

## **LOT-1: TECHNICAL SPECIFICATIONS**

### **A. 1.0 GENERAL**

#### **1.1 Generally**

These specifications shall be read in conjunction with the Conditions of Contract, Drawings and Bills of Quantities and it shall form part of the Contract Documents.

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

Where trade names are given the term "or equal and approved" shall apply in all cases and in no case it will denote preference to that trade name. The Contractor must submit samples from at least three manufacturers and these samples must be equal and approved.

#### **1.2 Construction Durations for all works to be: 8 months.**

#### **1.3 Materials**

Materials are to be of the best quality consistent with the character of the Works. Materials are deemed to be specified to comply in general with the relevant British standards or European standards and Eurocodes unless otherwise indicated.

Where a particular proprietary product, supplier, or supplier's catalogue is referred to in the Bills of Quantities, the material specified may be obtained from another source provided it is equivalent, equal and complies with the appropriate British standards. 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.

If during the course of the Contract certain materials required for use in the Works should be unobtainable despite the best efforts of the Contractor, then the Contractor may offer for the approval of the Engineer substitute materials.

These substitute materials, although not complying fully with the Specification, must nevertheless be suitable and appropriate for use in the Works. Acceptance or refusal of such substitute materials shall be at the sole discretion of the Engineer.

In the event of acceptance of the substitute materials a suitable price reduction shall be made in respect of decrease in quality or value but no price addition shall be made in respect of increase in quality or value. In the event of refusal of the substitute materials the Contractor shall not be relieved of any of his obligations under the Contract and shall be solely liable for any delay or loss occasioned by his failure to provide materials as specified.

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

The Contractor shall furnish for approval all sample of materials and workmanship required by the Engineer. Materials rejected by the Engineer are to be removed from site within 24 hours of such rejection and the Contractor shall substitute proper and suitable materials to the approval of the Engineer. All additional costs in connection therewith shall be borne by the Contractor.

The Contractor will be held entirely responsible for ensuring that all materials to be imported arrive on Site in sufficient time to maintain the programme.

The Bills of Quantities shall not be used as a basis for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered and no claim will be entertained in respect of the quantities contained in the Bills of Quantities being approximate.

#### **1.4 Workmanship**

The Engineer have the right to issue instructions requiring the dismissal from the Works of any person employed thereon, whose performance is judged as unsuitable. The Engineer have also the right to issue instructions in regard to the removal from the site of any equipment or plant which are not safe or suitable for the correct execution of the works.

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

Workmanship is to be of a high standard throughout, particularly with regard to the accuracy of dimensions, lines, planes, levels and the quality of surface textures. The Contractor is to do everything necessary to ensure that the standard of finish which is hereby demanded by this contract is achieved.

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

### **1.5 Samples and shop drawings**

The Contractor shall furnish for approval, with reasonable promptness, all samples of materials and workmanship required by the Engineer. All materials or workmanship which according to the Engineer's judgment are not equal in quality, appearance and strength or otherwise to the approved samples, shall be rejected. All additional costs in connection therewith shall be borne by the Contractor.

The Contractor must prepare, whenever required by the Engineer and for any workmanship, shop drawings.

### **1.6 Testing**

All costs in connection with routine tests for quality of materials and workmanship, referred to in the specification, shall be borne by the Contractor despite their results.

In addition to the above tests the Engineer has the right to obtain samples of materials and workmanship and demand testing by independent laboratories.

All costs in connection with such testing shall be borne by the Employer except in the cases where the results are negative and require rejection of the materials or workmanship being tested. In such cases all costs shall be borne by the Contractor.

### **1.7 Drawings**

All original drawings that have been used for the preparation of the Bills of Quantities, shall constitute part of the Contract.

Additionally to the above drawings, the Engineer has the right to issue during construction, supplementary or explanatory drawing which shall be binding and constitute part of the Contract provided they are not different from original drawings.

All shop drawings of temporary works (scaffolding, formwork etc.) reinforcement drawings and reinforcement bending schedules shall be prepared by the Contractor and submitted to the Engineer for approval at least 4 weeks prior to the execution of the works.

All drawings / schedules prepared by the Contractor must be in the metric system (SI Units). The approval or modification of the above drawings / schedules by the Engineer shall not relieve the Contractor of any of his obligations or responsibilities.

### **1.8 Levels**

The Contractor before carrying out any excavations must verify all the levels and contours shown in drawings and must report any discrepancies to the Engineer.

### **1.9 Measurements and rates generally**

The Contractor is to allow in his pricing and rates for all items mentioned in the specifications sections and/or in all other sections of the Bills of Quantities and which have a cost and are not specifically mentioned in the items description in the Schedules of Quantities section, and irrespective whether mentioned or not the "measurement and rates" for each trade.

All work has been measured net as fixed in position. The order of stating dimensions in the description is generally in the sequence of length, width and height. Where that sequence is not appropriate or where ambiguity could arise, the dimensions have been specifically identified.

Where the unit of billing is the meter, quantities have been billed to the nearest whole unit. Fractions or a unit less than half have been disregarded and all other fractions have been regarded as whole units.

Unless otherwise specifically stated herein, the following are deemed to be included with all items:

- a) Labour and all costs in connection therewith.
- b) Materials, goods and costs in connection therewith (e.g. conveyance, delivery, unloading, storing, handling, hoisting, lowering).
- c) Fitting and fixing materials and goods in position.
- d) Use of plant.
- e) All straight, raking and circular cutting and notching.
- f) Establishment charges, overhead charges and profit.

Junctions between straight and curved and straight and raking works are in all cases deemed to be included with the work in which they occur.

Each trade name shall be read as if it contained the phrase "equal and approved".

"Approved", "Directed", "Selected", and equivalent expression shall relate to the Engineer's /Engineers decision.

"Protect the work". Temporarily casing up, covering, protecting and the like to ensure that the work is left clean and perfect at the completion of the works.

"Test the work". Testing before covering up and again on completion of the works in the presence of the Engineer /Engineer and local and other authorities or their representatives and leaving perfect including the provision of water, instruments, apparatus and attendance.

"Profile Cutting". Configured cutting at edges measured the shortest distance between the points at which the cutting begins and ends.

"Falls", "Slopes", "Weathered". Inclination out of the horizontal in one plane.

"Cross Falls", "Cross Slopes", "Cross Weathered". Inclination out of the horizontal in more than one plane.

The terms "Plug", "Plugging" and the like are to include work in all materials. Plugging unless otherwise restricted, is to include the use of gun pinning, shot firing and patent plugs at the Contractor's volition.

Items which have prime cost (P.C.) rates shall be deemed to be exclusive of the cost of conveying the goods or materials to the site from the supplier in Cyprus and of loading and unloading, the cost of which is to be allowed for by the Contractor in his prices.

Generally all items are to include all labors.

Fillings are to include packing around pipes and other items.

Building paper, damp-proof membranes, quilts and all non-rigid sheet materials are to include holes and notching and the extra labor or turning up at edges and the like.

Holes, mortises, pockets, grooves, chases and the like and items described as "built in" are to include making good in its fullest sense and through, around, into, over and up to the items concerned.

Curved is to include work to any radius.

**The contractor needs to make photographic recordings of all the works carried out. This will deliver to the Engineer with the completion of the work.**

## **B. 2.0 SET UP OF SITE**

Set up of site, including provisional works to protect the site and provide functional devices, cleaning, demolition and removal of inappropriate additions (concrete slabs located around the church).

### **2.1 Provisional and protection works**

#### **2.1.1 Temporary Fencing:**

Temporary fences have to guarantee security and prevent access to unauthorized persons. Erection of corrugated sheet fences around the building will be completed before any initialization of work. The access to the building will be provided by demolishing partly the existing wired fence and inserting a temporary entrance door.

New fences of at least 2m tall will be placed distanced min 3,5m from the building.

Standard aluminum warning plates with refracting adhesive film on square or rectangular support on a white background will be installed.

#### **2.1.2 Scaffoldings**

External scaffolding all around the building made of Tube-Coupler system, with working levels carried out in such a way as to allow the restoration works on the masonries, including safety ladders, two protective side railings, side feet board, grounding and synthetic fibre net for shielding of scaffoldings. Installation and maintenance of scaffolding shall be guaranteed during all Works.

Before erection of the internal scaffoldings concrete flooring will be cleaned. Wooden boards shall be placed under the scaffoldings and under any machinery that shall be introduced in the church if necessary. Scaffolding inside the church and the same as outside, will be carried out in such a way as to allow the restoration works on the masonry, spaced at least 20cm from walls and with working levels every 200cm maximum. Including safety ladders, two protective side railings, side feet board. Maintenance of scaffolding shall be guaranteed all along the restoration works of internal surfaces.

#### **2.1.3 Permanent Fencing**

Site is at present enclosed by a wired fence that shall be checked and, if necessary, reinforced or repaired. The part demolished to give access to the site will be reconstructed accordingly at the end of the works.

#### **2.1.4 Protection of internal paintings/historical plasters**

**(To be done by conservator and specialized mason before any work regarding interior and before injections)**

The detached parts will be attached via micro injection hydraulic plaster afore.

- Application of perimeter consolidation material Mape Antique FC ultrafine or equivalent approved by conservator around the painting if necessary.

-attachment of breathable net cover held in place with wooden frame in order to protect the paintings during the works.

#### **2.1.5 Removal of debris, inappropriate additions and vegetation**

- 1 Removal of concrete additions and/or inappropriate additions (hand executed or by 'restrained mechanical removal').
- 2 Removal of non-compacted debris, any tiles, not related stones, rubbish etc. around the church. Stones of historical value are to be preserved and stored near the site.
- 3 Removal of all vegetation (trees and shrubs) and general cleaning of the area to set up the site especially for the drainage works and erection of scaffoldings.

### **C. 3.0 EXCAVATIONS AND EARTHWORK**

#### **3.1. Excavations**

The Contractor is advised to survey the Work Site and acquaint himself with the existing surface conditions of the area so as to carry out an individual assessment as regards the implementation of the Drawings in relation to the excavation to be performed.

All excavation, earth moving, landfills, leveling, grading, trench digging and other such operations shall be properly performed and set out true to the required lines, curves, section, grades and/or inclinations.

All trenches, ditches, foundation pits etc. shall be excavated correctly in reference to widths, depths and dimensions as indicated in the Drawings/Plans and as ordered by the Engineer. In his Tender the Contractor is to include excavation in all types of soil, including those containing rocks and boulders. No extra payment/claim is admissible on account of the variable hardness of the soils, including rocks and boulders.

The Contractor shall bear full responsibility for the manufacture, provision and removal, once no longer needed, of all necessary types of support having adequate strength, in order to resist bearing pressure /the bearing capacity of the soil and safeguard the Project's execution as well as accidents and injuries to the workers.

The bottom of the trenches, ditches, foundation pits etc. shall be dug up and well rammed and tamped down to a depth not less than is required. If the bottom surface of the excavation is deeper than the depth shown on the Drawings or as per instructed, by error of the Contractor, the condition must be corrected by backfilling to the proper grade with concrete, conforming to the foundation requirements. All costs shall be borne by the Contractor and no claim/compensation shall be admissible.

The excavated areas should be kept free of water and/or mud at no extra cost.

After the excavation is completed, the Contractor shall notify the Engineer to that effect and no further work, including refilling, shall be taken up until the Engineer has checked and approved the depth and dimensions and also the nature of foundation materials. The Contractor is required to notify the Engineer upon completion of excavations. No foundation fills and refills shall be carried out before the excavations are checked and approved by the Engineer.

In general, excavation next to the side walls of the excavated area shall be conducted with utmost care and attention (per meter) and at all times adequate support should be provided.

#### **3.2. Earth work (according to angles and gradient towards the road)**

All earthwork operations shall be executed with selected/approved fine soils, free of silt, rock, debris, impurities and other undesirable or deleterious matter. Filled earth shall be placed in uniform consecutive layers of a thickness not exceeding 0,30 m each layer being watered to saturation, effectively rammed and tamped down, and properly compacted to ensure a compression of 98% and thus get maximum consolidation before the succeeding one is laid. Compaction shall be by mechanical compactor. Considerable attention shall be given to the proper and correct compaction so as to prevent any risks associated with fill subsidence and collapse.

Particular attention shall also be given to filling behind retaining walls.

#### **3.3. Archaeological Excavations**

Excavations shall use standard archaeological practice. Units shall be excavated using trowels, hand picks, shovels and rarely, rock hammers. Ceramic, metal, coal, slag, glass, shell, bone, mortar, charcoal shall be kept as well as any materials in question.

At each level, detailed notes, measurements and photographs shall be taken. The materials shall be cleaned at the Site and transferred somewhere safe.

## D. 4.0 CONCRETE, STEEL & INSULATION WORK

### 4.1. Concrete – Quality

Gross beton intended for use under footings and steel joints, shall be grade C15. Ordinary Portland cement shall be used. Ordinary Portland Cement (OPC) shall be in accordance with BS 12.

Natural or crushed aggregates shall conform to the requirements of the BS EN 12620. 20 mm of natural or crushed aggregates shall conform to the BS EN 12620.

Reinforced concrete, in general shall be grade C25 in accordance with the requirements of the BS 8110.

Water proofing compound conplast Prolapin 421 or equivalent shall be used for all retaining walls and subsurface slab.

### 4.2. Concrete – Admixture

**Sand:** The sand shall conform to BS EN 12620 with such aggregate grading (particle size distribution) suitable for cement concrete, of natural or crushed aggregates. The sand shall be free from dust or large amounts of other fine granular materials and its chemical composition shall be such that it does not cause any undesirable effects on the cement concrete properties. If sea sand is required, it shall be well-cleaned. Sieve analysis and chemical analyses shall be conducted and furnished to the Engineer before and after concrete production.

**Coarse aggregates/Gravel:** Coarse aggregates for concrete shall conform to the BS EN 12620 and shall have a maximum size of 20 mm, consisting of natural or crushed aggregations (stone and gravel). They shall be clean and free of dust or other deleterious matter and their chemical composition shall be such that it does not affect the behavior of the cement, thus influencing the setting qualities/strength/staining corrosion/durability of concrete. If sea-dredged coarse aggregates are required, these shall be well cleaned and washed. Chemical analyses shall be conducted and furnished to the Engineer before concrete production.

**Cement:** Unless otherwise specified in the relevant Conditions or Drawings or as otherwise approved in writing, the use of any other type of cement shall not be permitted.

**Admixtures:** Admixtures shall not be used without prior authorization.

**Water:** The suitability of concrete mixing water shall be ascertained by special analysis tests specified in RS5328, unless it is fit for drinking and comes from a public water system.

**Mixing:** Concrete mixing shall be carried out by equipment capable of properly mixing materials in sufficient quantities at the time and place of application. For accurate concrete mixture proportioning to be achieved, materials shall have to be measured by weight. Volume batching, measurements by handfuls of the aggregate constituents or any other such methods shall not be permitted and adopted. Cement quantities for each batch of concrete shall be decided in terms of a whole number of cement bags. Quantities of water shall be measured by volume.

**Ratios:** The ratios of materials used in the production of various types of concrete shall be adjusted, depending on the appropriate mix design of aggregates, to meet both quality and strength requirements of the particular class of concrete specified. By way of illustration, the concrete mixture ratio shall approximately be within the limits indicated in the table hereunder:

Material:	Quantities by Weight (kg) per cubic metre of concrete				Quantities by Weight (kg) per bag of concrete			
	<i>C15/20</i>	<i>C20/25</i>	<i>C25/30</i>	<i>C30/37</i>	<i>C15/20</i>	<i>C20/25</i>	<i>C25/30</i>	<i>C30/37</i>
<b>Cement</b>	150	250	350	400	50	50	50	50
<b>Sand</b>	650	600			130	75		
<b>Coarse aggregate</b>	1250	1100			250	135		

The selection of proportions of available materials to produce cement of required properties/any variations in concrete ingredients/any mix design should take into account the following criteria:

1. Fineness of concrete aggregates.
2. Degree of workability required, which shall range between 30mm – 100 mm.
3. Sand Moisture/The varying moisture content of the sand.

**Fine and Coarse Aggregate Storage:** All fine and coarse aggregates shall be kept in separate stock piles on hard surfaces (such as palettes or other suitable support) at the work site so as to prevent contamination by earth and/or other foreign matter or stored in properly constructed silos.

**Concrete Storage:** Cement may be stored in silos designed and configured for the purpose or in dry weather-tight and properly ventilated structures with floors raised above ground level with adequate provision to avoid absorption of moisture.

Water used for both mixing and curing concrete shall be clean, potable and completely free from foreign substances and impurities (organic or inorganic matter, acids, salt and other such deleterious matter.), which may affect the quality of the concrete. Where possible, a public water supply shall be used if available within a reasonable distance.

In the event that the quality and/or purity of the water are called into question by the Engineer, he shall have authority to order water tests to be conducted.

#### **4.3. Ready-Mixed Concrete**

Shall be considered and used if:

Conforming to the specifications under the Conditions herein laid down;

Produced by a manufacturer who meets the Engineer's approval;

Records of delivery note orders are kept;

The mix shall be capable of being applied within a maximum period of 30 minutes after mixing;

The addition of water shall not be permitted at the mixing plant and therefore water shall be kept separate from the cement, allowing for concrete to be mixed immediately before placement on the Work Site;

Colour of Undressed Concrete: No change in cementitious materials, proportions or way of mixing shall be made, where the concrete remains undressed.

