuffed, spattered, flaking surfaces, or in conditions detrimental to formation of durable paint films and coatings.
1. Paint colours, surface treatments, and finishes are indicated in "schedules".
 2. Provide finish coats that are compatible with primers used.
 3. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

4. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, colour, and appearance. Give special attention to ensure that surfaces, including edges, comers, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
 5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector cover, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.
 6. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment of furniture with prime coat only before final installation of equipment.
 7. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, nonspecular black paint.
 8. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
 10. Finish exterior doors on tops, bottoms, and side edges same as exterior faces. Sand lightly between each succeeding enamel or varnish coat.
 12. Omit primer on metal surfaces that have been shop-primed and touch up painted.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pre-treated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- D. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the paint or coating manufacturer.
- E. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces.
- F. Mechanical items to be painted include but are not limited to:
1. Piping, pipe hangers and supports
 2. Heat exchangers
 3. Tanks
 4. Ductwork
 5. Insulation
 6. Supports
 7. Motors and mechanical equipment
 8. Accessory items.
- G. Electrical items to be painted include but are not limited to:
1. Conduit and fittings
 2. Switchgear.
- H. Prime Coats: Before application of finish coats, apply a prime coat of material as recommended by the manufacturer to material that is required to be painted or finished and has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing.
- I. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surface imperfections.
- J. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, colour, appearance, and coverage. Cloudiness, spotting, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable.
- K. Transparent (clear) Finishes: Use multiple coats to produce glass-smooth surface film of even lustre. Provide a finish free of laps, cloudiness, colour irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.

- L. Completed Work: Match approved samples for colour, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

11.2.5 CLEANING

- A. Clean up: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
- B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

11.2.6 PROTECTION

- A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to the Engineer.
- B. Provide "wet paint" signs in Greek/English, and as required protecting newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.
1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

11.2.7 EXTERIOR PAINT SCHEDULE

- A. General: Provide the following paint systems for the various substrates indicated.
- B. Ferrous Metal: Primer is not required on shop-primed items.
1. Full-Gloss Alkyd Enamel: 2 finish coats over primer.
 - a. Primer: Synthetic Rust-Inhibiting Primer.
 - b. First and Second Coats: Alkyd Gloss Enamel.
 2. Lustreless Alkyd Enamel: 2 finish coats over primer
 - a. Primer: Synthetic Rust-Inhibiting Primer.
 - b. First and Second Coats: Lustreless Alkyd Enamel.
- C. Zinc-Coated Metal:
1. Full-Gloss Alkyd Enamel: 2 finish coats over primer.
 - a. Primer: Galvanized Metal Primer
 - b. First and Second Coats: Alkyd Gloss Enamel

11.2.8 INTERIOR PAINT SCHEDULE

- A. General: Provide the following paint systems for the various substrates, as indicated.
- B. Concrete and Plasters.
1. Lustreless (Flat) Emulsion Finish: 3 coats
 - a. Primer: Latex-Based Interior Flat Paint.
 - b. Under Coat: Latex-Based Interior Flat Paint.
 - c. Finish Coat: Latex-Based Interior Flat Paint.
 2. Odourless Lustreless (Flat) Latex Finish: 3 coats.
 - a. Primer: Latex-Based Interior Flat Paint
 - b. First Coat: Latex-Based Interior Flat Paint
 - c. Second Coat: Interior Flat Odourless Alkyd Paint.
 3. Semi-gloss Enamel Finish: 3 coats with total dry film thickness not less than: 0.09 mm, on concrete, 0.06 mm on plaster.
 - a. Primer: Latex-Based Interior Flat Paint
 - b. Undercoat: Interior Enamel Undercoat.
 - c. Finish Coat: Interior Semi-gloss Odourless Alkyd Enamel.
 4. Plastic Coating Finish: Multiple coating systems including preparation sealer, primer and undercoats; applied in strict accordance with manufacturer's recommendations and instructions for substrate and purpose of use.

- a. Purpose: Provision of a heavy duty washable, monolithic and anti-bacterial surface finish to cement plastered walls and ceilings in hospital rooms and areas requiring a high degree of cleanliness and hygiene.
- C. Concrete Masonry Units:
1. Lustreless (Flat) Emulsion Finish: 2 finish coats over filled surface.
 - a. Latex Block Filler.
 - b. First and Second Coats: Latex-Based Interior Flat Paint
 2. Semi-gloss Alkyd Enamel Finish: 2 coats over filled surface with total dry film thickness not less than 0.09 mm, excluding filler coat.
 - a. Latex Block Filler
 - b. Undercoat: Interior Enamel Undercoat.
 - c. Finish Coat: Interior Semi-gloss Odourless Alkyd Enamel.
- D. Painted Wood and Hardboard:
1. Semi-gloss Enamel Finish: 3 coats.
 - a. Undercoat: Interior Enamel Undercoat.
 - b. First and Second Coats: Interior Semi-gloss Odourless Alkyd Enamel.
 2. Full-Gloss Enamel Finish: 3 coats.
 - a. Undercoat: Interior Enamel Undercoat.
 - b. First and Second Coats: Alkyd Gloss Enamel.
- E. Stained Wood:
1. Full Gloss Stained Varnish Finish: 3 Finish coats over stain plus filler on open grain wood.
 - a. Stain Coat: Semi-transparent exterior oil stain
 - b. Filler Coat on Open Grain Wood: Paste wood fillers. Wipe before first varnish coat.
 - c. First, Second and Third Finish Coats: Exterior spar varnish.
 2. Flat Stain, No Finish: 1 coat.
 - a. First Coat: Semi-transparent oil stain.
- F. Natural Finish Wood:
1. Full Gloss Varnish Finish: 3 finish coats over filler on open coats grain wood.
 - a. Filler Coat on Open Grain Wood: Paste wood filler. Wipe before first varnish coat.
 - b. First. Second and Third Coats: Exterior spar varnish.
- G. Ferrous Metal:
1. Lustreless (Flat) Finish: 2 finish coats over primer with total dry film thickness not less than 0.06 mm
 - a. Primer: Synthetic Rust-Inhibiting Primer.
 - b. First and Second Coats: Later-Based Interior Flat Paint.
 2. Semi-gloss Enamel Finish: 2 coats over primer with total dry film thickness not less than 0.06 mm.
 - a. Primer: Synthetic Rust-Inhibiting Primer.
 - b. Undercoat: Interior Enamel Undercoat.
 - c. Finish Coat: Interior Semi-gloss Odourless Alkyd Enamel.
- H. Zinc-Coated Metal:
1. Lustreless (Flat) Finish: 2 finish coats over primer with total dry film thickness not less than 0.06 mm.
 - a. Primer: Galvanized Metal Primer.
 - b. First and Second Coats: Latex-Based Interior Flat Paint.
 2. Semi-gloss Finish: 2 coats over primer, with total dry film thickness not less than 0.06 mm.
 - a. Primer: Galvanized Metal Primer.
 - b. Undercoat: Interior Enamel Undercoat.
 - c. Finish Coat: Interior Semi-gloss Odourless Alkyd Enamel.
 3. Full-Gloss Enamel Finish: 2 Coats over primer with total dry film thickness not less than 0.06 mm.
 - a. Primer: Galvanized Metal Primer.
 - b. Undercoats: Interior Enamel Undercoat.
 - c. Finish Coat: Alkyd Gloss Enamel.

12.0 PLASTERBOARD DRY LININGS/ PARTITIONS**12.1.1 GENERAL****12.1.1.1 SCOPE OF THE WORKS**

- A. Extent of plasterboard dry linings/ partitions is indicated on drawings and schedules.
- B. Types of work include:
 - 1. Plasterboard dry linings/ partitions.
- C. Gypsum plaster skim coat to plasterboard is specified elsewhere.
- D. Painting is specified elsewhere.

12.1.1.2 STANDARD OF WORKMANSHIP

- A. Generally: In considering standards of workmanship which will be expected, the Contractor is to note that a high standard of finished workmanship and precision in assembly and fixing of components is required and that an exceptional degree of care will be needed to reach the required standard.
- B. Concealed Services: Systems are to be capable of accommodating concealed lighting and power lines, associated switches and outlets, supports for plumbing and other fixtures, communication and cable trunking as required.
- C. Design Criteria: Systems must not rely on ceiling support frames and grids for lateral support. Provide all metalwork necessary if required, and as indicated, for attachment to ceiling structure and forward to suspended ceiling sub-contractor/ Contractor, for fixing suspended ceiling grid..

12.1.1.2 QUALITY ASSURANCE

- A. Source of Materials: Provide materials obtained from one source acceptable to the Engineer for plasterboard and accessories.
- B. Coordination of Work: Coordinate layout and installation of dry lining/ partition components with other work supported by, or penetrating through partitions, including light fixtures, HVAC equipment, fire-suppression system components (if any), and suspended ceiling units and suspension system components (if any), etc.

12.1.1.3 APPLICABLE CODES AND STANDARDS

- A. Cyprus Standards:

CYS EN 309	Particleboards. Definition and classification.
CYS EN 311	Wood-based panels. Surface soundness. Test method.
CYS EN 313	Plywood. Classification and terminology.
CYS EN 520	Gypsum plasterboards – Definitions, requirements and test methods.
CYS EN 1063	Glass in building. Security glazing.
CYS EN 1087-1	Particle boards. Determination of moisture resistance. Particle boards. Determination of moisture resistance. Boil test.
CYS EN 1363-1	Fire resistance tests. General requirements.
CYS EN 1364-1	Fire resistance tests for non-loadbearing elements. Walls.
CYS EN 1991-1-1	Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight and imposed loads for buildings.
CYS EN 1998-1	Eurocode 8. Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings.
CYS EN 10326	Continuously hot-dip coated strip and sheet of structural steels. Technical delivery conditions.
CYS EN 10327	Continuously hot-dip coated strip and sheet of low carbon steels for cold forming. Technical delivery conditions.
CYS EN 12373-1	Aluminium and aluminium alloys. Anodizing. Method for specifying decorative and protective anodic oxidation coatings on aluminium.

CYS EN 12400	Windows and pedestrian doors - Mechanical durability - Requirements and classification.
CYS EN 12600	Glass in building – Pendulum test – Impact test method and classification for flat glass.
CYS EN 13162	Thermal insulation products for buildings.
CYS EN 13279	Gypsum binders and gypsum plasters.
CYS EN 13501-1	Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests.
CYS EN 13501-2	Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services.
CYS EN 13658-1	Metal lath and beads – Definitions requirements and test methods – Part 1: Internal plastering.
CYS EN 13815	Fibrous gypsum plaster casts – Definitions, requirements and test methods.
CYS EN 13915	Prefabricated gypsum plasterboard panels with a cellular paperboard core – Definitions, requirements and test methods.
CYS EN 13950	Gypsum plasterboard thermal/acoustic insulation composite panels – Definitions requirements and test methods.
CYS EN 13963	Jointing materials for gypsum plasterboards – Definitions, requirements and test methods.
CYS EN 14190	Gypsum plasterboard products from reprocessing – Definitions, requirements and test methods.
CYS EN 14195	Metal framing components for gypsum plasterboard systems – Definitions requirements and test methods.
CYS EN 14496	Gypsum based adhesives for thermal/acoustic insulation composite panels and plasterboards – Definitions, requirements and test methods.
CYS EN 20140	Acoustics. Measurement of sound insulation in buildings and of building elements.
CYS EN ISO 140-3	Acoustics – Measurement of sound insulation in buildings and of building elements – Part 3: Laboratory measurements of airborne sound insulation of building elements (ISO 140-3:1995).
CYS EN ISO 717-1	Acoustics – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation (ISO 717-1:1996).
CYS EN ISO 717-2	Acoustics – Rating of sound insulation in buildings and of building elements – Part 2: Impact sound insulation (ISO 717-2:1996).
CYS EN ISO 3506	Mechanical properties of corrosion-resistant stainless-steel fasteners.
CYS EN ISO 4624	Paints and varnishes. Pull-off test for adhesion.

B.	British Standards:	
	BS 476-6	Fire tests on building materials and structures. Method of test for fire propagation for products.
	BS 476-7	Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.
	BS 476-20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles).
	BS 476-22	Fire tests on building materials and structures. Methods for determination of the fire resistance of non-loadbearing elements of construction. Determination of the Fire Resistance of Uninsulated Doorsets and Shutter Assembly.
	BS 476-31.1	Fire tests on building materials and structures. Methods for measuring smoke penetration through doorsets and shutter assemblies. Method of measurement under ambient temperature conditions.
	BS 952-1	Glass for Glazing - Part 1: Classification.
	BS 952-2	Glass for glazing. Terminology for work on glass.
	BS 1186	Timber for and workmanship in joinery.
	BS 1230	Gypsum Plasterboard.
	BS 1449-1.1	Steel plate, sheet and strip. Carbon and carbon-manganese plate, sheet and strip. General specification.
	BS 1474	Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections.
	BS 1982	Fungal resistance of panel products made of or containing materials of organic origin.