#### **4.4. Quality of Work**

**Transporting Concrete:** Concrete shall in all cases be conveyed from the mixer to its place in the Works in such manner as to prevent inter mixing with foreign materials, segregation of its components and/ or loss of the concrete composite and ensure that the concrete is of the required workability at the time of placing.

**Flooring Substrate:** The Contractor shall carefully study the widths of the various floorings and elevations as determined and shown on the Drawings, in order to calculate and measure the different substrate elevation and grading of the substrata.

For pipelines/conduits which exist on top of reinforced concrete floors, the full length of the piping or conduits shall be encased in cement paste and the rest of the area shall be covered with screed. Special attention must be paid so as not to disturb, distort, or cause any other damage to the pipes/conduits in the course of Work. Alternative methods and approaches of Work, whenever available and suitable to be adopted, are to be specified and incorporated into the supplementary conditions.

**Cleanliness of Surfaces:** All surfaces which will come into contact with concrete shall be clean and free from impurities and/or free water.

**Inspection:** The Contractor shall notify the Engineer at least three (3) working days in advance of each concrete placement to allow for sufficient time to schedule required inspection and testing of all reinforcing work, formwork and bracing, inserts and other embedded items. Prior to the placement of concrete, all works, without exception and in all respects, shall have to be completed. Any inspection on the part of the Engineer shall not relieve the Contractor of the responsibility to perform the Work in accordance with approved Drawings and Conditions/ specifications.

**Records of Concreting:** The Contractor shall maintain an accurate and up to date record in respect of the conditions of the pouring of concrete, showing:

Date and time of concrete pouring; Weather and temperatures and sampling, when each part of Works was concreted.

**Sampling and Testing of Concrete:** Except otherwise approved, during concrete works one set of cubes (three cubes per set) per 20m<sup>3</sup> shall be taken from a randomly selected batch/sample taken of concrete at the worksite for testing and evaluation of the strength of the concrete.

**Cubes:** Cube test moulds shall be 150X150X150 mm in size. The cube moulds shall be manufactured with the level of precision and stiffness required for test samples to provide a fair representation of the quality of concrete used in the construction. The Contractor shall ensure that sufficient representative test cubes are produced to enable the concrete quality to be monitored properly, and in any case no less than six (6).

A minimum of three (3) cubes shall be made from batches of concrete for each particular grade sampled at each time concreting is in progress at the Site (from a different drum), which shall be cured and kept submerged in water and maintained at a controlled temperature of 20°C for a period of 28 days until ready for testing. Cube specimens shall be crushed at the approved Laboratory of the Cyprus Higher Technical Institute (HTI) or the Central Laboratory of the Cyprus Public Works Department or at another laboratory approved by the Engineer. All incidental charges/costs shall be borne by the Contractor.

The concrete specimen moulds shall be made by the Contractor in the presence of the Engineer.

Expected strength of the specimens shall be:

Grades of Concrete	Average volume of 4 concrete cubes/ Minimum strength at 28 days
C15/20	20.0 MPa
C20/25	26.5 MPa
C25/30	32.5 MPa
C30/37	35.0 MPa

**Placement:** All concrete shall be placed in final position strictly within a period of not more than half an hour (30 minutes) after the introduction of water to the cement and aggregates to ensure the sufficient plasticity and workability required for proper placing and full compaction of the concrete, thus achieving maximum strength and durability.

**Workability and Slump:** The workability of each concrete mixture shall be determined and measured at frequent intervals during the progress of corresponding Work, by means of the slump test carried out by a mould in the shape of a frustum of a mould, called the slump cone (apparatus). Any concrete mix that exceeds the maximum slump of 125 mm shall be rejected.

**Placing:** At no time shall concrete be deposited directly, chute, caused to flow or even dropped freely from height into the place of work, if reinforcement or other obstacles are in the way, particularly in columns and thin walls, so as not to cause segregation, uneven spreading or loss of the concrete composite.

**Compaction:** All concrete places in situ shall be compacted at all times:

**With power driver internal type vibrators**

Throughout the whole volume being compacted, until the concrete has been consolidated to the maximum practicable density, properly and thoroughly so as to form a solid mass free of voids, and fit tightly against all form surfaces, reinforcement and embedded fixtures;

Until the concrete surface is free of air pockets and blisters of coarse aggregates;

Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints and holes is free from voids or cavities.



**Concreting in Cold Weather/Monitoring of Temperature Changes:** On no account shall concrete be placed during cold periods, when the air temperature falls at or below 5°C. Sets of thermometers for regular monitoring and recording temperatures shall be placed at the Work Site at positions in the concrete near to each exposed face.

**Protection of Concrete Surfaces:** As soon as practicable after the initial set has taken place in the slabs or following the removal of formwork in columns and walls, all form surfaces shall be covered at once.

**Period of Protection:** All concrete surfaces shall remain covered for a continuous period of at least seven (7) days.

**Period of Protection:** For flooring surfaces which shall not have any other finish, the concrete shall remain protected and covered for a continuous period of at least ten (10) days.

**Method of Protection:** The method of protection adopted shall need the prior approval of the Engineer and shall not cause damage to the appearance of the undressed surfaces and shall not affect the cohesion with the paints, mortars or other finishes.

**Methods of Curing Concrete:** If no other requirements are affected, the curing shall be applied as soon as practicable after completion of placing and shall include one or more of the following methods as may best suit the circumstances:

- by maintaining the formwork in position and/or;
- by covering the surface with a layer of nylon sheet or;
- by using a chemical compound membrane that has been approved by the Engineer, or;
- by use of a wet covering.

**Protection:** Concrete must continuously be protected as follows:

- All surfaces in general shall be protected against harmful effects of weather elements, including rain, cold/frost, hail, and heat, rapid temperature changes, against physical damage or defacement of any nature.
- All surfaces shall be protected against rust, stains or other results of corrosion.
- Protection of immature concrete from physical damage or movement.
- Protection of immature concrete from rapid temperature changes, particularly against wetting by cold water.

**TSIRCON – FLOPROOF, a waterproofing plasticizing admixture, shall be added to the concrete mix for further protection against moisture and to obtain concrete of higher density and lower absorption. For every cubic meter of concrete, a dose of 1.5 litres shall be added to the mix. In other words, 2.5 packs of 20 litres per drum.**

**No concrete of slump below 30N/mm shall be permitted for use.**

#### 4.5. Steel

1. Reinforcing Bars: High-tensile steel deformed bars conforming to the requirements of BS4449. Minimum Leakage Limit: 500 MPa (steel grade B500S).
2. Welded Mesh Reinforcement: Welded steel mesh reinforcement conforming to the requirements of BS4483.
3. Cover Blocks : Types of covering blocks include:

Concrete cover blocks : shall be made with 10 mm gravel,

Cement cover blocks : shall be made with sand clay and cement at a 2:1 ratio

Plastic cover blocks : shall be sufficiently rigid and approved by the Engineer.

4. Cleanliness: Prior to the placing of concrete, all reinforcement shall be thoroughly clean and free from rust, scale, dust, oil or any other objectionable foreign substances that may adversely affect either the steel, concrete or the bond between them.
5. Protection from rust: Reinforcing steels projecting from the concrete shall be properly protected at all times against the adverse effects of weather conditions to prevent rust and other results of corrosion forming on the concrete surfaces.

6. Cutting and Bending: Cutting and bending of reinforcement steel shall be carried out with a precision of +/- 50 mm and performed by mechanical methods using equipment designed for the purpose and approved by the Engineer.
7. Straightening and Re-Bending: Straightening or re-bending of reinforcement shall not be permitted without prior approval.
8. Protruding Reinforcing Steel: All protruding reinforcing steel shall not be bended without prior approval.
9. Steel Joints: Wherever instructions are not provided, all steel joints shall not exceed sixty (60) times the diameter of the smallest reinforcing bar.
10. Profile Joints: Wherever special instructions are not provided, the joints in the profiles shall be thirty (30) times the diameter of the smallest reinforcing bar.
11. Welded joints for welded mesh: For welded meshes, all welded joints shall be 400 mm in length and 200 mm in width.

Fastening Reinforcing Steel: All steel shall be satisfactorily fastened and secured in position by the use of rib laths. All ends by the use of flexible metallic reinforcing wires shall be turned inwards and diverted away from the form.

Rebar Spacers: The upper reinforcement steel shall be secured in position by spacers per at least one (1) meter distance, unless otherwise specified.

Mesh Panel Fixing Clips: All mesh panels shall be joined together with mesh clips with diameter of eight (8) mm per one (1) meter, unless otherwise specified,

Cover Blocks: Cover blocks shall be positioned at relatively close distances from one another so as to ensure sufficient stability and cover all around the reinforcement.

Cover Blocks: In case of undressed concrete surfaces, the cover blocks shall be made of plastic or other material, which shall remain hidden from view underneath the final surface layer.

Steel Placement: All reinforcement steel shall be placed and secured in their position prior to pouring the concrete. No steel shall be placed after the depositing of concrete.

#### **4.6. Formwork**

Ordinary timber formwork shall be used, constructed of rough-cut timber boards intended for concrete surfaces which are to be dressed.

Timber formwork used for fair-face concrete surfaces shall be sheathed with waterproof oiled hardboard sheet or plywood or sheet metal or marine plywood or other such approved materials which are certain to ensure a perfectly smooth –visibly- and fine surface.

It is noted that wherever moulds for fair-face concrete are to be placed, all panels shall be of such new material so as not to cause any defects to the surface of the concrete.

Formworks need to be of rigid construction true to shape and dimensions shown on Drawings. Formworks need to be sufficiently strong enough to withstand all the dead and live loads and forces, such as the weights of equipment, labour, ramming etc. required for placing and compacting the concrete. Forms shall be of good quality, designed and built accurately so that the desired shape, size and finish of the concrete are attained.

The formwork used shall be removed with utmost care, avoiding shock or vibration that may cause damage to the cast concrete.

The responsibility for the adequacy and safety of all formwork shall rest entirely with the Contractor and the Contractor shall be held liable for any defects incurred or damage done to the formwork and shall have to make good the same at his own expenses.

Joints between sections of the formwork shall be firmed and secured so as not to permit leakage of cement paste through the joints.

The inside surface of wooden surfaces of the formwork which come into contact with the concrete shall be smooth and shall be applied with crude oil or other oily solutions that do not dilute with water to make the removal of formwork easy.

Mould removal work shall commence only after prior authorization of the Engineer, at minimum periods of time elapsed between the placing of the concrete and the striking of the mould as described below hereunder:

MINIMUM PERIOD (in days)

FORMWORK TYPES OF MOULD	SUMMER	WINTER
Vertical column moulds	1 days	2 days
Wall moulds	2 days	4 days
Slab and beam moulds	7 days	14 days
Soffits of slabs and cantilevers	14 days	21 days

In case of adverse weather conditions (frost etc.) as well as in the event that great load is to expected, the moulds shall remain in place, until otherwise instructed. Prior to the placing of the concrete, the moulds shall be watered and slats shall be positioned, where necessary.

All necessary holes for funnels chimneys, sewage piping etc., shall at all times be carefully and thoroughly cleaned.

#### 4.7. Consolidation

Consolidation work shall be thoroughly carried out on the existing structures, on the outer surface of the masonry as specified in the Drawings.

Existing foundation walls shall be brought to uniformly smooth, compacted and even surfaces by the use of cement plaster and flexible metallic reinforcing wires and allowed to set. After sufficient drying time, the insulation referenced herein shall take place.

#### 4.8. Insulation

##### 4.8.1 Polythene Sheet

A heavy duty double Polythene Sheet shall be placed beneath the gross beton, which shall be turned up behind the face of the walls.

##### 4.8.2 Prior to Insulation Installation

Prior to the installation of insulation, all exposed faces of retaining walls and existing stone walls, footings and steel joints shall be smoothened and shaped into a uniform alignment /so as to achieve the required uniform alignment on all exposed surfaces by means of cement plaster poured over flexible metallic reinforcing wire. After sufficient drying time has passed, all said surfaces shall be reinforced and dressed with a 4mm wide waterproofing membrane of special polyester (fully bonded to the substrate by torching) as shall be approved by the Engineer.

The interior faces of the walls, across the length and height of the substrate, shall be troweled with a waterproofing material (of Vandex type applied with steel trowel) that meets the approval of the Engineer, after all existing interior wall surfaces are thoroughly aligned with plaster.

##### 4.8.3 Waterproofing Insulation of a new construction

On top of the gross beton and prior to the installation of the substrate, insulation with Primer shall take place and double layer bitumen double-layer felt shall be laid.

The interior surface of the perimeter walls shall be treated with three (3) layers of waterproofing coating of 15 cm wide special polyester, after first all moisture has been properly removed.

All external faces of walls shall be insulated. A drainage membrane shall then be placed (by the TAPPI method) to ensure optimum protection of the insulation protection followed by a polythene sheet.

In general, wherever concrete comes into contact with the soil, insulation must be installed to the height of 30 cm above the finished flooring. Prior to installing the insulation, each such surface shall be smoothened, and a triangular fillet formed with cement-clay mixture shall be inserted as necessary to facilitate the application of the insulation material.

At the interior face of the walls, the insulation shall be extended upwards up to a height of minimum 30 cm along the length of the walls, as shown on the Drawings.

#### **4.8.4 Protection of Insulation**

Particular care shall be taken as to ensure the protection of all insulation. Prior to any earth moving operations, a polythene sheet shall be placed followed by a 3 cm wide drainage membrane (by the TAPPI method).

### **E. 5.0. CONCRETE WORK**

#### **GENERAL**

##### **5.1. Standards**

Unless modified by this Specification all concrete, sampling, testing and compliance shall comply with BS 5328 "Methods for specifying concrete, including ready-mixed concrete". In cases of conflict, this Specification takes precedence over BS 5328.

References in brackets in clause headings in this Specification are to clauses or sub-clauses of BS 8110 "Structural use of concrete". Unless modified by this Specification, concrete work shall comply with the requirements and recommendations of these clauses or sub-clauses. In cases of conflict, this Specification takes precedence over BS 8110.

The Contractor shall keep copies of these Standards on site.

A bracketed asterisk (\*) indicates that this clause of the Specification modifies the provisions of BS 8110 or BS 5328. This indication is included for convenience only; its absence does not mean that the provisions of BS 8110 or BS 5328 have not been modified by this Specification.

##### **5.2. Definitions**

###### **5.2.1. Characteristics strength**

"Characteristic strength" of concrete shall mean that value of strength below which no more than 5% of the works test results for each concrete grade will fall.

##### **5.3. Materials**

###### **5.3.1. General**

Before any concrete is supplied to the Works, the Contractor shall provide the following, which shall confirm compliance with specified requirements:

- Information listed in Clause 8 and/or Clause 14 of BS 5328.
- Information on aggregates in accordance with Appendix A of BS 882.
- Evidence of suitability of concrete mix.
- Workability of concrete mix.
- All other information regarding constituent materials required by this Specification.

##### **5.4. Materials**

###### **5.4.1. Cement**

###### **5.4.1.1. General**

All cement shall be delivered to the site in sealed containers or bulk cement lorries of suitable design.

All Portland cement used in the Works shall be obtained from a registered firm of assessed capability.

Super sulphated and high alumina cements shall not be used.

Written confirmation shall be provided that any proprietary grouts or mortars used in the works do not contain high alumina cement.

###### **5.4.2. Water**

If water is not supplied from Local Authority mains, then the Contractor shall arrange for tests to be carried out in accordance with BS 3148.

### **5.4.3. Admixtures**

Where permitted by this Specification, concrete admixtures shall comply with BS 5075. Acceptance of admixtures into the Works will only be made upon provision of satisfactory information relating to name, source, type, dosage and justification for use.

### **5.4.4. Chloride content**

The contractor shall provide written confirmation that any admixtures used in the Works are not substantially based upon calcium chloride and which states the actual chloride ion content.

### **5.4.5. Concrete**

#### **5.4.5.1. Concrete mixes**

Concrete mix requirements are scheduled in Table 1. Trial mixes and tests shall be carried out on concrete grade(s) C25 and above.

### **5.4.6. Reinforcement**

#### **5.4.6.1. Types of reinforcement**

All reinforcement supplies for the works shall be European B500C.

The types of reinforcement bars will be identified on the schedules by prefixes to the bar mark numbers.

The prefixes have the following meanings:

- (i) R: Plain round hot rolled mild steel bars with a characteristic strength of 250N/mm<sup>2</sup> and complying with BS 4449.
- (ii) Y: Type 2 deformed high yield steel bars complying with BS 4449 or BS 4461 with a characteristic strength of 460N/mm<sup>2</sup>.

Steel fabric shall comply with BS 4483 and shall be delivered to site in flat sheets.

### **5.4.7. Ready-mixed concrete**

#### **5.4.7.1. Approval of plant**

Ready-mixed concrete shall be produced at an approved depot by the Engineer.

Sulfate Resisting Cement shall be stored in an independent Silo.

The weighing and water - dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in the relevant ASTM standard and checked against accurate weights and volumes when required by the Engineer. The weights of cement and each size of aggregate shall be within a tolerance of  $\pm 2$  percent of the respective weights per batch approved by the Engineer. The weights of the fine and coarse aggregate shall be adjusted to allow for the free water contained in them.