BS 2989	Specification for continuously hot-dip zinc coated and iron-zinc alloy coated steel flat products: tolerances on dimensions and shape.
BS 3900	Methods of test for paint. Durability tests on paint films.
BS 3958	Thermal insulating materials.
BS 4255-1	Specification for non-cellular gaskets.
BS 4842	Specification for liquid organic coatings for application to aluminium alloy extrusions, sheet and preformed sections for external Engineerural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with liquid organic coatings.
BS 5051-1	Security glazing Part 1: Glazing for interior use.
BS 5234-2	Partitions (including matching linings). Specification for performance requirements for strength and robustness including methods of test.
BS 5357	Code of practice for installation and application of security glazing.
BS 5368	Methods of testing windows.
BS 5368-1	Air permeability test.
BS 5588	Fire precautions in the design and, construction and use of buildings.
BS 5606	Guide to accuracy in building.
BS 5713	Specification for hermetically sealed flat double glazing units.
BS 5821	Methods for rating the sound insulation in buildings and of building elements.
BS 5950	Structural use of steelwork in building.
BS 6161	Methods of test for anodic oxidation coatings on aluminium and its alloys.
BS 6180	Barriers in and about buildings. Code of practice.
BS 6206	Impact performance requirements for flat safety glass and safety plastics for use in buildings.
BS 6213	Selection of construction sealants. Guide.
BS 6262	Code of Practice for glazing for buildings.
BS 6375	Performance of windows.
BS 6396	Electrical systems in office furniture and office screens. Specification.
BS 6452	Beads for internal plastering and dry lining.
BS 6496	Specification for powder organic coatings for application and stoving to Aluminium alloy extrusions, sheets and preformed sections for external Engineerural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings.
BS 7364	Specification for galvanized steel studs and channels for stud and sheet partitions and linings using screw fixed gypsum wallboards.
BS 7371	Coatings on metal fasteners.
BS 7671	Requirements for electrical installations. IEE Wiring Regulations.
BS 8000-8	Workmanship on building sites. Code of practice for plasterboard partitions and dry linings.
BS 8118	Structural use of aluminium.
BS 8118-2	Specification for materials, workmanship and protection.
BS 8212	Code of practice for dry lining and partitioning using gypsum plasterboard.
BS 8213	Windows, doors and roof lights.
BS 8220	Guide for security of buildings against crime.

12.1.1.4 **SUBMITTALS**

- A. Product Data: Submit manufacturer's product data for plasterboard dry linings/ partitions to show compliance with the design intent and the Specification. Provide evidence that all products proposed are compliant with all other interfacing products and materials.

12.1.1.5 **DELIVERY, STORAGE AND HANDLING**

- A. Store, handle and protect materials and components in accordance with manufacturer's recommendations.
- B. Do not deliver to site any components which cannot be immediately unloaded into suitable conditions of storage. Follow manufacturer's recommendations.
- C. Deliver and handle materials and components so as to avoid overstressing distortion and damage.

12.1.1.6 GENERAL PREPARATION

- A. Preparation of Masonry to Receive Wall Linings:
1. General: Suitable to receive lining system. Redundant fixtures and services removed. Cutting, chasing and making good completed.
 2. Holes, gaps, service penetrations, perimeter junctions and around openings: Seal.
 3. Adhesive fixings: Prepare substrate to achieve effective bonding.
 - a. Contaminants: Remove loose material, dirt, grease, oil, paper, etc.
 - b. Absorption: Control by dampening, priming or applying bonding agents as necessary.
- B. Additional Supports:
1. Framing: Accurately position and securely fix to give full support to:
 - a. Partition heads running parallel with, but offset from main structural supports.
 - b. Fixtures, fittings and service outlets. Mark framing positions clearly and accurately on linings.
 - c. Board edges and lining perimeter: As recommended by board manufacturer to suit type and performance of lining.
- C. Control Samples:
1. General: Complete areas of finished work and obtain approval of appearance before proceeding.
 - a. Type of partition / dry lining: One of each type.
 - b. Location/ Size: First complete partition run and lining bay.

12.1.2 PRODUCTS**12.1.2.1 GYPSUM PLASTERBOARD (VAPOUR CONTROL)**

- A. Type: To BS 1230-1, type 1.
1. Core density (minimum): 650 kg/m³.
 2. Moisture vapour resistance of backing layer (minimum): 150 MNs/g.
- B. Exposed surface and edge profiles: Suitable to receive specified finish.

12.1.2.2 GYPSUM PLASTERBOARD (MOISTURE RESISTANT)

- A. Type: To BS 1230-1, type 3 and 4.
1. Core density (minimum): 710 kg/m³.
 2. Core: Moisture resistant.
 3. Paper facings: Moisture resistant.
- B. Exposed surface and edge profiles: Suitable to receive specified finish.

12.1.2.3 GYPSUM PLASTERBOARD (IMPROVED FIRE PROTECTION)

- A. Type: To BS 1230-1, type 5.
1. Core density (minimum): 800 kg/m³.
 2. Core: Including fibres for improved cohesion.
- B. Exposed surface and edge profiles: Suitable to receive specified finish.

12.1.2.4 GYPSUM PLASTERBOARD (IMPACT RESISTANT)

- A. Type: To BS 1230-1, type 5.
1. Core density (minimum): 900 kg/m³.
 2. Paper facings: Heavy duty.
- B. Exposed surface and edge profiles: Suitable to receive specified finish.

12.1.2.5 GYPSUM PLASTERBOARD (IMPROVED SOUND INSULATION)

- A. Type: To BS 1230-1, type 1.
 - 1. Core density (minimum): 820 kg/m³.
- B. Exposed surface and edge profiles: Suitable to receive specified finish.

12.1.2.6 METAL STUD AND FURRING CHANNELS

- A. Type: Proprietary system.
 - 1. Hot dipped cold rolled zinc coated galvanised mild steel to CYS EN 10326.
 - 2. Minimum thickness: 0.55mm.
 - 3. Coating designation Z 275, suitable for end use.

12.1.2.7 ACOUSTIC/ FIRE INSULATION

- A. Type: Mineral wool insulation of a thickness and density to provide an overall acoustic performance and fire rating for the partition as specified on the drawings.

12.1.2.8 ACCESSORIES

- A. Accessories such as reinforcing tape, joint compounds, corner beads, external/ internal 90° angle tapes, gaskets etc., as recommended by system manufacturer.

12.1.3 EXECUTION

12.1.3.1 INSTALLATION AND WORKMANSHIP GENERALLY

- A. Provide materials and workmanship that after the particular surface has been finished, is free from defect or damage liable to impair its appearance when viewed under normal installed lighting conditions (daylight or artificial light) from a distance of 1 m at normal viewing height.
- B. Erect partitions in accordance with manufacturers' instructions.
- C. Where horizontal services run on solid walls behind the wall lining, cut furring channels to length and erect in two parts leaving a gap sufficient to accommodate the service, the interruption in the vertical channels to be not more than 300 mm, or as recommended by the manufacturer.
- D. Include for the provision and fixing to studs on either side and heads of all openings in partitions.
- E. Switch boxes and socket outlets are to be supported on brackets formed by timber noggings or form cut and bent metal channel, or metal fixing channel bridging studs. Care should be taken to ensure that fire resistance and sound insulation performances are not impaired by the incorporation and fixing of services.
- F. Where a sound reduction requirement exists, seal all air passages including around switch and outlet boxes with acoustic sealant or an alternative method agreed with the Engineer, or in accordance with manufacturer's recommendations.
- G. Position vertically at centres recommended by manufacturer, screw or otherwise securely fix at base, and fit into steel inner head channels.
- H. Vertical studs to be boxed or full height mullions to be provided for:
 - 1. Partition heights over 3300mm,
 - 2. Locally where glazing is required.
- I. Plasterboard on double skin system: Joints of inner gypsum board to be staggered to joints of outer boards.
- J. Jointing plasterboard: Tapered edge boards to be jointed with a mechanical jointing tool, by filling and tape

bedding, finishing, and applying a surface treatment to even out differences in surface texture and suction, using a composite gypsum jointing compound and a paper jointing tape, or as recommended by manufacturer. Jointing materials should not be used at or subjected to temperatures below 2°C during setting or hardening. Apply board in accordance with manufacturers' instructions using longest possible lengths, cutting only where absolutely necessary, using proprietary fixings to hold boards together.

12.1.3.2 DRY LININGS GENERALLY

- A. General: Use fixing, jointing, sealing and finishing materials, components and installation methods recommended by board manufacturer.
- B. Cutting plasterboards: Neatly and accurately without damaging core or tearing paper facing.
 - 1. Cut edges: Minimize, and position at internal angles wherever possible. Mask with bound edges of adjacent boards at external corners.
- C. Fixing boards: Securely and firmly to suitably prepared and accurately levelled backgrounds.

12.1.3.2 DRY LININGS GENERALLY

- D. Finishing: Neatly to give flush, smooth, flat surfaces free from bowing and abrupt changes of level.

12.1.3.3 METAL FRAMING FOR PARTITIONS/ WALL LININGS

- A. Setting out: Accurately aligned and plumb.
 - 1. Frame/ Stud positions: Equal centres to suit specified linings, maintaining sequence across openings.
 - 2. Additional studs/ framing:
 - a. To support vertical edges of boards.
 - b. To support fixtures, fittings and services: Accurately positioned and securely fixed.
- B. Fixing centres at perimeters (maximum): 600 mm.
- C. Openings: Form accurately.
 - 1. Doorsets: Use sleeved or boxed metal studs and/ or suitable timber framing to achieve strength grade requirements for framing assembly and adequately support weight of door.
 - 2. Services penetrations: Allow for associated fire stopping.

12.1.3.4 INSTALLING MINERAL WOOL INSULATION

- A. Fitting insulation: Closely butted joints and no gaps. Use fasteners to prevent slumping or displacement.
- B. Services:
 - 1. Electrical cables overlaid by insulation: Sized accordingly.
 - 2. Ceilings: Cut insulation around electrical fittings, etc.

12.1.3.5 SEALING GAPS AND AIR PATHS

- A. Location of sealant: To perimeter abutments and around openings.
 - 1. Pressurized shafts and ducts: At board-to-board and board-to-metal frame junctions.
- B. Application: To clean, dry and dust free surfaces as a continuous bead with no gaps.
 - 1. Gaps greater than 6 mm between floor and underside of plasterboard: After sealing, fill with jointing compound.

12.1.3.6 FIRE STOPPING AT PERIMETERS OF DRY LINING SYSTEMS

- A. Material: Tightly packed mineral wool or intumescent mastic/ sealant.
- B. Application: To perimeter abutments to provide a complete barrier to smoke and flame.

12.1.3.7 JOINTS BETWEEN BOARDS

- A. Tapered edged plasterboards:
 - 1. Bound edges: Lightly butted.
 - 2. Cut/ Unbound edges: 3 mm gap.
- B. Square edged plasterboards: 3 mm gap.
- C. Square edged fibre reinforced gypsum boards: 5 mm gap.

12.1.3.8 VERTICAL JOINTS

- A. Joints: Centre on studs.
 - 1. Partitions: Stagger joints on opposite sides of studs.
 - 2. Two layer boarding: Stagger joints between layers.

12.1.3.9 HORIZONTAL JOINTS

- A. Surfaces exposed to view: Horizontal joints not permitted. Seek instructions where height of partition/ lining exceeds maximum available length of board.
- B. Two layer boarding: Stagger joints between layers by at least 600 mm.
- C. Edges of boards: Support using additional framing.
 - 1. Two layer boarding: Support edges of outer layer.

12.1.3.10 FIXING PLASTERBOARD TO METAL FRAMING

- A. Partitions/ Wall linings: Fix securely and firmly at the following centres (maximum):
 - 1. Single layer boarding: To all framing at 300 mm centres. Reduce to 200 mm centres at external angles.
 - 2. Multi-layer boarding: Face layer at 300 mm centres, and previous layers around perimeters at 300 mm centres.
- B. Ceilings: 230 mm. Reduce to 150 mm at board ends and at lining perimeters.
- C. Position of screws from edges of boards (minimum): 10 mm.
 - 1. Screw heads: Set in a depression. Do not break paper or gypsum core.