## **5.5. Materials**

### **5.5.1. Ready-mixed concrete**

#### **5.5.1.1. Approval of plant**

All delivery tickets shall be retained by the Contractor and made available for examination throughout the duration of the Contract.

- Date and time of arrival of truck.
- Time and place of mixing of concreting materials.
- Registration number of truck and name of depot.
- Time and place of adding water to materials.
- Time when concrete is placed in position and left undisturbed.
- Mix class.
- Position in the structure where the concrete is placed.
- Whether test cubes were taken from this delivery.
- In the event that cubes are taken, record of results.
- Slump.
- In the event that slump is taken, record of results.

- Details of additives, where the use has been approved.

The Contractor shall keep all such delivery notes for inspection by the Engineer.

**5.5.1.2. Additional water**

All the constituents for each mix shall be added at the manufacturer's depot. No extra water or other material shall be added after the concrete has left the depot.

**5.5.1.3. Rejected concrete**

Rejected concrete shall be removed from the site. The delivery ticket shall be marked "REJECTED".

**5.5.2. Materials**

**5.5.3. Storage of materials**

**5.5.3.1. Cement**

Cement shall be used in the order that it is received on site.

**5.5.3.2. Aggregates**

Aggregates shall be stored on hard paved self-draining areas or in suitable hoppers or containers.

Different types of aggregate shall be kept separate.

**5.5.3.3. Reinforcement**

Reinforcement shall be stored clear of the ground and protected from mud, oil and other substances which may adversely affect its use in the Works.

Steel fabric shall be delivered and stored flat.

**5.6. Workmanship**

**5.6.1.1. Reinforcement**

**5.6.1.1.1. Cutting and bending**

Reinforcement shall not be cut or bent except as shown in the Building Schedules without approval.

Each bundle of bars shall be clearly tagged with their schedule and mark numbers.

**5.6.1.1.2. Fixing**

Unless shown otherwise on the drawings, nominal concrete cover to reinforcement shall comply with BS 8110, Clause 3.3.

All reinforcement shall be positively held in its correct position before concreting starts. Spacers between reinforcement and formwork shall be of either concrete or plastic unless otherwise approved. Plastic spacers shall be of approved design. The Contractor shall supply and fix all chairs required to maintain the reinforcement in its correct position. Reinforcement shall not be welded without approval.

Galvanized reinforcement shall not be welded. Where concrete spacer blocks are required in exposed concrete they shall be made from the materials used in the surrounding concrete.

**5.7. Workmanship**

**5.7.1.1. Reinforcement**

**5.7.1.2. Rust staining**

Concrete surfaces which will be exposed to view in the finished Works shall be protected from staining due to resting of projecting reinforcement either by coating the reinforcement with cement grout or by another approved method.

**5.7.2. Concreting**

**5.7.2.1. Final preparation and inspection**

Unless directed otherwise, the Contractor shall give notice before each concrete pour so that an examination may be made before the concrete is placed.

If concreting is not started within 24 hours of approval being given, approval shall again be obtained from the Engineer.

#### **5.7.2.2. Transporting**

Runs of gangways for concrete transporters and main runs for foot traffic, shall not be supported or allowed to bear on the fixed reinforcement.

#### **5.7.2.3. Placing**

Concrete shall be placed continuously up to construction joints, while, in the opinion of the Engineer, it is still sufficiently plastic for adequate compaction.

In particular, for the placing of concrete for the pile cap the casting operation must be completed in an 18-hour period. At least three pumps will be used. One standby concrete pump will be required. One placing gang must be available for each concrete pump.

Unless otherwise agreed by the Engineer, concrete shall not be dropped into place from a height exceeding 1.2 meters.

#### **5.7.2.4. Placing for formed finishes**

The concrete shall be placed in one continuous operation rising uniformly in the formwork at a rate not less than 2 m per hour. The concrete shall not be handled in any manner that may cause segregation.

The concrete shall not be placed directly against a vertical form face but shall be caused to flow to this surface during the compaction process. Care shall be taken to avoid the form face being splashed with mortar during the placing operation.

### **5.8. Workmanship**

#### **5.8.1. Concreting**

##### **5.8.1.1. Compacting**

Unless otherwise specified all concrete shall be compacted by mechanical vibrators of appropriate type.

The Contractor shall provide details of the type, size and number of vibrators to be used in the Works. Whenever concrete is being vibrated at least one spare vibrator of each type in use shall be available in case of breakdown.

Vibrators should be used continuously by immersing in a large number of places for short periods rather than in one place for a long time. The spacing between points of application should be such that all parts of the section are equally and fully compacted.

The vibrators must not be used to cause the concrete to "flow" horizontally along the work, and placing of concrete shall therefore be kept sufficiently ahead of the vibrator to prevent this.

Under no circumstances should the vibrator be attached to or allowed to rest on reinforcement not embedded in the concrete.

Compaction shall start as soon as casting starts and shall continue during the placing operation so that at no time shall there be a large volume of un-compacted concrete in the formwork.

Starter sections of walls, columns, etc., shall be cast and compacted in such a way that their strength and other characteristics are at least equal to those specified for the whole member.

##### **5.8.1.2. Cleaning**

All equipment used for mixing, transporting, placing and compacting concrete shall be thoroughly cleaned before changing from one type of aggregate or cement to another and whenever mixing ceases.

#### **5.8.2. Concreting in hot weather**

Special precautions shall be taken in hot weather.

Any formwork made of metal, concrete or other material of high thermal capacity shall be cooled with water before concrete is placed against it.

Curing shall commence immediately after compaction. Protection from direct radiation shall be in place within 30 minutes after final tamping.

## **5.9. Workmanship**

### **5.9.1. Compliance**

(i) The Contractor shall check that the permitted deviations are not exceeded and shall keep a record of his checks. OR

(ii) The Contractor shall keep records in an approved form of the dimensions of all work as constructed.

These records, which shall be available for examination at any time, and shall be provided immediately after completion of each section.

### **5.10. Defective work**

In construction specified in the drawing as watertight, any leaks or damp patches shall be repaired in accordance with Section 9 of CP 102 or as approved.

### **5.11. Load tests**

Clause 9.5 of BS 8110 is excluded from this Specification. Test procedures and standards of acceptance will be as directed.

Where the results of such tests indicate that any part of the works does not comply with this Specification that part of the Works will not be accepted.

### **5.12. Measurement and rates**

Rates for plain and reinforced concrete shall be deemed to include for all necessary samples for testing as described above, apparatus, testing, hoisting, depositing and tamping, pouring into shuttering, formation of daywork construction joints, curing and the building in of all plugs, holdfasts, pipes, ducts etc., not exceeding 100 cm square in section and no deduction will be made in the volume of the concrete for these.

Rates for concrete work shall also include for all sundry items such as cutting or forming all holes, chases, sinkings, mortices and the like, wood or steel float finishes to horizontal surfaces, all necessary wood or metal members, pipes and generally performing all cutting away and making good for all trades, except where such work is measured specifically in the Bills of Quantities as "Builder's Work in Connection with Services.

Rates for precast concrete shall include for all moulds, reinforcement, finishing fair where required, hoisting and bedding and pointing in cement mortar (1:3) and temporary supports. Works described as precast in the Bill of Quantities may be cast in-situ if desired by the Contractor and approved by the Engineer but at no extra cost to the Contract.

### **5.13. Measurement and rates**

Rates for rod reinforcement shall include for cutting to lengths and waste, bending, hooking, placing and maintaining in position and tying at intersections with and including No. 16 SWG soft annealed tying wire, plastic spacers, spacer bars and supports (not included in weights given in the Bills of Quantities).

Rates for fabric reinforcement shall include for lapping a minimum of 40 mm bar diameter at all sides and end laps for cutting and waste, bending, fixing and tying at intersections with tying wire. Areas of fabric reinforcement have been measured net and the Contractor must allow for the extra material required for laps, etc., in his rates.

## **F. 6.0. FORMWORK (PERMANENT SUPPORTS)**

### **6.1. Materials**

All treatment of wood for the purposes of formwork construction shall be carried out in accordance with the drawings and the principles of first class joinery construction. Unless specifically stated otherwise, sizes shown on drawings are finished sizes and the Contractor must allow for wrought faces.

Where specified, timber is to be treated with an approved non-staining organic solvent type preservative.

The preservative shall be applied by brushing and spraying and care taken to treat all cracks and checks and shall be used strictly in accordance with the manufacturer's printed instructions.

All plugs inserted after cutting out defects shall be the full depth of the hole and the grain of the plug shall run in the same direction as the grain of the piece.



## **6.2. Timber**

All timber shall be properly seasoned and shall be planed square, straight and true and shall be reasonably free from sapwood, splits, ring shakes, soft pith, checks, knots, pitch pocket, decay and insect attack.

All timber shall be protected from worm attack and pests by VAC-VAC factory treatment before delivery to the site.

All timber is to be treated with one coat of approved wood preserver. All plugs inserted after cutting out defects shall be the full depth of the hole and the grain of the glue shall run in the same direction as the grain of the piece.

Samples of all timber shall be presented to the Engineer for approval and all timber incorporated in the works shall be of the same quality as the approved samples.

All the timber shall be burnt in a special furnace in accordance to the Engineer's approval.

### Softwood Timber

Softwood timber shall be Swedish Whitewood or other equal and approved.

### Hardwoods

Hardwoods shall be of the species given in the description and shall comply with the requirements of BS 1186: Part 1: 1971 for Class 1.

## **6.3. Timber**

Blockboard shall comply with the requirements of BS 3444.

Plywood shall be constructed in accordance with BS 1455 and shall be obtained from an approved manufacturer and shall be to the thickness shown on the Drawings. The Contractor will NOT be allowed to make up thicknesses by gluing together sheets of thinner plywood.

Plywood shall be free from end joints (including joints in veneers) overlaps in core veneers, dead knots, patches and plugs, open defects, depressions due to defects in cure, insect attack (except isolated pinworm holes through face only) fungal attack and from discoloration differing from that normally associated with species.

Face veneers shall be hard and durable and shall be capable of being finished to a smooth surface. Face veneers shall closely match the general joinery timber supplied.

Adhesives shall comply with the requirements of B.S. 1203 Grade W.B.P. and ensure proper adhesion between plies.

Edges of fasciae are to be planed smooth and square or are to be lipped with hardwood lipping tongued on so as to present a square and smooth surface for painting.

## **6.4. Workmanship**

Joinery shall comply with BS 1186 Part 2 and where possible shall be fabricated in a manufacturer's shop prior to delivery. It shall be accurately, properly and soundly constructed with all moulds and arises clean and sharp. Joinery shall be protected from damage during storage at site and throughout the construction period subsequent to fixing.

The terms "frame", "framed" or "framing" mean work put together by proper carpentry or joinery joints, such as morticing and tenoning, dovetailing, dowelling, etc., and the joints are to be as shown, specified or directed. Butted and screwed or nailed joints or halved joints and the like will not be deemed framed and will not be accepted for framed work.

Fixing of all joinery work, including fillets, architraves, frames, glazing beads and the like shall be by means of screws. Nailed work will not be permitted.

Screw heads in work to be painted shall be countersunk and stopped. Screw heads in wood to be oiled, varnished or polished shall be pellated, with the grain of the pellat in the same direction as the grain of the member.

### **6.5. Workmanship**

Unless otherwise described, work described as “plugged” shall be fixed by drilling holes in the wall or floor, plugging with “Philplug”, or “Raw plug”, or similar compound well rammed in all fixing the member with screws. Centres of the fixings must not exceed those necessary to provide adequate support and in any case must not exceed 600 mm.

The Contractor shall take overall measurements for joinery on site and not from the drawings.

The backs of all joinery are to be primed.

### **6.6. Metal supports and connections of timber members**

All materials shall be free from scale, rust, damage or defects. All welding, brazing or hot forming shall be carried out by approved processes. Metalwork generally shall comply with BS 3987.

All fabrication and welding shall comply with BS 449, Part 2.

Welding shall be carried out by skilled operatives with proven qualifications and experience in using the same electrode, class and welding positions which will be required in the work and shall comply with BS 1856. The competence of all welders shall be tested in accordance with the relevant British Standard.

Metal described as galvanised shall be entirely coated with zinc in accordance with BS 729, Part 1 with smooth and uniform finished surfaces. All exposed surfaces are to be painted with oil paint suitable for galvanised surfaces.

### **6.7. Measurement and rates**

Rates for woodwork are to include for all nails and screws, cutting and waste, halving, trimming, horing, sinking, notching and fitting dovetailed framing and/or scarf jointing and all other sundry labour of a like nature required. The rates are also to include for all scribing, rebates, grooves, chamfers, splayed and rounded edges, tongued angles, beads, mouldings, fair and returned ends, mitres, housing, holes for pipes etc. and for all short or isolated lengths.

## **G. 7.0. STEEL STRUCTURES**

### **General**

The design, fabrication and erection of all steel structures will be carried out in accordance with the provisions of EC3 and EC8 which will be deemed to form part of the present specifications.

The Contractor is obliged to employ expert staff who possess the required skills and training for structural steel works and who will be in a position to implement the requirements of these specifications.

The contractor will be responsible to prepare his own manufacturing drawings and cutting list in timely manner to be submitted and approved by the engineer.

The following work is included in the structural steel works: the supply, transportation to site, assembly, erection, adjustment and stabilisation in the correct position and the painting of all metal structures, and roof and column coverings, all as shown on the drawings and described in the specifications.

Four weeks prior to the commencement of any work related to structural steel works, the Contractor will submit to the Engineer the name and details of the independent quality control laboratory with expertise in Non-Destructive Testing – NDT, that is proposed to undertake the qualitative testing of the structural steel works. This laboratory is required to have experience in structural steelworks of similar scale in Cyprus and have, during the past 5 years, conducted similar qualitative tests in at least four projects with minimum value € 300.000.

The materials to be supplied by the Contractor will be identical, equivalent or of higher quality with regards to structure, performance, execution and strength, in relation to the materials described in the drawings and the specifications.

In the event the Contractor intends to use alternative materials with respect to the ones specified, then the Contractor must submit to the Engineer for approval the description of the manufacturing details, the manufacturer's name and details, and full technical description of the alternative materials for which approval is sought.

In the event that, during the defects liability period provided for in the contract, the alternative materials proposed by the Contractor fail for any reason to fulfil the requirements of the specifications, then the Contractor will, at his own expense, replace the said materials with the materials described in the drawings and specifications.

### **7.1. Submission of samples**

The Contractor is required to submit to the Engineer for approval, samples of all the materials that will be used, at least two months prior to the commencement of the work related to structural steel works.

These samples will be used as prototypes for the materials that will be installed in the works. In the event that any materials prove to be of inferior quality with respect to the approved prototype samples, then such materials will be immediately replaced. The Engineer reserves the right to request, at any time during execution, the submission of samples of the materials used in construction.

### **7.2. In situ measurements of dimensions**

The Contractor will, before the construction of any part of the work, satisfy himself that all the members fit and connect accurately and correctly in the structure's available space. In the event that the Contractor locates deviations, he will timely inform the Engineer in order to take the required actions.

### **7.3. Fabrication drawings**

The Contractor will furnish the Engineer with the fabrication methodology. This will include detailed suggestions in respect of:

- (a). The general schedule of welding both in the factory and in the site.
- (b). The category, type and method of the electrodes. In the case of automatic welding, the type of the materials used in this process.
- (c). For automatic or semi-automatic welding, the size of the electrode, the current wattage and voltage, the movement speed, the gas flow quantity and the consumption of materials that will be used in this process.
- (d). The number and alignment of passes where multiple pass welds are required. These are required to be shown diagrammatically.
- (e). The locations of the welds.
- (f). The frequency of the welding.
- (g). The surface preparation prior to welding.
- (h). Directions for usage and storage of electrodes.

The Contractor will furnish the Engineer with the methodology that will include detailed suggestions in respect of:

- (a). The schedule for erection on structural steelworks.
- (b). The methodology of erection, supported with drawings should this be considered necessary.

### **7.4. Materials**

#### Steel sections

The steel plates, sections, bars and hollow sections of the structural steelwork will be in accordance with BS 4360, BSEN 10025, BSEN 10013, EN 10210 and will be category S 325 JR and S355JR, Bolts Grade 10.9 and 8.8.

#### Manufacturer's Certificates – Samples and Tests

The Contractor, at his own expense, will submit manufacturer's certificates to confirm that the steel chemical composition and mechanical properties are in accordance with the relevant European standards.

The Engineer reserves the right to inspect the fabrication of the steel members at the workshop, to take samples for testing, BS4360, paragraph 24.1, and to be present at the testing process for the mechanical properties determination.

### Dimensions and Fabrication Tolerances of Steel Sections

The hollow and angle sections will be in accordance to the dimensions and fabrication tolerances of BS 4848: Part 2 and 4, respectively.

### Surface Defects

Repairs of surface defects on steel sections will not be allowed in the cases covered under BS 4360, paragraph 10.3, unless the Engineer issues special approval.

### Fabrication Tolerances of Steel Plates

The fabrication tolerances of the steel plates dimensions will be in accordance to BS 4360, chapter 2. For the plate thickness, the only tolerance acceptable will be in excess to the dimensions shown on the drawings.