12.1.4 FINISHING

12.1.4.1 SEAMLESS JOINTING TO PLASTERBOARDS

- A. Cut edges of boards: Lightly sand to remove paper burrs.
- B. Filling and taping: Fill joints, gaps and internal angles with jointing compound and cover with continuous lengths of paper tape, fully bedded.
- C. Protection of edges/ corners: Reinforce external angles, stop ends, etc. with specified edge/ angle bead.
- D. Finishing: Apply jointing compound. Feather out each application beyond previous application to give a flush, smooth, seamless surface.
- E. Nail/ Screw depressions: Fill with jointing compound to give a flush surface.
- F. Minor imperfections: Remove by light sanding.

12.1.4.2 SKIM COAT PLASTER FINISH

- A. Plaster type: As recommended by board manufacturer.
 - 1. Thickness: 2-3 mm.
- B. Joints: Fill and tape except where coincident with metal beads.
- C. Finish: Tight, matt, smooth surface with no hollows, abrupt changes of level or trowel marks.
- D. Fill minor indents and, after joint, angle and spotting treatments have dried, seal surface to even out texture and suction using dual purpose primer.

12.1.4.3 RIGID BEADS/ STOPS

- A. Type: Galvanized steel to BS 6452-1.

12.1.5 COMMISSIONING AND TESTING

- A. Carry out sound transmission loss tests conducted by an acceptable independent testing laboratory to confirm that performance requirements are met. Any partitions not meeting the performance criteria shall be demolished and rebuilt to the required standards at no cost to the Employer.
- B. Carry out electrical tests on the complete system on site to establish that system meets the electrical resistance requirements.
- C. Submit all reports covering the above tests in triplicate to the Engineer.

12.1.6 PROTECTION OF WORK

- A. Carry out protective treatments and other precautions required throughout construction period, to ensure that systems/ items will be without damage or deterioration (other than normal weathering) at Practical Completion. Making good to panels or panel finishes will not be permitted. Any such damaged panels shall be replaced by the Contractor at no cost to the Employer. Touching-up of minor damage to finishes on significant surfaces is at the discretion of the Engineer.

13.0 SANITARY FITTINGS AND BATHROOM ACCESSORIES**13.1.1 GENERAL****13.1.1.1 DESCRIPTION OF WORK**

- A. Furnish and install the sanitary fittings and bathroom accessories as indicated on the drawings and/or required by the Engineer.

13.1.1.2 SUBMITTALS

- A. Product Data for each item specified, including details of construction relative to materials, dimensions, gauges, profiles, method of mounting, specified options, finishes, and cleaning instructions.
- B. Samples: Full-size samples of each item for verification of design, operation, and finish requirements. Such samples will be accepted by the Engineer and after approval will be retained and used as a standard against which the manufactured articles will be compared. Any item falling below the standard of the approved samples will not, under any circumstances, be accepted. Incorporate approved samples into the finished work, provided they are identified and their locations noted.
- C. Certificates: Certificate for each item specified, attesting that the items meet the specified requirements.
- D. Warranty: Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

13.1.1.3 QUALITY ASSURANCE

- A. Standards: Comply and conform to CYS/ BS or alternative equivalent standards acceptable to the Engineer which establish minimum qualitative and quantitative requirements relevant to materials and finishes used in the production of sanitary fittings and bathroom accessories.
- B. Inserts and Anchorages: Furnish inserts and anchoring devices that must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.
- C. Delivery, storage and Handling: Comply with manufacturer's instructions for shipping, storing and handling sanitary fittings and bathroom accessories in order to avoid damage generally, abrasion of surface and deterioration of applied coatings. Store indoors, protected from moisture including condensation and from construction damage and vandalism.

13.1.1.4 SITE CONDITIONS

- A. Coordination: coordinate fitting locations, installation, and sequencing with other work to avoid interference and to assure proper installation, operation, adjustment, cleaning, and servicing of toilet accessory items.

13.2 PRODUCTS**13.2.1 MATERIALS, GENERAL****Sanitary Fittings and Brassware**

All materials used for the manufacture of sanitary appliances shall be first quality and shall be durable, impervious, and corrosion-resisting, always remain hygienic and have a smooth surface which can be easily cleaned.

13.2.1 MATERIALS, GENERAL

Materials, appliances and components shall conform to the following Cyprus/ British Standards.

A. Cyprus Standards:		
CYS EN 31	Pedestal wash basins. Connecting dimensions.	
CYS EN 32	Wall-hung wash basins. Connecting dimensions.	
CYS EN 33	Pedestal W.C. pans with close-coupled flushing cistern. Connecting dimensions.	
CYS EN 35	Pedestal bidets with over-rim supply. Connecting dimensions.	
CYS EN 36	Wall-hung bidets with over-rim supply. Connecting dimensions.	
CYS EN 37	Pedestal W.C. pans with independent water supply. Connecting dimensions.	
CYS EN 71-3	Safety of toys. Specification for migration of certain elements. (For toxicity).	
CYS EN 111	Wall-hung hand rinse basins. Connecting dimensions.	
CYS EN 274	Waste fittings for sanitary appliances.	
CYS EN 997	WC pans and WC suites with integral trap.	
CYS EN 1113	Shower hoses for (PN 10) sanitary tapware.	
CYS EN 1287	Sanitary tapware. Low pressure thermostatic mixing valves. General technical specifications.	
CYS EN 12056	Gravity drainage systems inside buildings.	
CYS EN 12540	Corrosion protection of metals. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and copper plus nickel plus chromium.	
CYS EN 12221	Changing units for domestic use.	
CYS EN 13310	Kitchen sinks. Functional requirements and test methods.	
CYS EN 14428	Shower enclosures. Functional requirements and test methods.	
B. British Standards:		
BS 1010-2	Specification for draw-off taps and stopvalves for water services (screw-down pattern). Draw-off taps and above-ground stopvalves.	
BS 1125	Specification for WC flushing cisterns (including dual flush cisterns and flush pipes).	
BS 1188	Specification for ceramic wash basins and pedestals.	
BS 1206	Specification for fireclay sinks: dimensions and workmanship.	
BS 1212	Float operated valves.	
BS 1254	Specification for WC seats (plastics).	
BS 1329	Specification for metal hand rinse basins.	
BS 1390	Specification for baths made from vitreous enamelled sheet steel.	
BS 1552	Specification for open bottomed taper plug valves for 1st, 2nd and 3rd family gases up to 200 mbar.	
BS 1876	Specification for automatic flushing cisterns for urinals.	
BS 2456	Specification for floats (plastics) for float operated valves for cold water services.	
BS 3402	Specification for quality of vitreous china sanitary appliances.	
BS 4880-1	Specification for urinals. Stainless steel slab urinals.	
BS 5412	Specification for low-resistance single taps and combination tap assemblies (nominal size $\frac{1}{2}$ and $\frac{3}{4}$) suitable for operation at PN 10 max. and a minimum flow pressure of 0.01 MPa (0.1 bar).	
BS 5504-1	Wall hung WC pan. Wall hung WC pan with close coupled cistern. Connecting dimensions.	
BS 5504-2	Wall hung WC pan. Wall hung WC pan with independent water supply. Connecting dimensions.	
BS 5505-3	Specification for bidets. Vitreous china bidets over rim supply only. Quality, workmanship and functional dimensions other than connecting dimensions.	
BS 5506-3	Specification for wash basins. Wash basins (one or three tap holes). Materials, quality, design and construction.	
BS 5520	Specification for vitreous china bowl urinals (rimless type).	
BS 5627	Specification for plastics connectors for use with horizontal outlet vitreous china WC pans.	
BS 6340	Shower units.	
BS 6465-1	Sanitary installations. Code of practice for the design of sanitary facilities and scales of provision of sanitary and associated appliances.	
BS 6465-2	Sanitary installations. Code of practice for space requirements for sanitary appliances.	
BS 6465-3	Sanitary installations. Code of practice for the selection, installation and maintenance of sanitary and associated appliances.	

13.2.2 FABRICATIONS, GENERAL

- A. General: No names or labels are permitted on exposed faces of sanitary fittings and bath accessory units. On either interior surface not exposed to view or on back surface, provide identification of each item by either a printed, waterproof label or a stamped nameplate indicating manufacturer's name and product model number.
- B. Surface-Mounted Bathroom Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Provide concealed anchorage and fasteners wherever possible of sturdy construction and with corrosion resistant surface. Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory.

13.3 EXECUTION**13.3.1 INSTALLATION GENERALLY**

- A. Sanitary Fittings: Install in accordance with manufacturer's instructions, using purpose made concealed fasteners appropriate to substrate and recommended by manufacturer of unit. Install units plumb, level and square, firmly anchored in locations and at heights indicated.

13.3.2 ADJUSTING AND CLEANING

- A. Adjust sanitary fittings and bathroom accessories and verify that mechanisms functions smoothly. Replace damaged or defective items.
- B. Clean and polish all exposed surface not more than 4 days prior to date scheduled for inspections intended to establish date for substantial completion, in strict accordance with manufacturer's recommendations after removing temporary labels and protective coatings. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

14.0 IRONMONGERY**14.1.1 GENERAL****A. Quantities:**

1. The Contractor shall be responsible for determining the proper quantity of ironmongery products to be applied to each opening. Items not specifically mentioned or indicated shall be supplied in type, quality and quantity required.
2. Final ironmongery schedule shall be based on the complete ironmongery requirements. The schedule shall list each opening in individual headings and by item number sequence. Each opening shall be listed showing location, door number, door and frame size, door and frame materials, hand of door, degree of opening, fire label identification and other details of the opening. Keying information shall be listed. The manufacturers' catalogue numbers shall be included in the item heading to properly identify the items scheduled.
 - a. Final draft of the schedule will be reviewed after samples, templates, shop drawings, delivery schedule, keying layout and other pertinent information have been submitted.

B. Samples:

1. Prior to submittal of the final ironmongery schedule and prior to final ordering of ironmongery, submit one sample of each exposed ironmongery unit, finished as specified, and tagged with full description for coordination with the schedule.
2. Samples will be returned to the Contractor. Units which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation be used in the work, within limitations of keying coordination requirements.

C. Submittal Sequence:

1. Submit schedule at earliest possible date particularly where acceptance of ironmongery schedule must precede fabrication of other work (e.g., hollow metal frames) which is critical in the project construction schedule and other information essential to the coordinated review of ironmongery schedule. These schedules must include the following information:
 - 1.1 Door number, location, hand type of door and frame.
 - 1.2 Hardware set number.
 - 1.3 Key symbol.
 - 1.4 Name of item.
 - 1.5 Manufacturer's name and reference.
 - 1.6 Material.
 - 1.7 Finish.

14.1.1.1 PRODUCT HANDLING

- A. Packaging of ironmongery shall be on a set by set basis.
- B. Inventory ironmongery jointly with representatives of the ironmongery supplier until each is satisfied that the count is correct.
- C. Provide secure lock-up for ironmongery delivered to the project, but not yet installed. Control the handling and installation of ironmongery items which are not immediately replaceable so that the completion of the work will not be delayed by ironmongery losses both before and after installation.

14.1.1.2 SITE CONDITIONS

- A. Coordination: Coordinate ironmongery with other work. Tag, each item or package separately, with identification related to the final ironmongery schedule and include basic installation instructions in the package. Provide ironmongery items of proper design for use on doors and frames of the types, thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function. Deliver individually labelled and packaged ironmongery items at the proper times to the proper locations (shop or project site) for installation.

14.2 EXECUTION**14.2.1 INSTALLATION**

- A. Install each ironmongery item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install ironmongery onto or into surfaces which are later to be painted or finished in another way coordinate removal, storage and reinstallation or application of surface protection with finishing work specified in other sections. Do not install surface-mounted items until finishes have been completed on the substrate.
- B. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- C. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

14.2.2 ADJUST AND CLEAN

- A. Adjust and check each operating item of ironmongery and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.
- B. Final Adjustment: Wherever ironmongery installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all ironmongery items in such space or area. Clean operating items as necessary to restore proper function and finish of ironmongery and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

15.0 **EXTERNAL WORKS****15.1** **ROADWORKS, PARKING AREAS, KERBS AND PAVEMENTS****15.1.1** **Generally**

- A. 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.

15.1.2 **Site Clearance**

- A. A working strip of 2 metres beyond the limits of the earthworks shall be cleared of all debris, bushes, vegetation and other obstructions. Trees and saplings shall not be cut down without the prior approval of the Engineer.
- B. 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 in layers, not exceeding 150mm, to at least 95% of the maximum dry density of the material achieved in test 13 of BS 1377.
- C. All materials arising from the site clearance shall be disposed of in tips off the Site to locations approved by the Engineer and the Contractor shall comply with the legislation governing the controlled tipping of refuse.

15.1.3 **Definitions**

- A. "Excavated level" shall denote the level at which excavation ceases, and upon which the first layer of fill is placed.
- B. "Embankment" shall denote the fill lower than 600 mm below the finished level of the road.
- C. "Sub-base" shall denote the material between the base and the sub-grade.
- D. "Sub-grade" shall denote the top layer of fill in embankments or the existing ground in cut.
- E. "Base" shall denote the material immediately below the base course.
- F. "Water bound Macadam" or "Dense Bitumen Macadam" as shown on the Drawings.

15.1.4 **Compaction under Embankments**

- A. 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 -2.0% of the optimum moisture content.

15.1.5 **Cuttings**

- A. 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 Engineer.
- B. When unsuitable soils are encountered in cuttings or below shallow fills, they shall be excavated to the depth directed by the Engineer and carted to spoil.
- C. Maximum slope of cuttings to be 1:1. Cuttings to terminate at least 500mm away from pavements in order to protect the construction from possible erosion and sliding.
- D. On completion of the cutting, the ground shall be shaped and the top 250mm shall be compacted to at least 95% of the maximum dry density of the material achieved in test 13 of BS 1377, at +1% to -2% of the optimum moisture.

15.1.6 Embankments

- A. 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 or clayey material exhibiting expansive properties and very fine single graded materials unsuitable for compaction, shall not be accepted.
- B. The minimum requirements for the fill material for embankments other than rock fill shall be as follows:
- | | |
|-------------------------------------|--------|
| Maximum particle size: | 200 mm |
| Maximum passing 63 micron BS sieve: | 15% |
| Maximum Liquid Limit LL | 50 |
| Maximum Plasticity Index PI | 20 |
- C. Embankments shall be constructed in horizontal layers to the final road grade in compacted layers with thickness not exceeding 300 mm.
- D. The fill for embankments shall be compacted to at least 95% of its maximum dry density achieved in test 13 of BS 1377, at +1% to - 2% pf the optimum moisture content.

15.1.6.a Capping Layer material

- A. Capping layer material shall be obtained either from excavations on the Site or from an approved source off the Site complying with the following requirements:
1.

<u>BS sieve size (mm)</u>	<u>% by weight passing</u>
75	100
37.5	85-100
10	45-100
5	25 -85
0.600	8 -45
0.750	5 -10
 2. 4-day soaked CBR compacted to 95% of the maximum dry density at moisture content on the dry side of optimum achieved in test 13 of BS 1377 shall be at least 20%.
 3. Limit (LL) not more than 35%.
 4. Plasticity Index (PI) not more than 12% for the material passing the BS 0.425mm sieve.
 5. Plasticity Modulus (PM: product of PI and percentage passing BS 0.425 mm sieve) not more than 250.
 6. Percentage swell at 4-day soaking not more than 1%.
- B. Where the excavated material arising from the excavations is to be used as filling, the Engineer 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.
- C. The fill material other than rock fill to be used beneath ground floor slabs shall be free of clay, rock or gravel larger than 75 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 the optimum moisture content.
- D. For landscaped areas, fill material when required shall be as above. For top soil requirements and treatment refer to the appropriate sections of the specification.
- E. Concrete used as fill for making up to correct level areas of over-excavation shall be, where required by the Engineer, grade C10/15.
- F. For the "capping layer" to the asphalted roads and parking the fill material shall be as above.

15.1.7 Sub-base Material

- A. Sub-base material other than rockfill shall be approved well graded crushed sands and gravels, or crushed rock or crusher run complying with the requirements of table 13.1.7.1.

Table 13.1.7.1 Approved Sub-base Material**A. Material Type 1**

1. Material Type 1 shall comply with the requirements of CYS EN 13043. Its grading shall be as per CYS EN 13043.
2. 4-day soaked CBR compacted to 95% of the maximum dry density achieved in test 13 of BS 1377 shall be at least 30%.
3. Plasticity Modulus (PM: product of PI and percentage passing BS 0.425 mm sieve) not more than 250.
4. Percentage swell at 4-day soaking not more than 1%.

B. Material Type 2

1. Material Type 2 may alternatively be used with the written approval of the Engineer and shall comply with the requirements of CYS EN 13043 except as amended below. These materials shall be naturally occurring sands and gravels free from clay, organic and other deleterious substances complying with the following requirements:
2.

<u>BS sieve size (mm)</u>	<u>% by weight passing</u>
75	100
37.5	85-100
10	45-100
5	25-85
0.600	8-45
0.750	5-10
3. 4-day soaked CBR, plasticity modulus and percentage swell shall be as described in 1.2, 1.3 and 1.4 above.
4. Liquid Limit (LL) not more than 30.
5. Plasticity Index (PI) not more than 6.
6. Los Angeles test not more than 30% when tested in accordance with ASTM C535.
 - a. Los Angeles (Small size AASHTO T96) 45% max.
 - b. Los Angeles (Large size ASTM C%535-65) 40% max.
7. 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 97% of the maximum dry density of the material achieved in test 13 of BS 1377 and at +1 to -2% of the optimum moisture content.
8. 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.
9. High spots shall be graded off and low spots shall be scarified, watered and filled with selected material and compacted to the required limits.
10. The sub-base shall extend beyond the road and under the pavements as shown on the drawings.
11. The finished surface shall comply with the tolerances given in section 13.1.26 of the Specification.

15.1.8 Rockfill

- A. Rockfill where used in the construction of embankments under roads or as sub-base material shall consist of hard durable inert well graded material which is the result of rock excavation by blasting or other means and its maximum size shall not exceed 2/3 of the thickness of the compacted layer or 300 mm whichever is greater.
- B. The rockfill shall be compacted as wet as possible to at least 95% of its maximum dry density as determined in test 13 of BS 1377.
- C. Rockfill shall be spread and levelled by a crawler tractor weighing not less than 15 tons in layers not exceeding 450 mm loose depth and compacted with at least 12 passes of a vibrating roller with a static mass per metre width of roll of at least 3000 kg.

- D. Layer-containing rockfill material shall terminate 600 mm below the formation level unless otherwise shown on the drawings.

15.1.9 Base (Water Bound Macadam)

- A. Approved road base material for Water Bound Macadam shall consist of crushed sands and gravels. The material shall be free of clay, organic substances, sulphates, chlorides, and other deleterious matter and shall comply with the requirements of CYS EN 13043 and table 13.1.9.1.

Table 13.1.9.1 Approved Road Base Material

1.	<u>BS sieve size (mm)</u>	<u>% by weight passing</u>
	50	100
	37.5	95-100
	20	60-80
	10	40-60
	5	25-40
	2.36	15-30
	0.600	8-22
	0.425	5-20
	0.075	0-8

Where this material shall be used as the top layer of unsurfaced roads the material passing 0.075 mm shall be 8 - 12%.

2. 4-day soaked CBR compacted to 95% of the maximum dry density achieved in test 13 of BS 1377 shall be at least 90%.
 3. Liquid Limit (LL) not more than 25.
 4. Percentage swell at 4-day soaking not more than 1%.
 5. When the material is subjected to five successive cycles of the sodium sulphate or the magnesium sulphate soundness test the weighted loss shall not exceed 12% and 20% respectively.
- B. The road base material shall be laid with a finisher at a moisture content of + 1% to - 1% of optimum in layers not exceeding 150mm after compaction and the total thickness and width shall be shown on the drawings.
- C. The material shall be compacted to at least 100 % of its maximum dry density achieved in test 13 of BS 1377 at a moisture content of +1% to -1% of optimum.
- D. 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.
- E. 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 re-compacted.
- F. High spots shall be graded off and low spots shall be scarified, watered and filled with selected material and compacted to the required limits.
- G. The finished surface shall comply with the tolerances given in Section 13.1.26 in the Specification.

15.1.10 Compaction of Sub-grade, Sub-base and Roadbase

- A. All pavement layers shall be compacted to the specified limits by plant approved by the Engineer.
- B. The Contractor shall submit to the Engineer 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 Engineer, using the procedure proposed by the Contractor and shall satisfy the Engineer that all the specified requirements regarding compaction can be achieved.
- C. 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.

- D. No layer shall be covered by the next layer until it has been tested by the Contractor and approved by the Engineer.

15.1.11 Earthworks Test Procedures

- A. Where defined, tests shall be carried out as listed below:

	<u>Test</u>	<u>Test Method</u>
1.	Liquid limit	BS 1377/Test 2
2.	Plastic limit	BS 1377/Test 3
3.	Plasticity index	BS 1377/Test 4
4.	Particle size analysis	BS 1377/Test 7
5.	Compaction test	BS 1377/Test 13 or 14
6.	Moisture content	BS 1377/Test 1

- B. The results obtained in test 13 or 14 on the fraction passing the 20 mm sieve shall be adjusted as follows where that fraction is less than 95% of the soil.
- C. 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 $(\% \text{ passing } 20 \text{ mm} \times \text{test optimum} \times 0.01) + (\% \text{ retained on } 20 \text{ mm} \times \text{moisture content of particles retained on } 20 \text{ mm after immersion in water followed by drainage but not drying})$.
7. Field dry density test
Sand replacement
(large pouring cylinder) BS 1377/Test 15B
8. CBR test BS 1377/Test 16
- D. Field dry density tests shall be carried out by the sand replacement methods (large pouring cylinder) in accordance with BS 1377. For material with a large percentage of coarse particles which in the opinion of the Engineer makes the sand replacement method unsuitable, a water replacement method will be used using a ring of 600 mm diameter suitably manufactured for the purpose and thin flexible rubber membrane. The procedure to be used shall be agreed with the Engineer and control testing shall be carried out prior to the use of the method.

15.1.12 Frequency of Testing

- A. Sub-grade, embankment materials, rockfill, sub-base and base material shall be tested at the frequencies stated below.
- B. 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 Engineer.
- C. 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 Section 13.1.11 of the Specification.

15.1.13 Prime Coat

- A. 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 Engineer 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 Engineer 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

15.1.14 Tack Coat

- A. 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 Engineer in the range of 0.3 to 0.5 litres per square metre of residual bitumen.

15.1.15 Asphaltic Concrete

- A. Asphaltic Concrete base course and wearing course shall comply with the requirements of CYS 99 except as amended below, 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.

15.1.16 Aggregates for Asphaltic Concrete

- A. The coarse aggregate for asphaltic concrete 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.
- B. The coarse aggregate for asphaltic concrete wearing course shall be hard, clean and durable crushed rock or crushed stone from gravels.
- C. 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 more than 2.5; the water absorption shall be less than 3% and the Los Angeles abrasion less than 25%.
- D. 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.
- E. Mineral filler shall consist of finely ground particles of 100% passing the 300 μ sieve of Portland cement or other non-plastic mineral matter approved by the Engineer. It shall be free from foreign matter or other deleterious material.
- F. Aggregates of different nominal size of grading shall be stockpiled separately as supplied and aggregates from different supply sources though of similar grading shall be stockpiled separately for each source of supply.
- G. Stockpiles shall be on a concrete or bituminous paved surface, laid to falls. The siting and preparation of the sites shall be approved by the Engineer. Aggregates of different gradings in close proximity shall be separated by sturdy bulkheads.
- H. At all times, the stockpiles shall be kept free from contact with deleterious matter.

15.1.17 Binder for Asphaltic Concrete

- A. The binder shall be 60/70 penetration straight run bitumen complying with AASHO Designation M20 or BS 3690.
- B. Petroleum bitumen shall comply with the properties specified in Table 1 of BS 3690, and a certificate shall be obtained from the supplier with each consignment delivered stating the grade of bitumen being supplied. This certificate shall include the relative density of the current production. Consignment certificates are to be submitted to the Engineer for his retention.