### Welding Steel

To avoid weld cracking, the carbon equivalent quantity of the members to be welded will not exceed the quantity specified for their steel grade, as shown in BS 4360, table 3, unless the contractor suggests an appropriate welding procedure that may not require meeting the above mentioned requirements. The connecting plates at the visible nodes will be laser cut, and the edges will be rounded. A sample will be presented to the Engineer for approval.

### Ultra Sound Testing for Steel Plates

Steel plates, that due to their welding and thickness may show lamellae tearing, will be grade A01 and will undergo ultrasound testing. The equipment used for the testing will be in accordance to the relevant British or other accredited equivalent Standards.

## **7.5. Materials**

### Bolts

The bolts that will be used in the works will be galvanised, of grade 8.8 or as shown in the drawings. They will be in accordance to the relevant European or other accredited equivalent Standards.

### Friction Bolts

For high strength friction bolts (HSFB), the appropriate nuts and washers for the bolt grade specified will be in accordance to BS 4395 parts 1 and 2. They will also be galvanised in accordance to BS 729. All the nuts will be “torsion nuts” with no exception.

### Mechanical Properties of Connection Parts

The Contractor will submit evidence that will prove the accordance of all the connecting parts mechanical properties to the relevant British Standards.

### Anchor Bolts and Nuts

Anchor bolts to be cast in concrete will be of Grade 8.8, will be provided by manufacturers approved by the Engineer and will be installed according to the manufacturer’s specifications.

The contractor will submit to the Engineer, three copies of the manufacturer’s documents with the necessary technical information and details for anchor bolts, including their mechanical properties, safe working loads, and method of instalment and use.

## **7.6. Fabrication**

### General

The Engineer and his representatives will have access to all the sites that steelwork related work is executed. The Contractor will provide all the necessary facilities to the Engineer for inspection during fabrication and assembly.

At all stages of fabrication, every steel member will have a visible distinct marking. The approved marking format will make the member recognition and position identification easy.

### Steel Cutting

The edges of the compression members will be cold sawn and evened out with the use of a grinder, so that smooth surfaces will be formed for the even distribution of loads across the area of the section.

The connecting plates at the visible nodes will be laser cut, and the edges will be rounded. A sample will be presented to the Engineer for approval.

## **7.7. Fabrication**

### Steel Cutting (cont'd)

Notches or other shaping to the ends of the members will be cold or hot sawn. Machine flame cutting will only be allowed with the Engineer approval. In no case will manual flame cutting be allowed.

The member edges will be free of any defects which may adversely affect the serviceability of the member. All small ridges or similar flaws will be mechanically evened out.

### Clearances

Care will be taken to ensure the defined clearances between the members. The erection clearance at the ends of beams will be 3mm, except in the cases which for practical reasons

The clearance has to be increased. In cases as such, the Engineer's approval is necessary.

### Bolt Holes

Bolt holes will be drilled. With the Engineers approval, in the cases that the use of a drill is not practical, then the holes can be punched out. In cases as such, the bolt-hole diameter will be 2mm smaller than the expected, and will be later enlarged to the desired diameter. All ridges will be removed before member assembly.

For black bolts up to 24mm diameter, holes will be 2mm bigger than the bolt diameter, and 3mm smaller for bolts with diameters larger than 24mm, except where it is defined otherwise by the Engineer.

If the HSFB will hold more than three plates, then the holes of the two outer plates will be as described above, while the holes for the inner plates will be 3mm larger than the bolt diameter.

Bolt holes will be formed using the appropriate equipment or the holes at the edges will be drilled and mid-section will be opened using a lathe so that the surface between the circular ends will be straight.

Provisions will be made to prevent the ingress of moisture to the interior of sealed hollow members where these are holed for bolts. Holes for bolts, pins or rivets will be in accordance to BS 4950 Part 2:1985, paragraph 3.4 and 3.5.

### Machining of butts

Butt joints of compression members will be accurately prepared to joined, so that the permitted stress in bearing is not exceeded nor eccentricity of loading created which would induce additional moments in the members.

## **7.8. Fabrication**

### Base Plates

Base plates will be grounded and placed accurately on bearing surfaces. Base plates in contact with columns will not be required to be grounded. Small holes on the bearing plates will be essential for trapped air to escape during grouting.

### Marking

All the steel members will be visibly marked before their delivery on site. The marking format will be such as to identify the exact position of the member in the structure during assembly.

### Transport

The materials will be protected from damage and any deformation during their transport. All the surfaces will be protected. All straight parts, except for small sections, will be transported in bundles, tied up together with steel wire.

On-site connections for the roof trusses should be kept to the minimum, so the sections to be assembled will not be shorter than 20m.

All bolts, pins, rivets, and other small piece, should be packed in boxes.

Every box or bundle will be distinctly and visibly marked before their dispatch from the workshop.

### Connections

All the connecting parts will be firmly drawn together so that the metal components will

Undergo no movement or deformation. When necessary, the washers will be tapered or be in an appropriate shape for the bolts and nuts to be adequately tight. Washers will be used under every bolt head and nut, except where differently specified.

The bolt and thread length will be such as a minimum of 6mm of thread to project from the nut. The bolt end will project from the nut a length equal to one bolt diameter. A full thread should remain clear between the nut and the unthreaded shank.

The bolts will always be installed vertically to the connecting parts. The shifting of the connecting parts for the bolt holes alignment should not affect in any way the steel or widen the bolt holes.

The friction bolts will be in accordance with the manufacturer's specifications. The tension on the bolt should not be smaller than the one necessary for the bolt diameter and strength.

In general all friction bolts will be in accordance to BS 4359 and will be installed in accordance to BS 4604.

### **7.9. Welding**

#### General

Welding will be carried out by expert welders who are required to submit for approval their welding certificates issued by an independent accredited certification organisation, according to the requirements of CYS EN 267, Part 1:1993.

Welding will be in accordance to BS 5135. The method of welding will be in accordance to BS 4870: Part 1, BS 4871: Part 1 and BS 4872: Part 1.

The Contractor will submit for the Engineer's approval detailed methodologies for each type of welded connection that he will use, and for the fusion faces preparation. The different types of weld connection will be tested in accordance to BS 4870: Part 1, unless there is authentic documentation relating to the experience gained with the welding of similar connections.

All welding sets to be used will be tested with approved testing methods; unless they were tested 6 months prior to the commencement of the steelworks and it was proven by Non Destructive Testing that they can produce satisfactory welds in accordance to the specifications.

Unless specified differently, butt welds will be full penetration welds made between prepared fusion faces. All butt welds will be completed before the final steel structure assembly.

In all the welded sections (e.g. varied section beams on the roof) welding will follow the provisions of the American Welding Society (A.W.S.) D1.1-1996, and of the AISC.

Any welding traces will be removed from the metal surface and the protective lining using an approved method.

#### Welding Consumables

The electrodes for manual arc welding, of grades of steel according to BS4360 or ENIO 025, will be in accordance to BS 639. All the electrodes, wire and fluxes for arc welding of steel grades according to BS 43025 or EN150 025, will be in accordance to BS 4165. Fillers, rods and wires for gas welding will be in accordance to BS 2901.

Every batch of welding consumables will be accompanied by the manufacturer's certificate -on which the date of production will be stated, initial test results certificates, and the most recent of the periodic testing results. A copy of all the above will be given to the Engineer.

The welding consumables will be stored, in their initial packaging, in a warm, dry and well aerated room, in which the Engineer and the Quality Control representative will have access. The use of damp electrodes will not be allowed. Electrodes of which the flux covering is broken, or electrodes that are damaged in any other way, will not be used.

Dirty, rusted or defective electrodes will be removed from site.

Quality Control

Welds that are considered critical will be tested in their whole length with radiography, ultrasound or other approved, by the Engineer, non-destructive testing method, appropriate for the weld type. The rest of the welds will be visually inspected and will be tested with the appropriate non-destructive method.

In addition to the structural steel tests that are mentioned in the contract documents, it is clarified that the following tests must be carried out by an accredited independent quality control test laboratory.

- (a) Welding tests
- (b) Qualification tests for welders in accordance to BS EN 287
- (c) Welding procedure tests for the arc welding of steels in accordance to BS EN 288: Part 3
- (d) Non destructive testing of welds
- (e) Visual inspection in accordance with the instructions of BS 5289
- (f) Surface testing with MPI in accordance to BS 6072
- (g) Ultrasound testing in accordance to BS 3923: Part 1 (2B)

Weld Quality

The welded steel will be correctly fused to the mother metal without showing any corrosion or overlap at the edge of the weld. The weld will not show cracking of any form. The welded joints will be rejected if any of the above mentioned defects are present. They will also be rejected if the weld testing shows reduced penetration, inadequate fusion, pores, impurities or rust.

Weld Repairs

Defective welding will be removed, including the mother metal, and the welding will be reformed with an approved method by the Engineer. The repaired welding will be tested with a non-destructive testing method. Care will be taken not to distort or damage the joining members. All the hollow sections will be protected against humidity.

**7.10. Welding**Quality Control by Independent Accredited Laboratory

The quality control by an independent accredited laboratory will include the following:-

- Certify that the Contractor's/Subcontractor's personnel have all the necessary certification to carry out the works as specified in the Contract.
- Verify Mill's Certificates for all steel grades that they are in accordance to the specifications
- Verify that the section's dimensions are in accordance to BS 4848 and BS 4360
- Connections: Inspection of connection assembly and testing for fitting and tightness for a minimum of 10% of the bolts.
- Testing of the pre-welded steel sections for the maximum value of equivalent carbon quantity as defined in BS 4360, table 3
- Welding Consumables
- Verify that the chemical and mechanical properties of the manual arc welding electrodes are in accordance to BS 639
- Verify the welding and the qualification for welders procedures for all types of welds
- Checking of dimensions to be in accordance to the specifications, cutting, drilling and slotting procedures, hole opening and fitting according to BS 5427
- Verify all the welding procedures
- Check tolerances for cuts, holes, notches.
- Verify that the blast cleaning of the surfaces to be painted is in accordance to BS 4232 (Surface finish SA21/2)
- Inspect the painting stages and check the dry film thickness (DFT) to be in accordance to BS 5493
- Visually inspect the welding – in accordance to BS 5289
- Non Destructive Testing of the welding as frequently as described below

### **Testing Frequency of Welds**

All welds will be visually inspected.

The frequency of non-destructive testing will be as follows:-

- (a) Full penetration welds or other critical welds: 50% of quantity tested by Radiography (RT) and 50% by Magnetic Particle testing (MPT) or Penetration testing (PT)
- (b) Partial penetration welds: minimum 20% of quantity tested by Magnetic Particle testing (MPT) or Penetration testing (PT) and 20% by Radiography (RT)
- (c) Fillet welds: minimum 10% of quantity tested by Magnetic Particle testing (MPT) or Penetration testing (PT).

### **7.11. Erection**

The Contractor will be responsible for the preparation in a timely manner and submission to the Engineer for approval, of erection drawings at least ten weeks before the commencement of any work related to structural steel works.

The scheme will include shop drawings, calculations, description of erection and generally everything necessary to enable the Engineer to assess the suitability and sufficiency of the materials and erection procedure.

All steel components will be transported, stored and handled in such a way as to avoid any additional unforeseen loading that may cause damage.

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

Where steelwork has been painted or received any other protective coating prior to delivery to the site, the maximum precautions will be taken to avoid damage to the paint or the protective coating during loading, transporting, unloading, stacking and erection. Slings, ropes and chains will be rubber sheathed or with similar material. Steelwork stored on site, will not be in contact with the ground to avoid damage to the protective coating.

The Contractor will take provisions to grease and tape the threading of the bolts. Tape will be removed at erection of the steelworks.

Before commencing erection of the steelwork, the Contractor will check the setting out and levels of the concrete supporting structure, fixing bolts and other bearings for the steelwork. If discrepancies or inaccuracies in site works are found, which affect the steel frame erection and its correct position in relation to the concrete work, these will be drawn to the attention of the Engineer. The erection, levelling and alignment of the steelworks will be in accordance to the specified tolerances.

Each part of the structure will be aligned as soon as possible after it has been erected. Members will not be permanently connected until a sufficient part of the structure has been erected. This is to ensure that they will not be displaced during the erection or alignment of the remainder of the structure. Special attention will be taken in erecting cantilever beams. Their ends must be well aligned after erection.

All the precautions will be taken for the safety of all the involved parties. All the measures will be taken to avoid any damage to any erecting or already erected steel section, or damage to any part of the permanent structure.

The erection will be carried out in accordance with the Safety Code for steel structures erection, BS 5531. During erection of the structure, steelwork must be securely bolted or otherwise fastened so as to make adequate provision for all erection loads and conditions.

Any temporary supports such as bracing or props will remain in position until the structure is sufficiently far advanced for the temporary supports to be required. Connections for temporary supports and generally for the measures that will be facilitated for the erection of the steelwork, will be in such a manner as not to weaken the permanent structure or to impair its serviceability.



The Engineer will have access to all the sites that steelwork related work is executed. The Contractor will provide all the necessary facilities to the Engineer for inspection during erection.

Assembled steelwork will be stored, free of soil, in such a way as to make testing and inspection possible. It must be confirmed that no foreign body, water or dirt will be deposited or absorbed by the steelwork surface. In the cases which covers will be used, the steelwork must be well aerated. Moisture must be kept to the minimum.

Welding electrodes will be stored according to the manufacturer's specifications.

#### **7.12. Tolerances**

##### Alignment

Unless otherwise specified, tolerances for beam, column and space frame alignment will be in accordance to the relevant British or other equivalent approved standards.

##### Length

Unless otherwise specified, the member length tolerances should be as follows:

- a) Compression members +1 mm
- b) Other members +3 mm

For space frames the tolerances are applicable for the entire length of the member. The member length will be such as to be able to be assembled with the necessary accuracy.

##### Setting Out and Erection Tolerances

The setting out, alignment and levelling of the steelworks will be carried out in such a way so that the following tolerances not to be exceeded.

- a)  $\pm 3.0$  mm from the suggested position for the centre of support
- b)  $\pm 1.5$  mm from the suggested levels
- c)  $\pm 6.0$  mm in the total length and width of the structure

#### **7.13. Inspection before grouting**

Grouting under the base plates will not be carried out until the Engineer has approved the setting out and erection. The Engineer will be given 48-hour notice of the time when the structures will be ready for inspection.

#### **7.14. Protection during transport**

The fabricated steelwork will resist, without permanent damage, all stresses induced by handling, storage and transport. It will be the contractor's responsibility to ensure that all fabricated steelwork will not be subjected to any stress or damage during transport.

All materials and members of fabricated steelwork will be distinctly marked and packaged, to the Engineer's satisfaction, for transport.

#### **7.15. Trial assembly**

Before steelwork transport to the site, the Contractor will check the assembly of the fabricated components to be in accordance to the approved fabrication drawings. Any necessary straightening or shaping will be carried out by methods that do not weaken or distort the steelwork. It will be the contractor's requirement to ensure that all the fabricated steelwork delivered to site will meet the design requirements, approved fabrication drawings and technical specifications.

#### **7.16. Payment for testing and inspection**

The cost of all the non-destructive tests for the welds, and of all the other tests and inspections that are required, will be the Contractor responsibility and is part of his tender price.

## **7.17. Protective treatment – painting**

### General

Steelwork will be protected against corrosion by the application of metal paint or other specified coating. The preparation and application of the protective coatings will be carried out in accordance with the provisions of BS 5493 for the protection of metal and steel structures against corrosion.

### Repairs to Damaged Surfaces - Onsite

Areas of paint that have been damaged will be repaired. Where metal coating has been damaged, the affected area will be rubbed down. The steel will be coated with an approved coating primer, in as many coats required to achieve the right coating thickness.

### Painting

Paints or primers will be applied by brush, airless spray or other method approved by the Engineer. Each painter will be skilled and experienced in the method he is using and the supervisor will be skilled in each method under his control.

Paint will not be applied to any surface until that surface has been prepared and cleared to receive the specified primer. Also, no paint will be applied until all damaged primer areas are repaired. Paints will not be applied to a previous paint coat until that coat has dried and cured sufficiently.

Any maximum time limit between coatings specified by the manufacturer will be strongly adhered to. If this time is exceeded, the surface will be prepared by a method recommended by the manufacturer to provide an adequate base for the following coat.

The thickness of each coat and the overall thickness of protection will not be less than the thickness specified.

The environment conditions will be such as not to affect the application or the characteristics of the paint. The manufacturer's recommendations will be strictly followed.

Any coating application will cease when condensation is present on the surface. Works will commence after the surfaces are thoroughly cleaned. Surfaces will be protected during drying and curing from the deposition of moisture, dust or dirt.

### Treatment of Welded Connections

The whole surface will be blast-cleaned and primed where a weld-through blast primer will be used. For other primers, the coating will be kept back from the weld by 30mm or greater width as necessary to suit the depth of the weld.

Each coat of a multi-coat system will be stepped back by 30mm or other dimension recommended by the manufacturer, to enable effective application of the protective system following the completion of the weld.

After weld completion, the welded surfaces will be protected and processed as specified. The coating of the welds will have the same thickness as the existing coatings.

### Treatment of Welded Connections

The flat surface of friction bolt connections will be temporarily covered during the coating application. The cover will be removed before assembly. If galvanisation is required, then the flat surface will be roughened to increase the friction coefficient before the cover placement. The cover adhesive will be such as not to cause any chemical reaction at the metal. Any traces of adhesive will be removed before connection assembly.