15.1.18 Composition of asphaltic mixes

- A. The particle size distribution of the combined aggregate and filler when determined by the method specified in BS 812 Part I, Method 7.1 and the bitumen content shall lie within the following limits:

% by weight passing

<u>Course</u>	<u>Base (DBM)</u>	<u>Base</u>	<u>Wearing Course</u>	<u>Course</u>
<u>BS sieve size (mm)</u>	<u>37 mm</u>	<u>28 mm</u>	<u>20mm</u>	<u>14 mm</u>
	<u>Nominal size</u>	<u>Nominal size</u>	<u>Nominal size</u>	<u>Nominal size</u>
50	100			
37.5	95-100	100		
28	70-94	90-100	100	
20	-	71-95	95-100	100
14	55-75	58-82	65-85	95-100
10	-	-	52-72	70-90
6.3	44-60	44-60	39-55	45-65
3.35	32-46	32-46	32-46	30-45
1.18	-	-	15-30	
0.300	7-21	7-21	7-21	-
0.075	3-8	2-8	2-8	2-6
Bitumen Content(%)	3.6-4.4	4.5-6.0	4.5-6.0	4.5-6.5

15.1.19 Selection of Job Mixes for Asphaltic Concrete

- A. Before surfacing begins, the Contractor shall submit in writing to the Engineer the precise gradings of combined aggregates and the bitumen content proposed for each mix of Asphaltic Concrete. 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.
- B. The Engineer shall give approval in writing or order changes to the proposed mixes following full scale plant trials for each mix using a range of bitumen contents.
- C. The trial mixtures shall be laid as preliminary trials in locations selected by the Engineer with the spreading and compacting equipment the Contractor proposes to use.
- D. If the preliminary trials indicate that the trial mixtures or the "Laboratory Design Mixtures" are unsatisfactory for mechanical spreading and compacting, or fail to product the specified surface accuracy, or result in surface blemishes which are unacceptable, the proportion of binder shall be adjusted and the grading of the combined aggregates and filler may be slightly modified to ensure that, at the adjusted binder content, the values of the modified mixture remains within the specified limits for the materials being laid. Further preliminary trials shall then be laid to demonstrate that a satisfactory mixture has been achieved. The Engineer will then agree the mixture and authorize the laying of a final trial area.
- E. Following completion of the preliminary trials, a trial of surfacing not less than 50 m long by one lane width shall be laid for each course thickness of each mixture to establish the most suitable compaction method.
- F. When the Engineer has approved the trial area (s) the Contractor shall confirm in writing the weights and proportions of the approved mixture to the Engineer and they shall be used thereafter as a basis for all future plant mixing.
- G. The trial areas shall be permanently marked "Approved" and dated.

- H. Until approval has been given, the general laying of bituminous surfacing required by the Contract will not be permitted to start.
- I. The standard of workmanship and finish of all layers included in the Contract shall be equal in all respects to that of the "Approved" areas and shall not be changed afterwards without the specific approval of the Engineer.
- J. If, for any reason, the quality, grading, or supply source of the aggregates is changed, a new mixture shall be designed and approved on the basis of further trial areas.
- K. No change shall be made afterwards in the mixing and spreading plant of rolling method without the approval of the Engineer and then only after new trials have been carried out and approved.
- L. Trial materials laid which do not form part of the approved trial area, and which are unacceptable to the Engineer, shall be removed and replaced with new material to the approved standard.
- M. The precise combined aggregate grading and bitumen content which complies with the specification and is acceptable to the Engineer following the plant trials will be known as the "Job Mix" for that mix. Unless specifically permitted by the Engineer, the maximum permissible variation from an approved job mix shall be as follows:

<u>Requirement</u>	<u>Permissible variation</u> <u>Percentage of total combined aggregate</u>
Aggregate passing BS sieve sizes other than those referred to below	± 5 percent
Aggregate passing B.S. sieve size 6.3mm	± 4 percent
Aggregate passing B.S sieve sizes 3.35 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
Voids in total mix (VTM)	± 1.0 percent

15.1.19 Selection of Job Mixes for Asphaltic Concrete

Voids filled with bitumen (VFB)	±5.0 percent
Flow	2 to 5 mm
Stability	680 Kg

15.1.20 Mixing of Asphaltic Concrete

- A. 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 Engineer. 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 Engineer. All aggregates on leaving the drier shall have a moisture content of less than 1%.

- B. The Engineer 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 prior to any mixing taking place and whenever the Engineer may require. If the checks reveal that the plant is inaccurate no mix from the plant shall be used until the fault has been rectified to the Engineer's satisfaction.
- C. The bitumen should be heated to a temperature of between 145° C and 165° 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.
- D. The aggregate shall be fed into the mixer at a temperature of between 150° C and 170° 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.
- E. The Contractor shall ensure that throughout the mixing and delivery of the mix no leakage of any of the materials takes place and no extraneous matter is admitted to the mixture.

15.1.21 Transporting of Asphaltic Concrete

- A. Asphaltic Concrete shall be transported from the batching plant to the work site as rapidly as possible in approved vehicles, with care to prevent segregation, and it shall be covered during transit and while waiting to prevent loss of heat, contamination and wetting. If necessary, during the winter, the Asphaltic Concrete shall be protected against loss of heat so as to ensure a suitable temperature at the spreader.

15.1.22 Spreading and Laying of Asphaltic Concrete and Dense Bitumen Macadam

- A. 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.
- B. 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.
- C. 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.
- D. 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 asphaltic concrete on gradients steeper than 4%, the paver shall be operated in an up-hill direction.
- E. Base Course and Wearing Course shall be laid in one single layer. For Base courses specified course thickness 70 to 100 mm the 28 mm nominal size grading shall be used and for specified course thickness 50 to 80 mm, the 20 mm nominal size aggregate shall be used. For Wearing Courses the 14 mm nominal size aggregate shall be used unless otherwise ordered by the Engineer.
- F. In the case of the bituminous road-base, the course shall be laid in more than one layer where required. The minimum layer thickness shall be 80 mm and the maximum 160 mm.
- G. Each course shall be firmly united with the underlying course.
- H. Wearing course and base course shall be laid on the underlying layers as soon as practicable.
- I. Trafficking of road base and base course shall be avoided. Where overlying courses are laid in less than twenty four hours, the Engineer may allow their laying without the application of tack-coat if he considers the surface suitable to accept the overlying course. Where tack-coated surfaces were, in the opinion of the Engineer, allowed to be contaminated, the Engineer may order the reapplication of tack-coat at the Contractor's own expense.

- J. The use of hand-rakes shall be prohibited when the mixtures are laid by spreading and finishing machines in accordance with Clause 520 except at joint edges and around manholes and pits where their use shall be restricted to an absolute minimum.
- K. After the spreading units have passed, hand-casting of fines behind the spreader as a means of making-up irregularities or disguising blemishes left by the spreader will not be permitted.
- L. At all times the courses shall be kept free from all extraneous matter.
- M. 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.
- N. 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 surface for the full thickness of the course. Fresh mixtures shall be raked uniformly against the joint, followed 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 painted with hot binder immediately before the adjoining surface is laid.
- O. 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 painted with hot binder. The adjoining surface material shall be laid up to the joint and any irregularities at the joint shall be smoothed out prior to rolling.
- P. After laying and compaction, the surface shall be checked for compliance with Section 13.1.26 of the Specification.
- Q. No laying of Asphaltic Concrete shall be permitted during periods of continuous or heavy rain, or when free water is present on the surface, or when the degree of moisture on a wet surface could be detrimental to the finished product.

15.1.23 Rolling of Asphaltic Concrete

- A. As soon as rolling can be effected without causing undue displacement of the mixed material and whilst the temperature is in the range of 130 ° C - 150° C the asphaltic concrete 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 Kg/m of roll.
- B. Temperatures shall be checked with approved thermometers immediately before starting rolling and at intervals not exceeding 3 minutes.
- C. 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 asphaltic concrete when reversing the roller.
- D. Rolling shall be finished using a 10-12 tonne tandem or three-wheeled smooth roller with a rear roll pressure variable up to at least 5300 Kg/m of roll. Rolling shall be continued until all roller marks are eliminated. Rollers shall not remain stationary on freshly compacted surfaces.
- E. Acceptance of the compacted course with respect to density shall be based on the average of five density determinations for each lot of asphaltic concrete placed. A lot shall be equal to one day's production. Each lot of the compacted base course and wearing course shall be accepted when the average of the five density determinations is equal to or greater than 98% and when no individual determination is lower than 95% of the average density of six laboratory prepared specimens.
- F. 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.

15.1.24 Testing of Asphaltic Concrete

A. The following tests are required for base course and wearing course:

1. The Marshall Stability test to be greater than 680 Kg.
2. The Marshall Flow to lie in the range of 2-4 mm.
3. The voids in the total mix shall be 3-6 percent for the base course and 3-5 percent for the wearing course.
4. Field density to be not less than 98% of the Job Standard mixture Relative Density or not less than 95% of the Theoretical Relative density.
 - a. The "Job Standard Mixture Relative Density" shall be obtained by making six standard Marshall specimens from samples of the approved "Job Standard Mixture"; determining the relative density of each, and comparing them with the mean value of the six. Any individual result which differs from the mean by more than 15 kg/cu m shall be rejected and, provided not more than two results are so rejected, the mean of the remaining results shall be designated the "Job Standard Mixture Relative Density".
 - b. The theoretical relative density shall be calculated in accordance with MS-2, "Mix Design Methods for Asphalt Concrete and other Hot Mix-Types".
5. The voids filled with bitumen shall be 67-77 percent for the base course and 76-82 percent for the wearing course.
6. When the aggregates are tested by the stripping test there shall be no more than 6 particles stripped from a 150 particle test sample or more than 3 particles in the case of aggregates intended for use in friction course materials.
7. The Index of Retained Stability shall not be less than 75%.
8. 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.

15.1.25 Frequency of Testing

A. **General**

1. Tests on bituminous materials and workmanship shall be carried out any time requested by the Engineer 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, Soundness Test, Water Absorption and Aggregate Abrasion Value.
 - 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.

B. **Routine tests on bulk supplies of aggregate throughout the mixing period**

1. As a check on the consistency of bulk supplies, for comparison with the qualitative values and gradings of the samples approved and as a check on the capability of the dryers to function efficiently with aggregates exposed to variable wetting, the Contractor shall carry out the following tests:-
 - a. A sieve analysis of all aggregates in accordance with BS 812, Part 1, not less than once a day on a representative sample from each stockpile, for comparison with the grading of the initial samples.
 - b. A sieve analysis in the same manner every 4 hours, on a sample taken from each hot bin, for computation of the combined grading as an initial check on the production, and for comparison with the approved grading for the mixture being laid.
 - c. The moisture content weekly on a sample taken from each hot bin. The samples shall be weighed dried in a ventilated oven at a controlled temperature of 175 ± 2 deg C for 24 hours, and shall then be weighed again.

C. **Routine tests on mixtures throughout plant mixing**

1. Throughout the work, whenever mixing is in progress, the Contractor shall carry out the tests specified in paragraph a. below in his site laboratory. Particular attention shall be given to ensure that the position of plant mixtures from which test samples are taken or specimens made can be accurately located in the finished pavement layer.

- i. Analysis of the plant mixtures in accordance with the American Asphalt Institute recommended practices on samples taken after completion of the mixing process for the determination of binder contents and aggregate/filler proportioning and gradings.
 - ii. An analysis shall be carried out every 4 hours and in any case not less than twice a day for each mixer in use. At least one test per day shall be carried out in such a manner as will enable the water content to be determined.
 - iii. The results of the grading tests shall be plotted on graphs to show comparison with the grading curve of the approved mixes and the relevant binder content shall be shown.
 - iv. If either the grading of the binder content of any individual test out of the total number of tests for the day's production fails to comply with the specified requirements, additional tests shall be carried out as stated in paragraph F. below.
2. Temperature readings, which shall be taken and recorded in compliance with the Specification.

D. Routine tests on compacted courses

1. Surface accuracy tests shall be made daily on the previous day's work to ensure compliance with the specified requirements.
2. If more than 2 tests in each group of 20 fail to comply with the specified requirement, the additional tests as specified in paragraph (f) below shall be carried out.
3. Duplicate core samples of the previous day's surfacing from every 1,000 square meter laid (or from every 2 hours' work, whichever is the more frequent) and at locations agreed with the Engineer, shall be cut through the surfacing to the underside of the previous layer to check the course thickness and adhesion.
4. Where the course thickness measured on any individual core fails to meet the requirement of the Specification the additional tests specified in paragraph (f) below shall be carried out.
5. The requirements of the Specification shall be checked when cores fail in adhesion, and the necessary corrections and adjustments shall be made to eliminate the cause of the failure.

E. Routine field and relative density tests

1. Twin core samples 150 mm in diameter shall be taken in accordance with paragraph (d) above with an approved coring machine, and their densities determined within 48 hours of their being cut. The mean value obtained according to AASHTO T-166 or T-275 from the twin samples from the same area shall be taken as the field relative density of the compacted course.
2. The field density shall be such that, of twenty consecutive mean values, not more than three results shall be below 98% of the "Job Standard Mixture Relative Density", or 94% of the theoretical relative density when appropriate, as specified in Clause 536, for base course and wearing course. In the case of the Road base, the mean field relative density shall be not less than 95% of the percentage refusal density (PRD) as determined in accordance with Clause 927 of the Specification for Highway Works Part 3, 1986 published by HMSO - U.K. No field density result may fall below 93%.
3. Material which does not meet this requirement shall be cut out and replaced.
4. The samples shall also be used to determine the course thickness.

F. Additional tests when routine tests on the mixture and on the compacted courses fail

1. The Contractor shall carry out the following additional tests when routine tests fail to establish the extent to which material already laid in the course fails to meet the requirements specified:-
 - a. For aggregate/filler grading, and binder content.
 - b. For surface accuracy.
 - c. For course thickness
2. These additional tests shall be made on four 0.3 m square samples for checking grading and binder content or on four 0.15 m diameter cores for checking course thickness. The samples or cores shall be cut from the compacted course, at positions selected by the Engineer within the lane width at a distance of not more than 5 m from the location in the pavement, at which the mixture was laid which failed to satisfy the routine test requirements specified.
3. If any one of these additional tests also fails to meet the specified requirement, further tests shall be made on 3 more samples or cores. These samples or cores shall be cut at further positions selected by the Engineer also within the lane width and at a distance of not more than 10 m further along the lane from the location of the subsequent failure point.
4. Should one of these additional samples or cores also fail to meet the specified requirement, the above process shall be repeated until all samples or cores are satisfactory.

5. The area covered by the failed samples or cores shall be cut out and replaced.
6. When the routine tests fail to meet the requirements for surface accuracy an additional 20 straightedge tests shall be made over the area between the two routine fail points, extended by 5 m either side of each along the length of lane.
7. If three or more of these additional tests also fail to meet the specified requirement, this area of the surfacing shall be condemned.
8. The condemned areas shall be removed and replaced by the Contractor, at his own expense.
9. Attempts to correct the surface accuracy with fine bituminous dressings synthetic resin formulations, surface dressing applications, or emulsion slurry films shall not be allowed.

15.1.26 Surface Levels and Tolerances of Construction Layers

- A. The level of any point on the surface of each of the construction layers shall conform to the tolerances shown in the table below:

Type of construction layer	Tolerance from true surface level of course	Maximum depression tested under a 3m straight edge
-----	-----	-----
Sub-grade + 5 mm to -25mm	15mm	
Sub-base and Road Base	+ 10mm to -15mm	10mm
Asphaltic Concrete Base Course and Single Course work	+ 6mm	6mm
Shoulder +0 to -10mm		10mm
Asphaltic Concrete Wearing Course	± 5 mm	3mm
The edges of pavements and all other alignments shall be within a tolerance of ±20 mm.		

15.1.27 Rectification of Surface out of Tolerance

- A. The surface area of any layer which does not comply with the requirements of the above clause shall be rectified to a minimum area of 15 m² as follows:

15.1.28 Base Course

- A. 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, at the Engineer's discretion; otherwise the whole area involved shall be removed to the full depth of the layer and reconstructed with fresh material.

15.1.29 Wearing Course

- A. Measurement of level and tolerance shall be carried out immediately after laying and compaction 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.

15.1.30 Shoulders

- A. Where shown on the drawings, shoulder shall be constructed with the same material as for the road-base.
- B. The shoulder shall be constructed soon after the completion of the wearing course.
- C. The surface preparation of the shoulder shall be carried out as described in section 13.1.13. Prime coat shall be applied at a rate between 1.1 and 1.6 litres per square metre and left for 24 hours.
- D. A single surface treatment shall be carried out as follows:
 1. 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.

2. 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.

15.1.31 Upgrading of Existing Asphalt Road

- A. 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.
- B. The edges of the asphalt shall be made straight to the lines and dimensions shown on the drawings.
- C. 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 Engineer. Tack coat of RC70 shall be applied to the surface at a minimum rate of 0.5 litres per square metre.
- D. The tacked surface shall be clear of all vehicular and other traffic.
- E. Wearing course shall be placed as specified with at least 24 hours lapse from the application of the tack coat.
- F. Footpaths, curbs, lay-by and shoulders shall be constructed as specified and as shown on the drawings.

15.1.32 Earthworks to be kept Free of Water

- A. 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.
- B. 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.

15.1.33 Use of Surfaces by Construction Plant

- A. Construction 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 Construction Plan shall be made good by the Contractor at his own expense.

15.1.34 Kerbing for Roads and Parking Areas

- A. Precast concrete kerbs shall be manufactured to the dimensions shown on the drawings with concrete grade C25/30 and shall comply with BS 7263, unless otherwise shown on the drawings. Kerbs shall be laid and bedded on 25mm thick 1:3 cement/sand mortar, on a 100mm thick concrete base grade C15/20, unless otherwise shown on the drawings. All kerbs shall be backed with concrete grade C15/20 to the dimensions shown on the drawings.
- B. Kerbs of the appropriate radii shall be used on curves with radii of 12 metres or less.
- C. Tolerances permitted on the dimensions shall be +1.5 mm, -3.0 mm for the width and ± 3.0 mm, for the height over 3 metres length.
- D. 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 arrises shall be clean and, with the exception of the rounded arrises, sharp. The wearing surfaces shall be true and out of winding and shall present a clean, homogeneous appearance.
- E. Movement joints as shown on the drawings shall be constructed at distances not exceeding 30 m. Joints between kerbs shall be 7mm ± 1 mm wide and they shall be evened out by a smooth steel rod.

- F. The rates for kerbing shall include the supply or manufacture of kerbs, excavation, foundation bed and haunch, laying and backfilling.
- G. Where shown on the drawings, kerbs shall be painted, white/black or yellow/black with road paint, supplied by an approved manufacturer.

15.2.1 Manufacturing of Tiles

- A. Concrete tiles for pavements shall be precast using automatic vibrating machine with hydraulic compression using concrete grade C25/30 as described in section 3.0 of the Specification.
- B. The dimensions of each tile shall be 400 x 400 x 40 mm. The upper face shall be smooth and level and a chamfer shall be made at the edges of the upper face of the tile.
- C. The paving slabs with exposed aggregate facing on the upper face shall be to the Engineer's approval.
- D. The aggregate shall be sieved to get the sand separated. It shall be washed so that earth and organic materials are removed. Then the materials shall be mixed according to the following gradations:
 75% 12-4 mm Aggregate
 15% 4-2 mm Sand
 10% less than 2 mm in diameter
- E. These proportions shall be kept during work by means of the necessary sieves. An alternative gradation may be used with the prior approval of the Engineer.
- F. Blending and addition of water shall be carried out automatically. Twenty-four hours after manufacturing, tiles shall be placed into water basins for three days. After three days they shall be kept wet for a period of two weeks and kept under shade.

15.2.2 Placing of Tiles

- A. Tiles for pavement shall be laid on 25mm thick 1:3 cement/sand mortar on well sprayed and compacted hardcore in layers, not exceeding 150mm, to a density of 95% of the maximum dry density achieved in test 13 of BS 1377, unless otherwise indicated or described on the drawings.
- B. A 9 mm \pm 1 mm wide 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. The completed work shall be protected from frost and premature drying for at least seven days after completion by securely fastened impermeable plastic sheeting with 300mm taped laps. Movement joints as shown on the drawings shall be constructed at distances not exceeding 10m and in areas not exceeding 100m².

15.2.3 Tolerances

- A. The tolerance permitted on the width of individual tiles shall be \pm 2 mm.
- B. The placed tiles shall have a maximum depression, tested under a 3 m straight edge, of 3 mm. The joints shall be parallel to the kerb.

15.3 CONCRETE BLOCK PAVING

15.3.1 Paving Blocks

- A. Concrete blocks to be used for external paving shall be 200 x 100 x 80 mm thick unless otherwise indicated on the drawings. The blocks and the workmanship shall comply with the requirements of CYS EN 1338.

15.3.2 Sub-base Bedding Materials

- A. The concrete for the sub-base shall be grade C15/20 and maximum aggregate size 20 mm. Alternatively, the sub-base may be approved granular material 150mm thick, unless otherwise indicated on the drawings, complying with the requirements of section 13.1.7 of the Specification.
- B. Sand for bedding shall be sharp and well washed, Zone 2 or 3 to CYS EN 12620 with silt and dust content not

exceeding 3 percent by weight and not more than 15 percent retained on a 2.36 mm sieve.

15.3.3 Workmanship

- A. The Contractor shall construct a concrete sub-base to a thickness not less than 100 mm, unless otherwise indicated on the drawings. 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 Engineer for approval. The concrete sub-base shall be reinforced with mesh Q257.
- B. 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.

15.3.4 Laying Blocks

- A. The Contractor shall provide and lay 80mm blocks as described in accordance with the block manufacturer's recommendations, unless otherwise indicated or described on the drawings.
- B. The Contractor shall 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.
- C. The Contractor shall lay blocks at junction with asphalt road and working into the Site.
- D. The Contractor shall lay a bed of sand not less than 50 mm thick and carefully adjust so that the finished paving is to correct levels and even falls. The Contractor shall prevent trafficking by vehicles or pedestrians until blocks are laid.
- E. The Contractor shall lay blocks butt jointed to a regular herringbone and/or stretcher bond pattern as indicated on the drawings and neatly cut blocks to fit at margins.
- F. The Contractor shall use a vibrator with a plate area between 0.2 and 0.3 m² and a centrifugal force of approximately 1 tonne to thoroughly compact blocks into the sand bed to final levels and falls.
- G. Dry sharp sand shall be brushed over the laid paving and vibrated into position using 3-5 passes of a plate vibrator until the joints are filled. Surplus sand shall be brushed off the finished surface.
- H. When completed, the entire paving area shall be sealed with "Uniseal" or equal and approved at the minimum rate of 0.5 lt/m².

15.4 NATURAL STONE PAVING

- A. Natural stone for paving shall be either laid in an irregular stone pattern or cut stone pattern as indicated on the drawings.

15.4.1 Natural Stone Laid in an Irregular Stone Pattern

- A. This paving shall be bedded on a concrete sub-base or a drainage course on a compacted subgrade as indicated on the drawings.

15.4.2 Natural Stone Laid in a Cut Stone Pattern

- A. This paving shall be soft laid i.e. laid directly on a drainage course on a well compacted subgrade.

15.4.3 Drainage Course

- A. The drainage course shall comprise a minimum of 150 mm well compacted hardcore or other approved granular material, passing a 75 mm BS sieve and packed solidly and evenly. The surface shall be blinded with sand or other approved fine well graded material which shall then be rolled to at least 95% of the maximum dry density of the material achieved in test 13 of BS 1377.

15.4.4 Concrete Sub-base

- A. The concrete for the sub-base shall be grade C15/20, maximum aggregate size 20 mm, 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 Engineer for approval. The concrete sub-base shall be reinforced with mesh Q257.
- B. 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.

15.4.5 **Laying Natural Stone Paving**

- A. Provide and lay "Anoyira" 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 1.0m unless otherwise directed. The joints shall be 9 mm \pm 1 mm wide for the stones laid in a cut stone pattern.
- B. Stone cutting necessary on site shall be carried out using an approved saw and hammer and bolster to leave straight broken upper edges (except for irregular stone pattern paving).
- C. Brush semi-dry 1:2 by volume cement: sand mortar into the joints and firmly pack to leave rounded joints 2-3 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.
- D. The completed work shall be protected from frost and premature drying for at least seven days from completion by securely fastened impermeable plastic sheeting with 300 mm taped laps.

15.5 **ROAD MARKINGS**

15.5.1 **General**

- A. The work under this Section comprises the supply and application of reflectorised tropical thermoplastic road marking paint in white and yellow for lines and traffic markings as follows:
1. Unless otherwise shown, lines shall be yellow for edge lines and white for all other lines to the width specified. The edge lines shall be solid and the lane lines shall be 3 m solid with 9 m gap.
 2. On completion, the material shall produce an adherent reflectorised line or marking of the specified thickness.

15.5.2 **Materials**

- A. The material shall conform to BS 3262 or other equivalent approved international standard, with the additional specific requirements stated herein.
- B. The material when laid shall consist of light coloured aggregate, pigment and extender, bound together with hard wearing resins, plasticised with oil as necessary, in the following proportions:

Constituents	Percentage by Weight	
	White	Yellow
Binder	20 +/- 2	20 +/- 2
Glass Beads (Ballotini)	20 min.	20 min.
Titanium Dioxide (White Pigment)	8 min.	-
Aggregate, Extender	54 max	62 max.
Yellow Pigment	-	

- C. The binder, aggregate, glass beads, pigments and extenders shall all conform to the requirements of BS 3262.
- D. The binder shall consist of synthetic resins, plasticised to meet the specification requirements. The resin shall comprise synthetic hydrocarbon resin or maleic modified glycerol ester resin (alkyd binder). Documentation describing the specific resin type shall be submitted with the tender.
- E. The thermoplastic paint shall be formulated to have the following specific properties when tested in accordance with BS 3262.