All surfaces for bolted connections will be prepared and painted, after assembly or erection, to the full protection specification. The paint at bolted connections will have a suitable overlap with the existing painted surface. Cracking at joints and gaps at washers will be sealed with paint or mastic, compatible with the coating system.

### Defects

If protective coating, which on completion is found to be defective as a result of inferior preparation, quality of materials and/or standards of workmanship, or which show signs of early degradation by blistering, peeling, flaking, cracking or lack of adhesion, then it will be assumed that the case is for the entire structural member.

After it will be cleaned, protective coating will be applied to the complete structural member, unless remedial work on a patch basis is permitted by the Engineer.

Where tests on completion indicate that the full dry film thickness of the protective system has not been achieved, additional coatings may be applied, subject to the Engineer's approval, to achieve the specified thickness. In cases as such, all measures will be taken to ensure inter-coat adhesion. The application of any additional coats will be in accordance to the specifications.

In all other cases, in which the protective system is thinner than the specified, it will be removed, cleaned and coating will be reapplied at the specified thickness.

#### **7.18. Protective treatment – painting**

##### Protective (paint) System for Metal Surfaces and 10 year Guarantee

The Contractor will supply the protective (paint) system, which will be from a sole manufacturer. The paint will be in sealed containers which they will be strictly used in delivery chronological order.

The suggested protective system of JOTUN, or other equal approved by the Engineer, will offer a 10 year guarantee. Initial Surface Preparation

- Metal surfaces will be prepared with sand or shot blasting in accordance to EN ISO 12944-4 Sa 2 ½
- If surface defects are present, they will be removed and air blasted before the primer is applied. Finally the surface must be brushed and cleaned with vacuum cleaner for dirt removal.

All metal constructions will be paint with a hand Primer ZINC PHOSPHATE, two hands undercoat and two hands finish coat Jotun type. Penguard express ZP Primer, Penguard express MIO & Hardtop XP in white color choice of Engineer. Will be placed painted in place and they will take the proper protection.

The method and timing of the protective system application will be in accordance to the manufacturer's recommendations.

### **I. 9.0. INJECTION / GROUTING/SOIL REINFORCEMENT**

#### **9.1. Scope**

This section covers the requirements for all drilling and grouting operations carried out from the surface. The works include, but are not limited to, the following:

- Drilling preliminary grout holes
- Drilling and re-drilling of grout holes
- Pressure water tests
- Injection grouting

#### **9.2. Equipment**

##### **9.2.1. Drilling rings**

For injection grouting the Contractor shall provide percussive or rotary drilling rings that are capable of drilling vertical or inclined holes in the diameter specified.

##### **9.2.2. Packers**

The Contractor shall provide on side a sufficient quantity of mechanical and pneumatic packets which can be easily expanded to seal a drilled hole of any diameter being used.

##### **9.2.3. Water Pumps**

Pumps for water pressure tests shall be capable of delivering at least 120l/min of water at a steady pressure of minimum 10 bars.

##### **9.2.4. Water Pressure Gauges**

Pressure gauges indicating pressures up to 10 bars shall be provided for use in water tests. Gauges shall be graduated to 0.1 bar, and shall be fitted with friction needles to record the maximum pressure used.

A combination of low, medium and high pressure gauges shall be used so that pressures are indicated well within the optimum range of the gauge.

### 9.2.5. Water Meters

Water meters shall be capable of withstanding pressures up to 10 bars and metering flows of 0.5 l/min. The Contractor shall test the accuracy of all water meters periodically and make any corrections that are necessary to maintain the error to within 2% of the reading value.

### 9.2.6. Grout Mixers

Grout mixers shall be high speeds mixers, which operate at 1500 rpm or faster, capable of preparing a colloidal grout. The grout mixers shall have a minimum capacity of 250 l. Grout shall be stored before injection in an agitator which shall have a capacity of not less than 500 l.

### 9.2.7. Grout Pumps

Grout pumps shall be capable of delivering thick grout (water:cement 0.6:1 by weight) at a rate of 60 l/min at a steady pressure of up to 20 bars. A recirculating grout system shall be used with grout flow and pressured measured and controlled at the top of the hole.

If the pressure delivered by the pump fluctuates by more than 10% then the Contractor shall install surge vessels or any other devices required to deliver a steady pressure.

### 9.3. Materials

Grout shall be composed of a mixture of cement and water, with the possible addition of sand, bentonite and other admixtures. The grout mixture shall be determined by the Engineer's representative to meet the ground conditions encountered at each stage.

Bentonite shall be supplied in powder form and shall comply with Publication N. 163, Drilling fluid materials, Engineering Equipment and Material Users Association, London.

### 9.4. Drilling

#### 9.4.1. Injection Grout Holes

Check before drilling for debris or gaps with trial drilling up to 50 cm.

Injection grout holes shall be drilled either by rotary or by percussive drilling equipment as instructed by the Engineers. Rigs shall be capable of drilling both vertical and inclined holes. The following diameters and depths will be required.

	<i>Min. Diameter</i> (mm)	<i>Max. Depth</i> (mm)
Rotary drilling	45	30
Percussive drilling	38	30

No core recovery will be required from rotary drilling.

### 9.5. Water pressure testing

Water pressure tests (Lugeon tests) shall be carried out in control holes as directed by the Engineer to determine the permeability of the grout.

Prior to commencing the water pressure tests, the holes shall be properly flushed to the bottom with clean water and flashing shall be continued until clean water emerges from the top of the hole.

The test pressures shall be as follows, subject to modification by the Engineer's representative during the course of the work:-

#### Water test Holes

<u>Stage</u>	<u>0-2 m below GL</u>	<u>0.5,</u>	<u>1.0,</u>	<u>1.5,</u>	<u>1.0,</u>	<u>0.5,</u>	<u>bars</u>
<u>Stage</u>	<u>2-5 m below GL</u>	<u>1.0,</u>	<u>1.5,</u>	<u>2.0,</u>	<u>1.5,</u>	<u>1.0,</u>	<u>bars</u>
<u>Stage</u>	<u>5-10 m below GL</u>	<u>1.5,</u>	<u>2.0,</u>	<u>2.5,</u>	<u>2.0,</u>	<u>1.5,</u>	<u>bars</u>

Water test shall be carried out over stages of 5m or as determined by the Engineer. The absorption at the specified test pressures shall be recorded over a minimum of 3 No. 5 minutes periods unless be absorption

between the last two readings differs by more than 10%, in which case the absorption shall be measured for a further 5 minutes period before the pressure is changed.

The equipment shall be such that the pressure can be maintained with reasonable accuracy and the pressure and absorption measured.

Permeability shall be expressed in terms of "Lugeons". Absorption of 1 litre per minute per metre length of hole at a pressure of 10 bars represents a permeability of 1 Lugeon.

## **9.6. Injection grout mix**

Grout will generally be composed of a stable cement grout. Grouting mortar (cement, sand and water mixture) will only be used in the case of high absorption. Bentonite may be added in a proportion 2%, if required to obtain a stable mix as defined below.

In all cases the Contractor shall submit for approval by the Engineer the composition and method of preparing the grouts which he proposes to use. Prior to their use, these grouts must undergo laboratory tests allowing the preparation of the diagram showing:

- the limit settling curve
- the curve of maximum possible viscosity for injection.

These tests are to be carried out on grouts prepared in the grout batching station or at least by methods similar to those used for the grouts to be applied.

Grout mixes to be injected shall be stable having a settlement level not exceeding 5%. This settling shall be expressed by the ratio between the water visible above the grout after setting and the total volume.

The viscosity shall be measured by means of a Marsh cone and shall be in the range 35 - 40 seconds or as otherwise directed by the Engineer.

The grout must be mixture of Portland cement and water, sand and water mixture. Proportions will vary depending on the whole characteristics revealed by the drilling and injection operations. Generally speaking, sand shall not be used and the water-cement ratio shall vary from 2:1 - to 0.75:1 by weight. The injection pressures will depend on the conditions encountered on the site during injection. The probable pressures used for each type of injection are described later in the relevant sections.

Bentonite shall have a plasticity index greater than 400%. Before use in the grout mix, the bentonite shall be mixed with water in a high turbulence mixer and then stored in a large container where it shall be agitated for at least 24 hours in order to achieve hydration.

## **9.7. Grouting procedure**

### **9.7.1. General**

The following general requirements shall be observed.

- I. Grout holes shall be properly flushed to the bottom of the hole with clean water before commencing injection. Flushing shall continue until clean water emerges at the top of the hole.
- II. In general no holes shall be left over open whilst other holes in the vicinity are being grouted. The number of holes to be drilled at any time shall therefore be limited to the number which can be grouted simultaneously.
- III. Grouting shall be generally carried out by the method of ascending stage and packer in stages of 5 meters. As and when directed by the Engineer and when required by the circumstances, the grouting shall be carried out in descending 5m stages with hole re-drilling and positioning of a packer at the top of the stage to be injected.
- IV. Care shall be taken to avoid uplifting structures or opening fissures during grouting by the use of excessive grouting pressures. Suitable control measures shall be taken to detect uplift. If grout appears at ground level during the injection operation grouting shall be suspended in the location until the grout has had time to set.

### 9.7.2. Grouting

Grouting in any stage shall be continued until refusal that is when the absorption measured over two consecutive periods of five minutes is reduced to zero at the pressure for the stage being grouted, or as otherwise directed by the Engineer.

The grouting procedure will be determined on site by the Engineer after contractor Method Statement given.

For initial guidance the following procedure is preferred:

- The initial grout mix shall be 2:1 water: hydraulic lime and small portion of cement sample to be made by weight. If there is no rise in pressure after the injection of 200 liters of grout over a 5 meter stage the mix shall be thickened to 1:1 and then if necessary to 0.75:1 and 0.5:1 after further volumes of 200 liters per mix have been injected. As soon as the pressure starts to rise the mix shall be maintained constant and the grouting continued until refusal.
- Grouting at any stage shall continue until a volume of 200 liters per meter of stage has been injected or until refusal is reached. If absorption of 200 liters per meter of stage is achieved, the operation shall be suspended until the grout has had time to set, after which injection shall be continued in units of 200 liters per meter of stage, following the procedure above, to refusal.

### 9.7.3. Records

Full records shall be kept of the progress of drilling, permeability tests, grout mixes pressures and consumption of grout materials. Daily record sheets in duplicate shall be delivered to the Engineers Representative the day following the completion of each day's work.

### 9.7.4. Drilling and Grouting Crews

All foremen, drillers, and leading hands employed on drilling and grouting work shall have adequate previous relevant experience. Satisfactory written evidence of such experience shall be supplied to the Engineers' Representative.

## 9.8. Grouting records

For each hole drilled, records will be kept and a report will be submitted in duplicate to the Engineer showing the position, inclination, direction, diameter and depth of the hole as actually drilled. In addition records will be kept for the water pressure tests, the grout injected at each stage, the grout takes at each stage, the shear zones and the cracks. All holes shall be numbered to an approval system.

Grouting for foundation treatment under the dam embankments, the spillway and the abutments of the dam will consist of pressure grouting of rock to seal seepage paths through fissures. Consolidation grouting will be carried out at the core trench / bedrock interface as shown on the drawings or as directed by the Engineer. This work shall be carried out prior to the curtain grouting as indicated to the drawings.

Grouting for the diversion tunnel included drilling of percussion holes for grouting, pressure grouting to control water ingress, pressure grouting of rock/concrete interfaces, pressure grouting of rock fissures and cavities and stemming of grout and exploratory holes.

## 9.9. Grout testing procedure

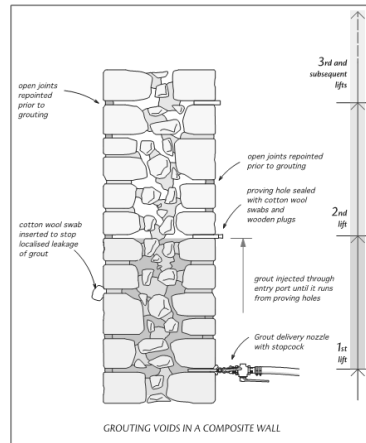
Before grouting work on site starts test mixes (trial mixes to engineer's approval) should be made in the site laboratory with that actual grout constituent such as cement aggregate water and admixtures to verify that they conform to the specifications.

### Tests should cover the following:

- Determination of the relative density of freshly mixed material. This is done with a mud balance. Grout is filled into a mud cup and the relative density is read directly on a balance arm.
- Determination of the grout flow properties. This is done in a Marsh funnel. A measuring cup containing 946 ml is filled from a standard funnel. The efflux time is a measure of the viscosity. Clean, fresh water will give a reading of 26 seconds.
- Determination of start and end of setting times.
- Bleed and volume change. Sedimentation is checked by pouring the grout in to a graduated plastic cylinder with a volume of 1000ml and a diameter of 60mm.

After two hours the height of the clear bleed water is measured. If the height is less than 5% of the total height the grout is considered stable.

- Temperature. The temperature is one way of observing the curing of the cement paste.
- Determination of compressive strength.



## **J. 10.0 WORK SPECIFICATION (WS) AS SHOWN ON DRAWINGS**

**10.1-WS.1.** Conserving / Fixing original plaster and or frescoes to be carried out by the conservator with the aid of specialized masons as follows:

Photo report prior any intervention;

- Fixing of the surviving but detached original thin plaster where necessary by injection of Mape-Antique FC21 ultrafine or Limepor IZ4 or equivalent.
- Application of perimeter consolidation material Limepor NHL 3.5 ultrafine or equivalent approved by conservator around the painting if necessary. To avoid harsh white surround use treatment with water colour and anything necessary to consolidate the historical plaster.
- Attachment of breathable polypropylene net with holes max 2-3mm net cover held in place with wooden frame.

Before any work, paintings will temporarily be protected by polystyrene sheets attached by gypsum plaster on the wall surface and/or supported by special wooden frame. Work to be approved by the Engineer (specimen to be given for approval).

**10.2-WS.2.** Soft cleaning and use of a material for disinfestations and cleaning of stone infested with bio deteriorating organisms, by applying a wide-spectrum, water-based, antimould and anti-mildew biocide solution with a brush, roller or spray (Kimistone BIOCIDA or equivalent and approved). The material should be biocide suitable for wide-ranging use in eliminating autotrophic and heterotrophic microflora from the surface of stone.

**10.3-WS.3.** If the surface crack is wide >4mm, heal it using the grouting method with injections (Limepor 100 or equivalent and approved) as the process is described in G.2.0 of this booklet). Combination with stainless steel bars (as described in WS.6) can be used as per drawings and specifications.

**10.4-WS.4.** If the crack is smaller <4mm, correct with a use of a material which has high resistance to sulphates, low water-soluble salt content, will be made out of natural hydraulic lime (NHL) with the addition of carbonate filler (Limepor NHL or equivalent and approved). The material should be an injection mix containing natural hydraulic lime (NHL) with the addition of natural pozzolan and carbonate filler, has low water-soluble salt content which makes it physically and chemically compatible with the original components of walls with equivalent mechanical properties.

**10.5-WS.5.** For all wall surfaces grouting will be done to stabilise and partially strengthen walls the procedure will be done with use injection low pressure with the use of the material natural hydraulic lime (NHL), metakaolin, with the addition of carbonate filler: the high quality of the hydraulic lime and metakaolin will result in a product which does not cause efflorescence, which contains almost no water-soluble salts (such limepor 100 or Limepor NHL or equivalent and approved). The material should be an injection mix that contains natural hydraulic lime (NHL), pozzolans (high-reactivity metakaolin), and a selected carbonated filler with very fine granulometry. This product was specifically designed to restore and pre-consolidate frescoed and un-frescoed curtain walls using low-pressure injection techniques.

**10.6-WS.6.** In the event of large-sized, through or not cracks >10mm. Stainless steel bars with enhanced adherence and/or glass fiber bar supplied and laid in the perforations will be used. It includes cutting to measure; lying inside the perforation taking care to ensure the bars are at least 5 cm inside the wall surface, grouting around the bars with Limepor 100 or equivalent for grouting of the bars required materials; the necessary equipment; waste. It also includes anything else required to finish the work.

**10.7-WS.7.** Removal of all damage or bad pointing (area to be approved by the supervision before any work done). Check all pointing up to a depth of 4mm and then apply matching pointing in a depth of 3mm to all previously pointed surfaces. Re-point with the use of a material that is a ready-to-use mortar containing natural hydraulic lime base material to match existing colour (Limepor NHL 3.5 or equivalent and approved). The material should be chemically compatible with materials used in historic buildings/ extremely breathable, porous mortar /low content of water-soluble salts and high resistance to sulphates / the product remains stably mineral over time.



**10.8-WS.8.** Reattach loose section by putting the stones back in place with the use of a material containing natural hydraulic lime masonry mortar with natural sand, special additives, micro-fibres (Tectoria M15 or Limepor NHL 3.5 or equivalent and approved) to complete any loose stones and surfaces. The material should be suitable for use on site in combination with reinforcement mesh to make high-strength, “structural” breathable render applied by trowel or with a continuous-feed rendering machine. Replace the missing stones with new stones with similar mechanical and physical characteristics of the existing and as per laboratory testing as per Table 1. The new stones must of similar colour, size, and texture in order to match existing stones characteristics. The stone should also be adequately resistant to salt crystallization (EN 12370) to fit the purpose of its use. The compressive strength (measured in accordance with EN 1926) of the replacement stone should exceed 5 MPa.

**10.9-WS.9.** Removal of the existing roof tiles and then removal of the added cement layer manually without using vibrators or heavy machinery. Removal of the layer of the roofing to falls. After the removal of the layer, all cracked surfaces must be healed with grouting injections using a Limepor 100 or equivalent. Next, new roofing material slopping to falls containing natural hydraulic lime (Tectoria M15 reinforced with Kimitech ELASTOFIX or equivalent to make the material more flexible and adhesive or a similar product for approval) must be used. After one week, finish the waterproofing by applying a hydrophobic (rendering) lime based coating. Ceramic roof tiles similar to the existing should be positioned back to their original position.

**10.10-W.S.10.** The belfry should be preserve and consolidate. The exposed bar reinforcement should be strength with additional reinforcement and new cover material should be added to prevent steel oxidation. Finally, the columns should be painted according to the specifications. The decorative elements (ashlar) stone will be cleaned and conserved as it is described in the specification sections.

**10.11-W.S.11.** Stabilize higher loose stones with the help of a hydraulic lime mortar and add an additional material (mortar and stones if necessary) in order to form a solid top layer with an outward inclination diverting rainwater to the outside facades of the church.

**10.12-W.S.12.** Rebuild the parts of the south and west façade that has collapsed so as to reinforce the structure with new wall elements similar in colour and mechanical characteristics to the original. The stone should also be adequately resistant to salt crystallization (EN 12370) to fit the purpose of its use. The compressive strength (measured in accordance with EN 1926) of the replacement stone should exceed 5 MPa see structural details.

## **K. 11.0. INSTALLATION OF DRAINAGE SYSTEM**

In order to remove humidity from foundation walls and arrange the water removal on ground surface, it's necessary to proceed with the excavation and/or filling of the existing ground. Any walls that are exposed during the digs are to remain and the engineers/Engineers to be notified.

- A trench construction for drainage and ventilation will be made outdoors with small equipment creating a constant section excavation 0.5m wide and about 0.45m deep following the external walls using mini-excavators, small tractors or mini-mechanical shovels with a maximum head of 20 cm. Works will be carried out for material and consistency, dry or wet. Also included: any required frames armature, even of the box type; removal from the excavation area of waste material; loading, transport and discharge of waste material at whatever distance. It also includes anything else required to finish the work.
- Placement of waterproofing membrane (double sided dimple drainage sheet) as vapor barrier application all along the foundation walls
- Laying coarse sand (7mm > coarse sand >3mm) of thickness 10cm with an elevation of %1 on compacted ground as bedding.
- Placement of plastic perforated drainage pipe of PVC with diameter 100mm on a coarse sand surface layer.
- Exposed foundations will be repaired if necessary with replacement of destroyed stone, mortar replacement and any strengthening of the stone construction required.

### **11.1. Filling of excavations:**

- Trench to be filled with large pebbles of size 10-15 cm thickness 10cm
- Trench fill with smaller pebbles of size 4-5 cm of thickness 30 cm

- Trench with stone filling to be covered with geotextile.
- Filling the rest, according to the existing ground level, with soil containing no organic matter and compacting all.

Filling works include levelling, tamping and compaction in layers not exceeding 30 cm; sprinkling and any necessary refilling. It also includes anything else required to finish the work. Compaction equipment will not be pneumatic. See also drawing details.

#### **11.2. PVC ventilation pipes:**

Installation of PVC perforated ventilation pipes of diameter 12,5mm placed as in the project along the humidity removal system as shown in the drawing's specification.

#### **11.3. Soil formation:**

Rainwater could be prevented by formation of wither small channels around the perimeter of the excavation site or mounding up soil in wide rows and angling the sides by at least 1 to 2% that it will facilitate the removal of rainwater from the site.

### **L. 12.0. INTERVENTIONS ON EXTERNAL/INTERNAL WALLS (MASONRY) AND ROOF**

ANY HISTORICAL PLASTERS ARE TO BE PRESERVED AND CONSOLIDATED BY CONTRACTOR'S CONSERVATOR.

**Please note that the contractor should give the method statement of the conservation work for approval before of this work.**

Before beginning of any work, samples will be done on external and internal surfaces. Works will be carried out by specialized masons, to test mortars, and appropriate tools to be used. The methodology for every kind of work will also be defined. (To be approved by the Engineer)

The samples will include:

- Cleaning and repairing of ashlar masonry wall surfaces and carved stone blocks
- Detachment of cement joints and replacement with joints of lime mortar mixed with fine grain sandstone
- Restoration of the damaged stones and replacement according to the defined criteria (see Table 1)
- Restoration of masonry including the filling of holes and small openings using ashlars
- Dry cleaning of stone surfaces from loose deposits
- Removal of paints (stains) from stone surfaces
- Consolidating historical plasters
- New mortars to be used in the restoration works
- New hydraulic lime mortars
- Removal of plaster from the wall
- Removal of the cement mortar
- Pointing and re-jointing

#### **12.1. General**

- At the points where deep and severe cracks are formed, as in the south and east wall, the stones should be carefully dismantled on either side of the cracks. Subsequently, the masonry should be rebuilt with stones similar to the original ones in both size and texture using of "stitching". It is suggested that additional timber beams are positioned in.
- Thereafter, rubble filling and mortar pointing, to be implemented on the masonry and then gypsum plaster coatings, to its interior face.
- Other smaller cracks to be filled up with solid rubblework and be properly pointed up, so that the stones which are displaced, and the rest of the masonry are well - bound together.
- The filling stones which either detached, weathered, decayed or at risk of collapsing, as well as any eroded and cracked mortar joints should be repointed, removed or replaced, for instance when the mortar joints go deeper than 3 cm from the surface of the stone, then the stone pointing must be renewed with mortar, after having first removed the original pointing.
- Most of the joints of the walls to be pointed.
- Injections grouting to be applied where indicate on drawings.

- Remove all internal plaster except where there are historical coatings and frescoes as shown in drawings. Re apply gypsum plaster after repair the stones and cracks as foreseen from the technical specifications below. Conserve the historical and frescoes according the conservator's prescriptions.
- The plaster at the bottom part of the Church should be cleaned and left to dry out all the remaining moisture prior to the reapplication of dehumidifying plasters. Small holes should be opened along the bottom part of the masonry walls to allow the moisture to dry out faster through them

#### **12.2. Dry cleaning of loose surface deposits on the stone surfaces**

***It is performed using soft flat brushes, natural fibre brooms and vacuum cleaners (BE AWARE OF POTENTIAL DAMAGE TO HISTORICAL PLASTERS).***

First level of cleaning aimed at removing loose deposits to be performed as follows:

- Removal of iron elements (if any) scattered over the walls (nails, iron items, hooks).
- Use of mild mechanical systems (cloths, natural fiber brooms) in order to remove traces of dirt, bird deposits and easily removable residues.
- Use of low pressure compressed air aspirator for the complete removal of residues.
- Localized use of scalpels, spatulas, small nylon or metal brushes, toothbrushes, wherever it is deemed necessary.

#### **12.3. Removal of stains (black spots) using solvent-based paint remover**

**To be carried out by a conservator with:**

- Photo report prior to any intervention
- Removal of overlying substances of various kinds such as oil, paint, wax, etc. (applied as patches on external surface stones) by the application of organic and/or inorganic substances; it includes the cost of tests to identify suitable solvents and application times and subsequent removal of dirt and solvent residues, on works located on the interior, computed per m over the total m affected by the phenomenon: solvent impregnated packs.

#### **12.4. Organic Growth Removal**

Localized application of the approved herbicide (Boxer, Kimistone BIOCIDA or equivalent) to remove vegetation: *Use of chemical products to complete manual removal, as follows:*

- local application of herbicide
- wait until dry
- Subsequent manual elimination of vegetation

Treatment with approved biocide to eliminate mosses, lichens and algae.

Operation to remove colonies of autotrophic or heterotrophic organisms, to be carried out as follows:

- Application of broad spectrum biocides in 1-3% aqueous solution by brush, spray or syringe.
- In the case of persistent micro flora proceed by applying methylcellulose packs soaked in more concentrated solutions and allow to act for 1 or 2 days.

Check the effectiveness of these products at least 60 days after their application. In case of inefficiency change the product.

#### **12.5. Manual removal of masonry and/or brick walls**

Demolition of any kind of walls of any shape and thickness, includes erection of scaffoldings with the relative net protection; the use of equipment is to be of a size appropriate to the structures to be demolished; the work of temporary fencing; loading, transportation and discharge at any distance of waste material. It also includes anything else required to finish the work.

**Any stones that are removed and belong to the original structure will be saved. Stones that are replaced that have any sculptural qualities and need to replace will be numbered and the contractor will note on the drawings where they came from. These will be saved in a decided site near the building.**

## **12.6. Removal of inappropriate additions (hand executed or by other manual system).**

- 12.6.1 Total or partial demolition of concrete, brick, and/or any inappropriate additions of any form and thickness. It includes the use of equipment of a size appropriate to the structures to be demolished; the adoption of all the measures to ensure the safety of workmen and the general public; signs; the work of temporary fencing; demolition, taking all due precautions and in small sections, of the structures connected to or abutting the structures not to be demolished, where necessary cutting material with oxy-acetylene flame or manual or mechanical saws; repair of any damage caused to third parties as a result of this work; loading, transportation and discharge at any distance of waste material. It also includes anything else required to finish the work.
- 12.6.2 Removal of cement mortars that cover the stone surface or the joints between two stones shall be made carefully in order not to damage the original stone. Masons must use small chisels and verify with Engineer the extension and depth of removal, eventually removing only parts that cause esthetical damage if cement mortar is too hard and deep to remove. To be realized under supervision. Pointing after removal of existing with hydraulic lime Limepor NHL 3.5 or Tectoria M15 equivalent with coloured powder ( Mortar should be placed 0,5cm recessed from stone surface and made of two layers, well pressed with spatula, and treated with a sponge a few hours after being placed, to have a coarse surface. Treatment with a wet sponge should be repeated to help lime carbonation during the following 12 hours. It Includes: supply of all the materials required; loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required completing the work.

## **12.7. Regular section cutting on stone masonry**

Any required regular section cutting of existing stone walls of all types and forms will be carried out at any height, both internally and externally, for the repair of structures, cutting for doors, windows and pipes. This includes restoration of cut walls; temporary protective and supporting works; loading, transportation and discharge at any distance of waste material. It also includes anything else required to finish the work and repairs around it.

## **12.8. Construction of New Stone masonry wall**

Common masonry made of local stone, with the same characteristics as that used for existing walls, hydraulic mortar (Tectoria M15 or equivalent and lime base pointing), level headed on several sides, in elevation. It includes: edges and recesses; any sloping configurations. It also includes anything else required to finish the work. Any stones which are being replaced and that bore a sculptural feature are to be replaced with equivalent feature. Restoring masonry using the “patching” or “cladding” techniques is necessary when the face of the wall is particularly deteriorated, if elements such as stone, are missing or if there are cracks or poor joints between portions of the masonry.

After making the structure safe using suitable temporary supports, (that must be done according to EC regulations) remove all the elements which are particularly loose and/or poorly bonded. “Break out” the areas of the wall where there are cracks or gaps, starting from the bottom working upwards, by removing deteriorated and/or cracked elements, all the unsuitable installation mortar and any other elements or objects which could compromise restoration of the masonry.

While carrying out this operation, put all the elements in good condition and which may be reused to restore and “patch up” the masonry together on one side. Also, while removing the deteriorated areas, leave rough edges to offer better grip between the areas of new masonry and existing masonry.

Clean all support and jointing surfaces with a low-pressure hydro-cleaner, where possible, to help the mortar adhere to the substrate.

“Patch” or “clad” the face of the wall by creating an “installation bed” of mortar and then lay the elements on the mortar (either the original ones previously removed or new ones with the same shape and size of the existing elements to prevent physical or chemical incompatibility). Press the elements down slightly so they form a better grip with the existing ones. Remove excess mortar with a trowel.

In order to strengthen the newly built / reconstructed masonry, and ensure a better connection it is possible to drown in fresh mortar one or more bands of stainless steel reinforcement (such as Kimisteel INOX and / or other equally approved) whose terminal parts will be grouted in drills previously drilled in the existing adjacent walls.

All new stones must be of equivalent color to the existing and samples must be given to the Engineer for approval together with all technical and mechanical characteristics from an approval technical laboratory to match the characteristics given below:

**A full and detailed report from the Technical Laboratory and not only result tables is needed for a holistic approach to this matter. The report shall incorporate comparison tables, comparing the existing and the new/proposed stone properties and the various standards used with mean values, upper and lower limits. All shall be prepared and signed by the qualified Laboratory Material Engineer.**

**The replacement stone should be compatible with the original stones in terms of colour and mineralogy analysis and a petrographic description needs also to be performed. Its open porosity/apparent density (measured in accordance with EN 1936) should be < 25% and > 1800 kg/m<sup>3</sup> respectively. The capillary absorption coefficient (measured in accordance with EN 1925) should be < 80 g/m<sup>2</sup>/s<sup>1/2</sup>. The stone should also be adequately resistant to salt crystallization (EN 12370) to fit the purpose of its use. The compressive strength (measured in accordance with EN 1926) of the replacement stone should exceed 25 MPa.**

## **12.9. Repairing of cracks on wall surfaces (Cut and Replace)**

Repairing cracks in visible face of walls of particular interest made of ashlars (fine dressed) stone. It includes disassembling and subsequent relaying of individual blocks according to the original layout, with tight joints; reassembly with suitable hydraulic natural lime for injections (Limepor 100 or Limepor NHL 3.5 or equivalent), corresponding if necessary to the original characteristics; possible integration with elements of the same quality and size, sanded or bush-hammered visible face depending on the original type of finish or curtain; photographic survey when the surface to disassemble is large and when the Engineers/Engineers requests it as well as possible numbering of elements (blocks) before removal. It also includes anything else required to finish the work.

### **12.10. Repairing of cracks by injection mortar**

Injection of mortars of wall cracks to be done by specialized masons. Method statement and material properties have to be given to the Engineer for approval prior to any work done.

#### **12.10.1 Temporary sealing on wall face before injection**

(Considered on 30% of curtains with joints already partly sealed)

Implementation of temporary single side sealing of stone joints using a lime based mixture such as tectoria PMP which must be conserved and maintained. The work involves also the subsequent complete removal of the paste and relative cleaning of joints before pointing and plastering.

The work includes anything else required to finish the work.

#### **12.10.2 Injection**

- Cleaning of stone / masonry with brushes and water. Closing any gaps by pointing prior to any work.
- Drilling using slow rotation dry (inside and outside) or, if needed, water drilling machine, avoiding use of any hammer drill. Circular and straight holes will be done with hardened steel drills, one every 40cm to 50cm. Length according to depth of wall 2/3 min of wall depth). Drillings shall be done along a line and shall be crossed along the crack.
- Compressed air cleaning of the hole and of the crack, eventually using vacuum cleaner machine.
- Insertion of transparent nozzles in the cracks (to ease air flowing) and in the drills; With grout seal any cracks and uneven areas on the face of the wall from which the slurry could seep through and fasten tubes or injectors in place with adequate masonry mortar (such as Tectoria PMP or equivalent).

- The day before injecting the slurry, we recommend saturating all the inside of the structure with water through the tubes or injectors previously fastened in place. Saturate the wall starting with the holes in the highest position. Make sure the structure has absorbed all the injected water before injecting the slurry.
- Injection with low pressure or hand pump of hydraulic binder controlling while injecting the correct flow of mortar and avoiding any leakage of mortar.
- Removal of nozzles and any sealing material after setting of mortar (see relevant drawings and/or details).
- Filling of cracks with injection mortar, Limepor 100. Mortar shall be made of two layers, well pressed with spatula, and treated with a sponge a few hours after being placed. Treatment with a wet sponge shall be repeated to help lime carbonation during the following 12 hours.

The work Includes: supply of all the materials required; loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required to complete the work, testing of the material used, method statement of the work used and material and contractor and manufacturer warranty of good and proper work used.

#### **12.11. Stitching of cracks with injection of mortar and stainless steel or reinforced glass fiber rod:**

To be done by specialized masons on passing through the wall cracks with injection of mortars and metal perforating the wall and injecting of mortars and metal. To be carried out as follows:

- Cleaning of blocks with brushes and water;
- Drilling using slow rotation dry or, if needed, water drilling machine, avoiding use of any hammer drill. Circular and straight holes will be done with hardened steel drills, one every 100cm. Length according to depth of wall. Drillings shall be done along a line and shall be crossed along the crack diagonally.
- use of compressed air for cleaning of the hole and of the crack, use of vacuum cleaner machine. - sealing of cracks to avoid leakage of mortar.
- Pouring in water, to moisten the cavity to be injected.
- Injection with pressure pump of consolidating hydraulic binder, controlling the correct flow of mortar while injecting and avoiding any leakage of mortar.
- Insertion of stainless steel threaded rod  $\varnothing 14\text{mm}$  and/or reinforced glass fiber rod all through the length of the hole.
- grout hole with Tectoria PMP mixed with latex Kimitech Elastofix or equivalent.
- Inject fluid epoxy sesin ( Kimiteck EP-In or equivalent)
- Filling of cracks with injection mortar Mape Antique I15 or . Mortar shall be made of two layers, well pressed with spatula, and treated with a sponge a few hours after being placed. Treatment with a wet sponge shall be repeated to help lime carbonation during the following 12 hours.