1.	Softening Point	95 Deg. C
2.	Luminance (White)	75
	(Yellow)	50
3.	Heat Stability (White)	70
	(Re-melted) (Yellow)	45
4.	Skid Resistance	45
5.	Abrasion Resistance	0.25g/100 revolutions

- F. Certification from a nationally registered laboratory either in Cyprus or overseas shall be presented to the Engineer stating that the thermoplastic paint complies with the specification requirements for constituent materials and for properties of the hardened paint, on the basis of one certificate per 25 tonnes of product or part of 25 tons.

15.5.3 Removal of road markings

- A. Where existing road markings are to be removed these shall be removed from the road surface at locations to be instructed by the Engineer. Removal shall be preferably by using a cold planer or by sand blasting or an approved hot air process. Chemical solvents shall not be used. All removed material, loose fractions and other debris shall be disposed off site and the road surface shall be swept clean to the Engineer's satisfaction using a compressed air jet.

15.5.4 Application

- A. Application for lines up to and including 200 mm wide shall be with a self-propelled mobile screed or spray machine. Lines shall be a minimum of 2 mm thick.
- B. Application for traffic markings, such as arrows, stripes, etc. shall be constructed using a template and shall be a minimum of 3 mm thick.
- C. Equipment shall be capable of placing the thermoplastic material to a uniform thickness and width and with clean edges. It shall provide continuous uniform heating to mixing and conveying equipment. The temperature limits shall not exceed the manufacturers declared safe heating temperatures.
- D. Application shall commence only after the asphalt surface which is to receive the paint is at least two weeks old. The road surface shall be dry and free of all foreign matter and loose material. The temperature of the road shall be above 10 Deg. C at the time of application. Where old paint or thermoplastic materials are to be covered by new, the old markings shall be vigorously mechanically wire brushed to remove loose material.
- E. Where thermoplastic paint is to be applied to polished road surfaces, a tack coat shall be applied first. The tack coat shall be of the type recommended by the manufacturer of the thermoplastic material and shall be applied strictly in accordance with the manufacturer's instructions.
- F. Application shall generally be in accordance with BS 3262. In addition to the glass beads included in the mix, an additional quantity of glass beads shall be pressure sprayed on to the hot line at the time of application at the rate of not less than 400 grams per square metre.
- G. The lines and markings produced shall have surfaces free from streaks, blisters, lumps and other defects and be free from ragged edges.
- H. Quality assurance records shall be maintained by the Contractor on a daily basis. Weather and road conditions shall be recorded. Temperature records both ambient and of material being deposited, as well as material consumption records and records of thickness, width and colour of markings shall be maintained. Thickness measurement shall be checked and recorded by the Contractor for every 500 m of line placed and at each traffic marking. Measurement shall be by placing tape or film in the area to be marked. Once marked, the sample shall be removed by making sharp cuts with a knife and measurement made with a vernier calliper with a proper correction for the film base.

15.5.5 Sampling and Testing

- A. Sampling and testing will be carried out by the Employer generally in accordance with BS 3262 to confirm compliance of the materials and finished work with the requirements of the Specification. Samples may be taken of the cold or hot thermoplastic materials and also of the applied materials by means of a metal sheet placed in the path of the laying equipment. Line thickness and application rate of glass beads will be tested in accordance with BS 3262.
- B. Testing will be carried out by the Public Works Department Laboratories, Nicosia. The Employer will bear the cost of initial testing, while the Contractor shall bear the cost of repeat testing if the paint proves initially unacceptable. Testing shall be repeated until the material conforms in all respects with the Specification.
- C. Material or finished line work which does not comply with the Specification shall be rejected. Rejected materials shall be removed from the Works at the cost of the Contractor.

15.5.6 Traffic Control and Protection of the Work

- A. The Contractor shall control the traffic in such a manner as to protect the freshly marked surface from damage. The traffic control shall be so arranged as to give minimum interference to the travelling public. Signs, barricades, flagmen and control devices shall be supplied by the Contractor and a system of spaced warning flags or blocks shall be used to protect the fresh marking until it has dried. Any lines, stripes or markings which become blurred or smeared by the traffic shall be corrected by the Contractor at his own expense.

16.0 LANDSCAPING AND PLANTING**16.1 EARTH WORKS**

- A. As and when the course of the work requires the Contractor is to give 48 hours minimum notice to the Engineer in advance of completion of the final shaping up of the various banks before the topsoil is placed so that they can be inspected and approved by the Engineer.
- B. Grading is intended to be carried out without double handing any topsoil or subsoil. In particular the soil moving connected with the forming of earth banks should be carried out as a single operation.
- C. The Contractor shall be responsible for the protection and conservation of existing topsoil in all parts of the site included in his operations, whether in areas affected by earth moving or not.
- D. On no account is the contractor to permit the subsoil to be mixed with the topsoil. Should the grade and/or the surface of the existing topsoil be disturbed or destroyed during the provision of access of his equipment of machinery, he shall notify the Engineer and make good.
- E. Before any areas are excavated or filled the existing topsoil to its full depth, is first to be removed.
- F. Levels shown are finished levels, and are to allow for the spreading of topsoil over all disturbed areas. Unless otherwise stated, finished levels of grass areas shall be 25 mm proud of adjoining paving or kerbs. Levels shall be arranged to give gentle falls, minimum 1 in 60, for drainage and to avoid ponding hollows. Where finished levels are not given, the levels shall be such that the finished surface shall have a smooth, even fall (or gently rolling curve if shown) between the finished levels and those of the boundaries of the area. Where the contours of the banks adjoin roads, etc which are shown on the Engineer's drawings and there are discrepancies which require adjustments of levels, these are to be modified as agreed with the Engineer on site.
- G. Grass slopes are to be maximum 1:3, minimum 1:60 gradient. If it should prove, during the course of the work, that more or less materials should be used on various mounds than has been provided for in the contours shown on the drawings, subject to the general confirmation of the contours being unchanged, the Engineer may authorise such modifications as prove to be necessary as the work proceeds.
- H. Uneven settlement which becomes apparent within 6 months is to be rectified and reinstated at the contractor's expense at a time agreed with the Engineer.
- I. In all cases at the foot of all banks adjacent to paths, paved surfaces, walls or buildings, there is to be a horizontal strip, lightly hollowed, towards the bank. The slopes are to rise in an open curve from this up the bank. Under no circumstances are changes of direction in the slope, whether horizontal or vertical, to be sharp or angular, unless as shown on the drawings.
- J. Where fill is required to make up levels to required grades this is to be made up with approved subsoil, allowances being made for the subsequent spreading of a 150 mm depth of topsoil generally and 300 mm in plant beds.
- K. Where soil is placed on graded banks it is to be spread to match up with slopes, grades etc. and in accordance with the specification clauses covering this work.
- L. Any other material, i.e. hardcore, broken brick, may be deposited only where and as directed on site.
- M. Rubbish shall be removed from site.
- N. The Contractor is to take all due care in the course of the earth moving work to ensure that all deposited material is evenly consolidated, and especially that any lumps of soil are completely broken up in the course of the grading work. The placing of all soil to grades as shown is to allow for settlement.
A suitable period is, if possible to be permitted to elapse subsequent to soil being placed and prior to finished grading. Should special problems connected with the programming of this work arise, these are to be resolved with the Engineer before further work proceeds.

- O. Where earth moving work takes place within the vicinity of existing tree roots, the greatest care is to be taken to ensure that they are in no way damaged or destroyed, whether by compaction due to heavy vehicles, by lowering the ground within the roof spread of trees or by placing of fill, without the prior consent of the Engineer. The Contractor shall in no case lower the existing level of the ground within the branch spread of these trees.
- P. Where fill is placed, it is not to exceed 75 mm overall additional depth without the approval of the Engineer.
- Q. Only lightweight, rubber tyred vehicles and equipment are to be used after the grading has been shaped up and approved. Under no circumstances may heavy or track equipment be taken onto such areas.
- R. Final grading is to be free from any pronounced local mounds or depressions and all areas are to be graded to a true and even surface at the levels and slopes shown on the drawings. Topsoil shall not be contaminated by contact with salt, cement, lime etc, or by petrol, oil or other harmful liquids.
- S. Before application of topsoil all rubbish, stones exceeding 50 mm gauge and extraneous materials are to be removed from site.
- T. The topsoil application shall be carried out in such a manner that, duly consolidated, the topsoil forms a finished surface at no point less than 150 mm in depth.
- U. If, after topsoil application is completed, the upper level of soil within a depth of 225 mm from surface is considered by the Engineer to be unduly compacted as a result of prolonged operational traffic or from working under unfavourable weather conditions, the contractor shall loosen the soil to the required depth over such areas as shall be indicated to him. This loosening shall be done by transverse operations of a rotovator or other approved equipment, followed by chain harrowing. No rotovation shall be done if the spoil is wet, or during wet weather.

16.2 PROTECTION OF EXISTING TREES

- A. The Contractor shall ensure that disturbance to existing trees etc. is kept to an absolute minimum, and shall take the necessary care in maintaining the trees within the working area that are not to be removed.

16.3 NEW WORK

- A. Landscape work shall be carried out by experienced personnel and with approved methods, and in accordance with the following Cyprus/ British Standards:
- | | |
|--|------------------------------|
| CYS EN 12579, CYS EN 13038, CYS EN 13039, CYS EN 13041 | Peat |
| BS 4428 | General Landscape Operations |
| BS 3998 | Tree Work |
| BS 3936 | Nursery Stock |
| | Part 1 Trees and Shrubs |
| | Part 10 Ground Cover Plants |

16.4 MATERIALS

16.4.1 Delivery

- A. All material shall be delivered in original containers, with all labels legible and intact. Materials shall be protected from deterioration during delivery and while stored at the site.

16.4.2 Gravel Mulch

- A. Gravel mulch shall be of stone aggregate, crushed or uncrushed of which 80% will pass through a 10 mm sieve. It shall be reasonably clean and free of dirt, sand, organic matter and other debris. Gravel mulch shall be placed to a total thickness of 50 mm.

16.4.3 Fertilizers (to be used by planting subcontractor)

- A. Commercial fertilizer shall be 12-6-4 grade, uniform in composition and shall be delivered to the site unopened and conforming to the applicable local fertilizer laws bearing the warranty of the producer. Each sack shall bear the manufacturer's statement of analysis and shall contain the following minimum percentage of plant food by weight and approved equivalent; 12% available nitrogen, and 6% available phosphoric acid and 4% potash.
- B. Fertilizer for re-fertilizing shall be ammonium sulphate containing 21% nitrogen or ammonium nitrate containing 33% nitrogen, uniform in composition, free flowing and suitable for application with approved equipment. The fertilizer shall be delivered to the site and bearing the warranty of the producer.
- C. Sulphur shall be finely ground, raw, agricultural grade a purity of at least 98%.
- D. Iron sulphate shall be fine salt produced from the chemical FeSO_4 free of lumps, suitable for uniform mixing with soil.
- E. Slow release fertilizer for tree pits shall be in pocket or pill form and shall be agriform Planting Tables 20-10-5 or other equal and approved.

16.4.4 Peat Moss

- A. Peat Moss shall be a natural product of sphagnum moss or sedge peat, and shall comply with BS 4156. Peat shall be free from lumps, stones or other foreign matter and of such physical condition that the peat can be readily incorporated with the topsoil. Peat shall contain not less than 70% organic matter by weight.

16.4.5 Organic Matter

- A. Locally available animal manure of an approved source to be well rotted, free from chemicals to hasten decomposition artificially or any other injurious substance. Manure shall be at least nine months, old and not more than two years old and shall be free from sawdust, salt, hay, or refuse of any kind. Manure shall consist of not more than 25% straw.

- B. Composted sewage sludge dried in lagoons or drying beds exposed to the air to produce a raw sludge with a moisture content of 3-50%. Digested sludge shall have the following minimum content:

Dry matter	25%
Organic Matter	23%
Total N	1.4%
P205	1.1%
K20	0.2%

16.4.6 Water

- A. Water for landscape work shall be of potable quality and shall be kept free from oil, acids, alkali, salt, and other substances harmful to the growth of plants. The source of water shall be subject to approval. No salty water, i.e. with more than 0.5 per thousand of sodium chloride shall be used. The Contractor shall submit sufficient quantities of water to be sent to the laboratory to be analysed.

16.4.7 Wrapping

- A. Tree wrap tape shall not be less than 100 mm wide designed to prevent bore damage. Burlap, galvanized insect screen or other material for wrapping tree trunks may be used in lieu of tree wrap tape upon approval.

16.4.8 Stakes and Guys

- A. Where required provide stakes and deadmen of sound new softwood, free of knot holes and other defects. Provide galvanized iron wire with zinc-coated turnbuckles. Provide new 2-ply garden hose not less than 13 mm in diameter and to required lengths to protect tree trunks from damage by wires or guys.

- B. Provide where required burlap of jute and weight not less than 34 grams per square metre. Substitute cloth shall possess an equal strength and resistance to tearing.

16.5 SOIL

16.5.1 Source of Soil

- A. The Contractor shall locate and supply top soil from approved areas as basic soil material for subsequent enrichment for the prepared soil mix as specified below. Suitable basic material will comprise friable free draining silty material containing no particles exceeding 50 mm. Samples shall be tested by an independent laboratory to the discretion of the Engineer for approval and conform to the following requirements:

16.5 SOIL (CONT'D)

16.5.1 Source of Soil

pH	6.0-7.5, saturated soil
Electrical conductivity	Less than 1.00 ohms, saturation extract
Free carbonates	Less than 0.5% air dried soil
Chlorides	Less than 200ppm in saturation extract
Sulphates	Less than 200ppm in saturation extract
Exchangeable sodium	Less than 15% in neutral normal ammonium
Acetate	
Nitrates	Less than 75ppm in saturation extract
Phosphorous	10-15ppm in 1.5 ammonium nitrate extractant: 1/2 hour shake
Potassium	100-400ppm in 1.5 ammonium nitrate extractant: 1/2 hour shake
Magnesium	25-100ppm in 1.5 ammonium extractant: 1/2 hour shake
Boron	Less 1.00ppm, hot water soluble
Physical Characteristics	Loamy sand made up by particle size as follows: Sand 2mm-0.05mm, 80-85% Silt 0.050-0.002mm, 20% maximum Clay less than 0.002mm, 5% maximum

- B. For the tests samples of 50 Kg shall be collected in the direction of the Engineer. Retesting as required shall be carried out if considered necessary or if the source of any material changes. Testing shall be at the Contractors expense.

16.5.2 Enrichment of Soil

- A. Organic animal manure for counteracting soil deficiencies and to improve the water retentive capacity of the soil, shall be added at the rate of 1 part bulk (being not less than 20% of volume) to 3 parts bulk basic sweet soil. If the soil already contains organic matter, the amount of manure can be reduced with the prior agreement of the Engineer.

16.5.3 Soil Mixing

- A. Imported soil and added ingredients shall be thoroughly mixed by machine prior to being transported to the planting area.

16.6 PREPARATION OF GROUND SURFACE

16.6.1 General

- A. Equipment in good condition shall be used for the proper preparation of the ground. Equipment shall be subject to approval before work is started.

16.6.2 Clearing

- A. Prior to grading and tilling, vegetation that may interfere with operations shall be moved, grubbed and raked. The collected material shall be removed from the site. The surface shall be cleared of stumps, and stones larger than 30 mm in diameter, and roots, cable, wire and other materials that might hinder the work or subsequent maintenance shall also be removed.

16.6.3 Grading

- A. Final Grades shall be maintained on the areas to be treated in a true and even condition, and necessary repairs shall be made to previously graded areas. All surfaces shall be left in a smooth condition to prevent formation of depressions. Areas having inadequate drainage as indicated by the ponding of water near foundations, walks, driveways, or on other areas shall be filled or graded to drain as so directed. Ruts, deep tracks, dead fur rows, and ridges shall be eliminated and the necessary replanting accomplished prior to acceptance of the completed work. The finished grade shall be such that after the various operations, the planted grade will be 50 mm below the adjacent surfaced grade of walks, drives and curbs.

16.6.4 Tillage

- A. After the areas have been brought to the grades shown, tillage shall be accomplished in such manner as to destroy existing vegetation and to prepare an acceptable seed bed. The Contractor shall utilize cultivators with adequate horsepower and heavy duty tillage equipment if required to accomplish the specified tillage/cultivation operations. All areas shall be tilled with a Roto-Tiller or other approved mechanical or hand equipment. Tillage shall be sufficient to prepare a smooth surface sufficient for planting and moving operations. Depth of tillage shall be 300 mm.

16.6.5 Excavation

- A. Such areas that cannot be cultivated by hand or hand operated machine to a depth to 300 mm and to the satisfaction of the Engineer are to be excavated to a depth of 300 mm below final levels and the material carted off site.
- B. Excavation for planting shall include the stripping and stacking of all existing planting mixture encountered with the areas to be excavated for planting. Tree stations and planting pits shall be excavated to the sizes and in the positions shown on the drawings (min. 1000 x 1000 x 1200 mm for single tree station and min. 600 mm deep for area of shrubs and 300 mm deep for ground cover and grass areas) including breaking out any rock or other obstructions. Hardcore and rubbish shall be carted from the site and disposed off as directed.
- C. Prior to backfilling tree pits the base must be broken up so as to minimize compaction. A layer of crushed stone or other approved porous material shall be laid to the depth shown (min. of 200 mm) on the drawings and made suitable provision in pits for drainage.
- D. It is not contemplated that planting shall be done where the depth of soil over underground construction, obstructions, or rock is insufficient to accommodate the depth of soil. Where such conditions are encountered in excavation of planting areas and where stone, boulders, or other obstructions cannot be broken and removed by normal means, or where trees to be planted are found to be under overhead wires, other locations for the planting shall be designated.

16.6.6 Backfilling

- A. Prior to backfilling (if required) the base of any excavated area for grassing is to be broken up and covered with 50 mm layer of loose gravel if so shown on the drawings. Backfilling, using soil as previously specified for the planting areas is to be carried out to 50 mm below final levels.

Backfilling in tree pits using soil for planting as specified shall be carried out in layers to fill the complete pit. Each layer shall be carefully consolidated, care being taken to avoid damage to irrigation pipes, and services if any.

17.0 EXTERNAL SERVICES**17.1 EXTERNAL WATER SUPPLY****GENERAL**

- A. The work under this heading includes all external water supply piping and fittings, excavations, backfilling etc as hereinafter specified and as shown on the relevant design drawing.
- B. The supply and installation of the general water supply piping, fittings, valves and testing of the system is the mechanical sub-contractor's responsibility.

17.1.2 PIPING AND FITTINGS

- A. All external water supply piping and fittings run underground shall be polythene pipes to Class "C" (130 psi-9 Bar). Fittings shall be UPVC to BS 4346.
- B. Compression fittings for polythene pipes shall conform to BS 864. The size of fittings shall be designated by the normal size of the pipe stated in BS 6572, BS 6730. Metal components shall be in accordance with 1.5.1 of BS 864 Part 2.

17.1.3 VALVES

- A. On underground cold water valves shall be sluice flanged type, constructed from cast iron with wedge disc, non-rising stem, inside screw and bronze trim according to BS 3464, complete with operating key. A cast iron surface box (size 150x150x230mm high) shall be provided for each sluice valve, consisting of a top cover with lettering S.V. and embedded cover.

17.1.4 PIPEWORK INSTALLATION

- A. Pipework and fittings and associated equipment shall be installed and tested strictly in accordance with the manufacturer's instructions and recommendations.
- B. 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 Engineer's approval before concreting commences.

17.1.5 PIPEWORK CLEARANCES

- A. 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.

17.1.6 SEALING OPEN ENDS OF PIPEWORK

- A. 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.
- B. 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.

17.1.7 FLUSHING OUT AND CLEANING SYSTEM

- A. At the completion of the water pipework installation all plugs shall be removed and the pipework shall be rodded and flushed with water. The operation may be phased at the direction of the Engineer.

17.1.8 COVERING WORK

- A. Under no circumstances shall any of the pipework installation be covered up, until it has been inspected by the Engineer and tested. If the work is covered before inspection, the Engineer shall be empowered to have the coverings removed for the purpose of any inspection or test he deems necessary.

17.1.9 TRENCHES, PIPE LAYING, PIPE BEDDING, BACKFILLING, COMPACTION

- A. The relevant section of this specification related to the above works shall apply.

17.1.10 PIPES UNDER ROADS

- A. 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.

17.1.11 TESTING

- A. After all piping has been installed the system shall be flushed out then filled with water under a minimum pressure of one and a half (1 1/2) times the working pressure designed for the system or 9 bar, whichever is greater. The pressure shall be maintained for twenty four (24) hours. Testing shall be performed by the mechanical sub-contractor in the presence of and to the satisfaction of the Engineer or his representative.

17.2 EXTERNAL SEWERAGE**17.2.1 GENERAL**

- A. The work under this heading includes all external drainage piping and fittings, excavations, backfilling, construction of manholes, manhole covers and frames, construction of pumping station, drainage pumps and chemical injection system as hereinafter specified and as shown on the relevant design drawing. All mechanical works associated with the pumping station and the chemical injection system shall be executed by the mechanical sub-contractor. This includes the drainage pumps, control panels, force piping, dosing pumps, storage tanks and all necessary controls.
- B. All workmanship shall comply with the CYS EN 752 Building Drainage.
- C. 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 Engineer for approval.
- D. 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 Engineer shall, at the discretion of the Engineer, be removed, and restored to the original working drawings design at the Contractor's expense.
- E. 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.
- F. The whole of the installation shall be carried out in accordance with the statutory requirements and to the entire satisfaction of the Engineer.
- G. All materials used in the construction of the works and all suppliers shall be approved in writing before orders are placed.

17.2.2 PIPING FITTINGS

- A. All external drainage piping and fittings shall be UPVC pipes in accordance to BS 4660 for underground piping.

17.2.3 PIPEWORK INSTALLATION

- A. Pipework and fittings and associated equipment shall be installed and tested strictly in accordance with the manufacturer's instructions and recommendations.
- B. 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 Engineer, inconsistencies in gradient in individual pipe lengths shall not be accepted.
- C. Where cast into reinforced concrete, pipes are to be positioned so that at no point will be 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 Engineer's approval before concreting commences.

17.2.4 JOINTING

- A. 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.

17.2.5 PIPEWORK CLEARANCES

- A. 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.

17.2.6 CARE AND STORAGE OF PIPES AND FITTINGS

- A. The Contractor shall be responsible for the protection of all pipework during the installation.
- B. 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.
- C. Joint sealing rings and gaskets shall be carefully stored in boxes to prevent damage.

17.2.7 SEALING OPEN ENDS OF PIPEWORK

- A. To prevent the entry of building debris, the contractor shall seal all open ended drainage pipework immediately after installation. This shall be carried out with suitable purpose made plugs, temporarily fixed in position to avoid removal.
- B. 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.

17.2.8 FLUSHING OUT AND CLEANING SYSTEM

- A. 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 Engineer.

17.2.9 COVERING WORK

- A. Under no circumstances shall any of the pipework installation be covered up, until it has been inspected by the Engineer and tested. If the work is covered before inspection, the Engineer shall be empowered to have the coverings removed for the purpose of any inspection or test he deems necessary.

17.2.10 CONCRETE MANHOLES

- A. In situ concrete manholes shall be constructed as per detail drawings. The section of this specification related to concrete work shall apply.
- B. Malleable cast iron step irons for use in manholes shall comply with CYS EN 13101.

17.2.11 MANHOLE FRAMES AND COVERS

- A. All manhole frames and covers shall comply with CYS EN 124.

17.2.12 TRENCHES, PIPE LAYING, PIPE BEDDING, BACKFILLING, COMPACTION

- A. The relevant section of this specification related to the above works shall apply.

17.2.13 UPVC PIPES UNDER ROADS

- A. 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.

17.2.14 TESTING

- A. 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 Engineer so approves, the water level shall be maintained for 1/2 hour without loss of water.
- B. 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.
- C. All works shall be tested as specified and to the satisfaction of the Engineer before refilling of excavation is commenced.
- D. 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 Engineer.
- E. 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.
- F. The Contractor shall provide and fix testing branches and bends as required and seal off or remove them as directed by the Engineer.

17.2.15 PUMPING STATION

- A. The Contractor shall execute all builders' work, associated with the pumping station whereas the mechanical sub-contractor shall execute all mechanical works including the supply and installation of the force pipe as described in the mechanical specification and indicated on the drawings.

17.2.16 FINAL TESTING

- A. Final inspections and tests of the whole of the works in this section may be required by the Engineer. 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.