Including: supply of all the materials required; loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required to complete the work. Also testing and method statement of work.

#### **12.12. Insertion of stainless steel rods and/or reinforced glass fibre rods**

Stainless steel bars with enhanced adherence and or glass fiber bar supplied and laid in the perforations as described above. It includes cutting to measure; laying inside the perforation taking care to ensure the bars are at least 5 cm inside the wall surface, grouting around the bars with Kimitech EP-IN or equivalent for grouting of the bars required materials; the necessary equipment; waste. It also includes anything else required to finish the work.

#### **12.13. Crack Stitching repair**

Wherever cracks exist within the masonry, masonry stones shall be sawn (stitched) according to the details of the Structural Drawings.

In the case of stone masonry, nature and seriousness of the cracking, or of the cavities and gaps formed by the extraction of small stones resulting in the distress of the internal stone masonry core, which is almost always double-layered, should be evaluated.

- **Distress:** In the event of local stone extraction and structural distress, it is imperative to thoroughly clean all voids and gaps as well as remove any plants, grasses and weeds with their roots that might be present. Attention must be given to the use of chemicals, as they can potentially affect and harm the stone units. The next step is the restructuring of the void spaces of the masonry with stones of compatible size and appropriate pointing of the joints, which must strictly be carried out by either mud or lime mortar with added ochre pigment to get a close colour match with the stones, and then be placed to adequate depth etc.
- **Stitching of cracks:** In the case of stone masonry, nature and seriousness of the cracking, or of the cavities and gaps formed by the extraction of small stones resulting in the distress of the internal stone masonry core, which is almost always double-layered, should be evaluated.

Stainless steel horizontal elements may also be used, which should be placed in the centre of the two side surfaces and follow the horizontal layers of the stones. Next follows the appropriate pointing and, if necessary, the application of grouting material between the side surfaces of the masonry wall. All said shall be performed, provided that the issues pertaining to the root cause of the cracking, whether it be foundation sedimentation or movement or any other causes, have previously been resolved.

To be done by specialized masons on passing through the wall cracks with injection of mortars and metal perforating the wall and injecting of mortars and metal. To be carried out as follows:

**12.14. Strengthening of masonry by injection of mortars, to be carried out by specialized masons as follows:**

- Cleaning of blocks with brushes and water;
- Drilling using slow rotation dry or, if needed, water drilling machine, avoiding use of any hammer drill. Circular and straight 20mm holes will be done with hardened steel drills, along a grid consisting of 4 holes per m<sup>2</sup>. Length according to depth of wall. Drillings shall be done along a line and shall be crossed along the crack.
- Compressed air cleaning of the hole and of the crack, eventually using vacuum cleaner machine.
- Insertion of transparent funnels and nozzles in the holes (to ease air flowing) and in the drills; nozzles shall be fixed with polyester resin or equivalent sealing material.
- External sealing of the damages and surrounding detached joints with mortar or with clay (temporary sealing).
- Pouring in water, to moisten the cavity to be injected.
- Injection with low pressure pump (1 bar at the nozzle) of hydraulic binder MapeAntique I15 or Limepor 100 or equivalent for non frescoed walls and Limepor IZ8 for frescoed walls or equivalent, controlling while injecting the correct flow of mortar and avoiding any leakage of mortar. Contractor needs to start at the bottom and work upwards to help expel air from cavities. When the slurry seeps out of a tube or injection near the one being injected, stop injecting, close the injector used and continue operation from the tube or injector from which the slurry seeped out. Follow this pattern until the slurry seeps out from the highest hole.
- Removal of injection funnels and nozzles and any sealing material after setting of mortar.
- Filling joints with approved pointing mortar (Limepor NHL 3.5 or equivalent).

Mortar shall be made of two layers, well pressed with spatula, and treated with a sponge a few hours after being placed. Treatment with a wet sponge shall be repeated to help lime carbonation during the following 12 hours. Including: supply of all the materials required; loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required to complete the work.

**12.15. Drillings in any type of structure (Min. diameter of drilling 25mm).**

Execution of perforations in structures of all kinds, forms and consistency, at any height or depth, any diameter, in any position, performed taking the necessary precautions to avoid damage to adjacent or abutting constructions, to be compensated according to the diameter and length of the perforation performed. It includes reinforcing; perforation, which must be performed using a rotating probe with water or air cooled hardened steel bit in the case of particular jobs according to the Engineer's indications, to obtain a circular hole of constant section executed at reduced rotation speed so as to avoid damaging any structures traversed; compressed air to clean the perforation, with a prohibition on the use of water and in any case following the directions of the Engineer, the use of other operations if necessary; the supply and inclusion of guiding apparatus for the probe control rod, where necessary, to guarantee the linear travel of the perforation and its exact positioning according to the Engineer's indications. It also includes anything else required to finish the work. Drilling is expected to exceed the 1 m length and the contractor needs to make provisions for that.

**12.16. Removal of the plaster applied on masonry walls and repairing of the walls**

Removal of the plaster applied on the internal surface of the masonry walls and repairing of the walls will be done as follows:

- Use of appropriate hand tools for removal. Sampling before beginning of the work
- Dry cleaning of the masonry surface.
- Repairing of stones according to table 1. If the stones are heavily decayed insertion of stainless steel mesh of 2.5mm and application of Limepor NHL 3.5 or equivalent of max. 40mm will be done following the instructions of the Engineers/Engineers.
- Re plastering the surface with hydraulic lime mortar after repairing stones (25mm)

**12.17. Repairing deep cracks**

Repairing of cracks passing through the wall will be done by specialized masons as follows:

- Delineation of all cracks;
- Dismantling of the first level of masonry facing to allow perforation and later insertion of the rods; (Numeration of stones and photographic report will be done to allow the re use )
- Cleaning of blocks with soft brush and water;
- Drilling by means of electric rotary drill, dry or with reduced water jet performed with all necessary precautions to nearby structures.
- Circular and straight holes of about Ø 20mm will be done with hardened steel drills, one every 40-50cm. Length according to depth of wall. Drillings shall be done along a line and shall cross the crack diagonally.
- Cleaning of the hole and of the existing crack by using compressor.
- Sealing of the existing crack to avoid leakage of mortar.
- Pouring in water, to moisten the cavity to be filled according to the instructions of the injection material.
- Insertion of stainless steel threaded rod Ø14mm and/or reinforced glass fiber rod all through the length of the hole.
- Injection with Limepor 100 controlling the correct flow and avoiding any leakage. Rod will be left 1cm recessed.
- Waiting till hardening of filling material
- Removal of previously applied sealing of crack (preferably after 24hrs.)
- Cleaning and wetting of crack
- Filling of crack with injection mortar Limepor NHL or equivalent.
- Re placement of the first level of masonry after perforation and insertion of the rod by using original stones numerated in the beginning of the work. New stones equivalent in size, color and texture with the original ones will be used only where necessary.
- Pointing mortar shall be applied of two layers, well pressed with spatula, and treated with a sponge a few hours after being placed. Treatment with a wet sponge shall be repeated to help lime carbonation during the following 12 hours.



Including: supply of all the materials required; loading, transporting and unloading debris material at the dumping ground, at any distance, and whatever required to complete the work.

**12.18. Replacement after disassembly of portions of degraded stone lacking curtain mechanical resistance. (See also Table 1)**

To be performed as follows:

- Delineation of part or elements of masonry to be replaced;
- Removal of (unrecoverable) crumbling/pulverized/loose elements using hand held hammer and chisel.
- Cleaning and baring of nucleus using wire brush and washing of surface;
- filling of empty spaces with stone blocks from the area (biocalcarene), with elements having the same quality and size, stepped on the visible surface according to the type of finishing;
- bedding with hydraulic lime mortar with low soluble salt content and sifted sand (Tectoria m15 or ), the attachment surfaces between block and nucleus being sealed by means of injections of or pouring in fluid mixtures of hydraulic mortar (Limepor NHL 3.5);
- closure of joints with pointing hydraulic lime mortar(Limepor NHL 3.5 or equivalent). It will recess with respect to the surface so that the pointing mortar can be applied after its withdrawal. Pointing should be placed 0,5 cm recessed from stone surface and made of two layers, well pressed with spatula, and treated with a sponge.

Treatment with a wet sponge should be repeated to help lime carbonation during the following 12 hours.

No mechanical tools will be used for the removal of stones unless approved first by the Engineer.

Any corner stones are to be replaced whole even if the damage on them is less than 45%.

**12.19. Filling of deep gaps in the wall structure including also the filling of internal core of the cavities with 'diathons'**

To be performed as follows:

- delineation of the portion or elements of masonry to be replaced;
- cleaning and baring of core using steel brushes and surface washing;
- Filling of empty spaces with stone blocks from the area (biocalcarene), with elements of the same quality and size, bush-hammered original. The elements will be perfectly flat and dressed with a rectangular visible face, worked with an ordinary grain and must have the same height over the whole length of the same course;
- jointed by means of diathons traversing from one curtain to the next and preparation of necessary anchorage;
- bedding with Tectoria M15 or equivalent , the surfaces between block and nucleus to be filled by means of injection of Limepor 100 or of pouring in fluid mixtures of hydraulic mortar;
- Closure of joints with hydraulic mortar to which powdered local stone and acrylic resin in a 20% aqueous solution have been added. Exposed part will recess with respect to the surface so that re pointing mortar can be applied after withdrawal.
- Pointing should be placed 0,5 cm recessed from stone surface and made of two layers, well pressed with spatula, and treated with a sponge. Pointing mortar will be constructed only after the approval of samples.

**12.20. Placement of missing stones on the external stone masonry**

To be performed as follows and according to drawings and details:

- Delineation of the portion of masonry to be replaced; shoring/supporting walls or lintel prior to work,
- Cleaning and baring of core using steel brushes and surface washing;
- Filling of gap with local stone (biocalcarene) blocks, using elements of the same quality and size, according to the type of finishing or original curtains. The elements will be perfectly flat and dressed with a rectangular visible face, worked with an ordinary grain and must have the same height over the whole

length of the same course;

- Bedding with hydraulic mortar with low soluble salt content and sifted sand, the attachment surfaces between block and nucleus being sealed by means of injections or of pouring in fluid mixtures of hydraulic mortar;
- Closure of joints with limepor 100 or limepor IZ8 /or Mape antique allettamento or equivalent mixed with powered color to match stones. Approval after samplings. Pointing mortar with tectoria PMP or equivalent will be placed 0,5 cm recessed from stone surface and made of two layers, well pressed with spatula, and treated with a sponge.

#### **12.21. Pointing and Re pointing with hydraulic lime mortar**

**All walls will be pointed or repointed except where there is historical plaster after the Engineer's approval of satisfactory sample.**

Operation of pointing mortar joints to be performed as follows:

- abundant washing with deionized water,
- First pointing with Limepor NHL 3.5 or equivalent. The rendering applied using small brushes, carefully avoiding affecting surfaces that are not involved.
- Finishing pointing with hydraulic lime Limepor SK or equivalent with local coloured powder to match in colour with the surrounding stone. If pointing is <1cm thick use Limepor SK or equivalent. If pointing is >1cm thick use Limepor FN or equivalent.
- Regularization finish using small sponges moistened with deionized water.
- Pointing mortar will be placed 0,5 cm recessed from stone surface and made of two layers, well pressed with spatula, and treated with a sponge. Stones are to remain clean of any pointing overflows.

#### **12.22. Conservator work - Consolidation of historical plasters (interior and exterior)**

Fixing original plaster to be carried out by the conservator with the aid of specialized masons as follows:

- Photo report prior any intervention;
- Fixing of the surviving but detached original thin plaster where necessary by injection of Mape-Antique FC21 ultrafine or Limepor IZ4 or equivalent.
- Application of perimeter consolidation material Limepor NHL 3.5 ultrafine or equivalent approved by conservator around the painting if necessary. To avoid harsh white surround use treatment with watercolor and anything necessary to consolidate the historical plaster.
- Attachment of breathable polypropylene net with holes max 2-3mm net cover held in place with wooden frame. Before any work, paintings will temporarily be protected by polystyrene sheets attached by gypsum plaster on the wall surface and/or supported by special wooden frame. Work to be approved by Supervisor (specimen to be given for approval).

#### **12.23. Moisture and Rising Damp Treatment**

In order to handle and treat moisture problems, excavation operation shall be conducted at the foundation, extending across the entire length of the exterior and interior side of the stone masonry walls, to the depths and widths designated in the Details. Afterwards, the foundation walls shall be impregnated, by means of pressure grouting, with Limepor 100, or other similar material, as shall be approved by the Engineer and according to the suppliers' instructions. The grouting method will be used inside the entire section of the masonry wall using a bottom-up filling procedure. Place stainless steel rods where big cracks exist, as per specifications and drawings. For the purpose of grouting by impregnation of the surfaces with said special solution, holes (openings) at a depth of 60 cm and at a spacing of 15 cm shall have to be drilled into the masonry walls using a  $\Phi 1/2$ " hammer drill at a 45° angle inclination.

The mouth of the holes shall be opened across a horizontal joint line of the masonry, which shall be 30 cm above the final external height of the ground level. Such hole openings shall also be drilled on the internal side of the masonry but alternately with those on the external side. The impregnation shall be carried out in accordance

with the instructions and under supervision of the supplier. After the impregnation is complete, all cavities shall be filled with tile mortar.

Rising damp barriers injections will be performed in the masonry wall using KIMICOVER IN, a consolidate based material as per drawings. The diffusion of the materials will be made using perforated plastic pipes. The penetration can preferably perform at the internal and external side of the masonry wall to ensure better results. However, extra caution must take into account not to harm any historical plaster or frescos. The application of such technique shall be made on a higher level as well in order to ensure maximum protection results from rising damp phenomenon as per drawings.

#### **12.24. Plastering and Rendering (Coatings) – Mortars**

In the scope of minimal intervention, all coatings and mortars used in the event of new masonry construction after demolition, masonry patching, stone stitching and/or stone repositioning shall be repaired or supplemented with equal materials and features as the original ones.

#### **12.25. Materials**

##### **12.25.1 Lime (not applicable)**

Slaked (hydrated) lime shall be used, whose inert material shall be removed during filtering in order to produce a glue-like paste, free from lumps.

The slaking of the lime shall be done in a man-made container which shall be constructed on site by the Contractor, next to which a pit shall be dug. During the slaking, prickly pear pads shall be added, according to the traditional method, for the purpose of attaching slimy properties and texture to the paste. The slaking of lime shall be carried out in metal slaking box made of stainless steel. The procedure of its production shall be as follows:

- a) The water to be used shall be warm water.
- b) The quick lime shall be located into the metal box up, which shall be filled up to 1/3 of its capacity.
- c) The slaked lime paste ( $\text{Ca}(\text{OH})_2$ ) shall be pressed down while being inserted into the man-made container and shall be left to set and dry after surplus water is removed.

##### **12.25.2 Sand**

Sand for the manufacture of mortars shall be natural, crushed sand, judged on the basis of its quality and gradation criteria (different grain size diameter) according to the British Standard Specification B55 No. 11. The sand shall be washed and salt-free. Sand produced from crushed brick shall also be used, as described hereunder with respect to specific mortars.

##### **12.25.3 Mortars**

Lime mortar shall primarily be used made with natural lime. The mortar proportions shall be measured by volume. During measuring, the mixture shall not be shaken or squeezed inside the measuring vessels. Each time only that much quantity of mortar mix which can be consumed within half an hour, shall be prepared. The lime mortar shall be mixed to a ratio of 1:2 of :

1. lime/sand. As far as cement paste is concerned, it shall be mixed to a ratio of one (1) part white cement to
2. two (2) parts lime and nine (9) parts of sand.

For repointing of stone masonry, the sand to be used shall be obtained from crushed brick consisting of inhomogeneous particles.

##### **12.25.4 Execution**

Plastering mortar shall be applied to all internal surfaces as follows:

- (a) "A" Layer Coating: shall be sprayed with rough cast cement plaster at a ratio of 1:3. (cement and coarse-graded crushed sand).
- (b) "B" Layer Coating: lime plaster shall be applied in a ration of 1:2 (pressed lime and coarse-grained crushed sand with added 10% cement).

(c) "C" Layer Coating: shall be applied after the two previous coatings are allowed to completely dry out at a ratio of 1:2 (pressed lime and white marmoreal)

The "C" Layer shall be well rubbed and repeatedly floated with use of pan floats. The thickness of the second coating shall be approximately 1/2", while the final one shall be 1/4" thick. In other words, combined coating thickness for all three layers shall not exceed one inch (1").

The final layer of plastering shall be completely flat, while its edges and corner angles shall be properly treated and finished neatly. Prior to over-coating, the previous coat shall be allowed to dry and sufficiently harden.

On the internal surfaces which come into contact with earth, the waterproofing admixture Acrylic Bondcrete by Burke or equivalent shall be added to the mortar 25 kg of cement.

## **12.26. Mortars for Masonry**

### **12.26.1 Internally – Plastering mortar**

Wherever referenced in the Drawings and Technical Specifications, new plastering mortar shall be prepared for the interior surfaces to the satisfaction of the Engineer.

### **12.26.2 Externally – Lime Mortar**

The external surfaces of all existing stone masonry structures shall remain undressed and after being thoroughly cleaned from top to bottom, all said surfaces shall be repaired, carefully filled and packed with solid rubblework and repointed.

Wherever referenced in the Drawings and the Technical Specifications, lime mortar is to be applied on every area. Lime mortar to be used shall be a ready-mixed lime mortar of the Engineer's approval, and shall be applied by hand with a trowel with the addition of hay according to the instructions of the Engineer.

All exterior surfaces shall be given a rubbed-finish by use of either a wooden or plastic float. The final rubbed finish shall be applied to said surfaces the following day with use of a sponge or wood or plastic float or 'fining' through grinding and polishing using a steel trowel. Five to six weeks after application, all rendered surfaces shall be wetted. The Contractor shall follow the instructions of the manufactures with respect to appropriate proportions and manner for laying out the specific mortar.

### **12.26.3 Waterproofing Admixture**

In the lime paste to be used for the pointing of the external masonry of the structure and the repair of existing masonry walls, a waterproofing admixture shall be added such as Febproof or other equivalent admixture approved by the Engineer, according to the instructions of the supplier, in the proportion of one (1) litre per a hundred (100) kg of white cement.

## **M. 13.0. ROOF AND TOP OF BUTTRESSES**

Before any intervention regarding the roof, the contractor will investigate on existing water exits and report the findings to the Engineers/engineers. The proposed roof project will be studied and defined. The engineer is to provide pictures and access to the roof for the engineers/Engineers inspection. This is to be approved by Engineer/Engineer. Also as the roof does not function as a whole it will need to be supported from below with appropriate scaffolding before any works are done.

### **13.1. Dry cleaning of loose surface deposits on the stone surfaces performed using flat brushes, natural fibre brooms and vacuum cleaners.**

First level of cleaning aimed at removing loose deposits to be performed as follows:

- Prior removal of iron elements scattered over the surfaces (nails, iron items, hooks).
- Use of mild mechanical systems (cloths, natural fiber brooms) in order to remove
- Traces of dirt and easily removable residues.
- Use of low pressure compressed air aspirator for the complete removal of residues.
- Localized use of scalpels, spatulas, small nylon or metal brushes, toothbrushes, wherever necessary.

### **13.2. Removal of loose dry deposits (soil, bird droppings, dust, etc.)**

To be performed with flat brushes and small vacuum cleaners, or using synthetic sponges or rubber blocks, to be computed per m<sup>2</sup> for the number of m<sup>2</sup> actually affected by the phenomenon, including the cost of protecting the surrounding surfaces;

### **13.3. Organic Growth and vegetation removal**

Localized application of the approved herbicide (Boxer or equivalent) to remove vegetation:

Use of chemical products to complete manual removal, as follows:

- Local application of herbicide
- Wait until dry
- Subsequent manual elimination of vegetation
- *Treatment with approved biocide to eliminate mosses, lichens and algae.*

Operation to remove colonies of autotrophic or heterotrophic organisms, to be carried out as follows:

- Application of broad spectrum biocides in 1-3% aqueous solution by brush, spray or syringe.
- In the case of persistent microflora proceed by applying methylcellulose packs soaked in more concentrated solutions and allow to act for 1 or 2 days.

***Check the effectiveness of these products at least 60 days after their application. In case of inefficiency change the product.***

### **13.4. Repairing of cracks by injection mortar:**

To be done by specialized masons on passing through the wall cracks with injection of mortars as follows:

#### **13.4.1. Temporary sealing before injection**

(Considered on 30% of curtains with joints already partly sealed):

Implementation of temporary single side sealing of stone joints using clay based mixture (20%) of sand and sawdust in order to avoid mixture dripping along the visible surface which must be conserved, protected and maintained. The work involves also the subsequent complete removal of the paste and relative cleaning of joints before pointing and plastering. It includes anything else required to finish the work.

### **13.5. Application of hydraulic lime mortars as capping on roof exposed and buttresses**

Use Tectoria M15 or equivalent to waterproof after it's dry

Works to be realized with the aid of specialized masons

- Dry cleaning of stone surfaces from loose deposits with soft mechanical systems in order to remove deposits from surfaces, including removal of nails, iron items, and whatever is not original to the historical building.
- Biocide treatment and removal of organic growth. Repairing of ashlar masonry surfaces (See Table 1) including fixing of pulverized stones or their replacement with new ones.
- Deep manual cleaning and consolidation of the joints with Limepor NHL 3.5.
- Laying on top of the walls a mixture of crushed brick with hydraulic lime mortar, coloured with ochre powder, 8-10cm layer and pressed many times along three-four days to get a very strong and compacted surface. Alternatively use Tectoria M15 or equivalent in two coats, a scotch coat and then a second 25mm thick. After one week apply lime based finish such as Tectoria TFT or Limepor SK or FN.
- Final surface is to have a convex curved surface to disperse the rain water.

Samples of crushed brick mortar shall be carried out before the beginning of the works, to find different types and colors of mortars, correct tools and procedure to be used, and precise procedures for every kind of restoration work. .

**Before any intervention on the roof relative supports and temporary protective works should be done internally.**

**13.6. Realization of metal props**

Construction of fabricated metal props, supplied and mounted for structures to be demolished or restored or in danger of collapsing, located both in the interior and the exterior, consisting of hot rolled circular steel sections. It includes: attachment and stiffening plates; cutting to measure; drilling; flanges; bolting (any class of bolts) or welding; setting up signs required to ensure public safety wherever necessary and all suitable action to safeguard worker safety. It also includes anything else needed to ensure a high quality of props. Wall surfaces will be protected by padding the metal props where necessary.

It does not include protective treatment and painting, which will be calculated separately

**13.7. Disassembly of metal props (in the end of the works)**

Dismantling of metal props. It includes: use of equipment proportionate to the size of the props to dismantle; adoption of all necessary procedures to safeguard worker safety. Waste material remains the property of the company unless the Engineer decides otherwise beforehand. It also includes anything else needed to finish.

**13.8. Removal of top layer of the roof and its reconstruction**

To be performed as follows:

- Supporting of the internal surface of the vaults as shown in structural drawings.
- Careful removal of existing tiles. Cleaning and storing in order to be replaced.
- Carefully removal of the top roof layer with hand tools (no heavy machinery tools to be used).
- Replace damaged stones and clean with biocides any deteriorated stones.
- Wherever vegetation is present, growing on either the walls or the roof it should be removed.
- Healing stone cracks with Limepor100.
- Preparation of plane for impermeabilization with lime slab (Tectoria M15 or Limepor NHL 3.5 reinforced with Kimitech ELASTOFIX or equivalent for approval) at least 3 cm. thick.
- Smoothing edges to facilitate flow of water,
- Waterproofing after one week with lime based traditional finish such as Tectoria TFT or limepor FN or SK or equivalent for approval.
- Place existing tiles to the roof and where is necessary complete with new similar to the existing. Sample to be given for approval prior to placement
- Placement of new stone gutters as per drawings.
- The slope of the roof will be checked as to not have any stationary rainwater
- Anything else needed to produce a perfect finished job according to the project

Existing Waterspouts will be consolidated and cleaned and secure that rainwater washed away properly with correct inclination from the roof.

**N. 14.0. FLOORING****14.1. Removal of stains using solvent-based paint remover**

Removal of overlying substances of various kinds such as oil, paint, wax, etc. by the application of organic and/or inorganic substances; it includes the cost of tests to identify suitable solvents and application times and subsequent removal of dirt and solvent residues, on works located on the interior, computed per m2 over the total m2 affected by the phenomenon: solvent impregnated packs.

**14.2. Damp cleaning of surface (gypsum tiles) to remove dust**

- Application of wax-stripping product to clean the floor thoroughly. Removal of all foreign matter and old wax. Rinsing very thoroughly, being sure all the cleaner is removed.
- Application of a thin coat of penetrating type of terrazzo sealer.
- When the floor is dry, buff with an electric polisher.

Use only neutral liquid cleaners meaning those which are neither acid nor alkaline.

### **14.3. Gypsum-marbles or similar ones approved by the Engineer**

Gypsum-marbles shall only be installed if missing from certain areas and no replacement whatsoever shall be required of those that are broken.

All gypsum-marbles shall only come and be obtained from recognized manufacturers and shall be of the right shape with square and clean-cut edges as specified and approved by the Engineer.

Gypsum-marbles shall be installed on a substrate of crushed and rinsed sand, fitted with lime paste of at least 2 cm wide. They shall be fitted with lime paste in which powder from the same marble slab shall be added. Joints shall have a thickness of 5 mm. Particular attention shall be given to ensuring that the surfaces of the slabs free of stains. After their installation, all slabs shall be watered with a water-cement mixture in a colour that best suits the colour of the stones and, additionally be thoroughly cleaned.

Wherever gypsum marbles are to be placed, no skirting boards shall be installed. Nylon shall be placed under the substrate to provide protection against moisture.

### **14.4. External flooring/Corridor**

An external corridor should be made along the exterior perimeter of the church as shown in the drawings. The composition of the mortar corridor is:

- A lining is made, using irregular stones, on both sides of the corridor. The upper part of the lining stones must protrude a little from the surface of the ground.
- For the filling, you mix 1 part\* ( a bucket ) of white cement, 4 parts of sand (it must be of a beige or light brown color), 6 parts of small gravel, with diameter between 1 and 1,5 cm. The color of the gravel must also be beige and light brown. These ingredients are well mixed together and water is added while mixing, enough to produce a workable mortar.
- The mortar is poured between the lining and then the surface is smoothed and left to dry and harden.

## **O. 15.0. WINDOWS SILLS AND DOORS**

### **15.1. Repairing of window sills and surrounding surfaces**

All window sills and all surrounding surfaces shall be restored by specialized mason under supervision. Photo report prior to any intervention.

- Dry cleaning of loose deposits with soft mechanical systems in order to remove deposits from surfaces, including removal of nails, iron items, and whatever not coherent.
- Removal of mortars and plasters covering stone surface, as for example modern cementitious pointing interventions, using suitable instruments not to damage while removing the stone surface covered by the mortar.
- Removal of paints with tested solvents.
- Fixing of small stone scabbling, injecting premixed cement-free hydraulic binder (Limepor NHL 3.5 or equivalent)
- Sealing of joints and little holes using premixed cement-free hydraulic binder Limepor NHL 3.5 or equivalent and ground stone powder in order to match the colour of mortar with the colour of the stone, pressing the mortar with a spatula and treating with sponge .
- Fixing of broken edges with mortar made with putty mixed with calcareous sandstone sand, well pressed with a spatula, matching the colour and the texture of the stone.
- Pulverized sandstone to be fixed with impregnation of lime wash using brushes or cellulose pulp, and repeating process as many times as necessary to consolidate damaged stone.

### **15.2. Construction of new wooden doors to church**

#### **Construction of new wooden doors to church**

The entire amount of timber will be purchased by an authorized firm and before use will be approved by the architect. Any kind of timber which was not approved by the Engineer will be removed from the site. The wood will enter the construction site must have a certificate of having dried in a kiln.

The timber will be free of knots, holes and biological components and dry and without cracks, The woods humidity factor will be according to EN 1995-1-1 to (less or equal)  $\leq 20\%$ . Prepare and fix new double-winged doors of longleaf pine wood, according to the drawings. New double winged doors are to be fixed to hinges, using ironmongery matching the existing doors found in the building.

New wooden doors will be treated 3 coats with Silvanol LM or equivalent. Wooden door/s will be installed as per drawings.

### **15.3. Door and Window Fixtures and Fittings**

New components and mechanisms shall be used, i.e. struts, and handles (spanioleta), hinges, latches, butterfly catches, after representative samples have been provided for approval.

Custom made components of traditional craftsmanship shall be used for the construction of all new doors. The following purchase amounts shall be counted upon for the supply of door and window fixtures and fittings either to be replaced or supplemented.

The phrase "*Custom made components.....of all new doors*" explains that some components (either steel/iron or wooden) may be custom made of traditional craftsmanship, e.g. made from a specialized mason (usually performed from a *Komodromos*), such as metallic hinges, latches etc. since there are no traditional components available in the market to match with old ones.

### **15.4. Carpentry and Joinery Works**

Prior to its arrival at the Site of the Works, all natural timber to be used, wherever needed, shall be treated with two coatings of the insecticide RENTOKILL or other appropriate equivalent to the approval of the Engineer. For their application, the Instructions of the Engineer and the Suppliers must strictly be followed.

In general, all framing and/or other wooden constructions shall be constructed in accordance with the Detail Drawings, the Conditions for each Site as well as the instructions of the Engineer.

The exact measures for all carpentry and joinery needs shall be taken by the Contractor in situ at the Worksite, who shall then submit for approval a complete set of construction designs to the Engineer, prior to construction commencing.

### **15.5. Timber**

Timber to be used shall be imported CE approved Swedish timber of first-class quality, unless otherwise specified in the Drawings or Conditions and shall meet the approval of the Engineer. All timber must be homogeneous, sound, straight and fine in grain and with dense growth rings. It shall be free from surface splits and irregularities, cracks, resin pockets, dead or black knots, as well as cracked knots, especially at the areas around joints and edges of cross-sections. The use of timber that has been infected by insect attacks and/or fungal decay or even bear signs of previous insect and/or damage shall not be permitted. All timber shall be free of decay, defects or combination of defects, knots or biological contamination, rendering it unsuitable for the purpose intended, according to the requirements of BS 186.

Timber to be selected for the construction or repair of internal framing must be dry, whereas timber selected for the construction or repair of external framing must have a moisture content of 10% during the stage of their cross-section formation at the factory.

Moist and/or bad quality timber shall be subject to immediate rejection and shall be removed from the worksite.

In all cases samples of the timber for use in the Works shall be submitted to the Engineer for approval prior to its use and all timber included in the Works shall be of equal quality as the approved samples.

### **15.6. Conservation arranged method for Wooden Fittings**

Wooden doors/windows and their fittings shall be firstly secured out of harm away from the building works. The fittings shall be covered in situ and treated in situ, whereas the doors shall be taken to a pre-arranged room, where the treatment can take place. Doors shall be placed on wooden supports lying horizontally. Firstly with a power controlled vacuum cleaner the dust and other dirt shall be brushed off the surface of the wooden doors on both sides as well as the edges. The treatment of wood against wood pests shall be injected



through the holes as well as by means of brushing on the surfaces. Depending on the state of the wood after close investigation this treatment may be repeated. Permetrine based treatment must be applied, which is a natural product and a common practice on heritage works internationally. Experienced personnel shall be wearing safety masks, gloves and protective clothing at all times. Photographic documentation shall be made during each stages of the work. After the wooden doors be treated, they should be covered by the colorless oil based element "Rustins outdoor woodstain" or equivalent, according to the manufacturer's specifications and instructions

#### **15.7. Transforming Openings with Wooden Lintels**

All lintels (at doors and windows) found deteriorated, deflected or otherwise damaged or rotten shall be replaced with beams made of 5" x 3" Swedish timber of first grade quality across the entire length of the masonry (at least 3 beams). Prior to installation, beams shall be properly painted with colourless preservative varnish.

The moisture content of the beams shall not exceed 12%. Beams shall mount on the wall at least 25 cm and shall be bonded with plaster. Beneath the wooden beams, boarding shall be installed made of Swedish timber 2,5 cm wide shall be installed.

#### **15.8. Window Meshes**

Meshes shall be installed in all structural openings so as to prevent the entry of flying birds into the internal area of the building. Meshes shall be fitted in a wooden frame and attached to the casing between external and internal shutters. The mesh grille shall be thin and made of connected strands of steel.

### **P. 16.0 SCAFFOLDING**

Scaffolding and temporary work platforms must be capable of being constructed without the need for major intervention into historic fabric.

Scaffolding and temporary works are a fundamental necessity of any building project and when they are erected in or around buildings of historic value and interest it is vital that they do not cause damage.

#### **16.1. Access Scaffolds**

'Independent tied' scaffolds shall be provided to gain access to façades and the Minaret for treatment, repair and other maintenance works.

They shall consist of two rows of standards (the vertical supports) connected by ledgers and transoms (the horizontal elements). They are termed 'independent' because this type of scaffold derives no vertical support from the building and 'tied' because they must be tied to the building for horizontal stability.

#### **16.2. Shoring or Support Scaffolding**

These are temporary works erected either because there is a danger of collapse or because it is necessary to remove some vital supporting member for renewal or alteration. Obviously the loads to be carried by shoring can be very great and failure can be disastrous causing major damage to historic fabric.

#### **16.3. Statutory Inspections**

It is a statutory requirement that all working scaffolds are inspected weekly by a suitably qualified person and that the results of these inspections are recorded in the scaffold register.

#### **16.4. Foundations**

The soil should be well rammed to ensure that there are no cavities and timber sole plates at least 230 mm X40 mm should be used.

Foundations should always be level and should never be undermined. The foundation and the standard or prop set on it should be concentric to avoid inducing moments or eccentric forces.

#### **16.5. Vertical Members**

Steel base plates should always be used. Joints in standards should be staggered, that is, joints in adjacent standards should not occur in the same lift.

All standards should sit on timber sole plates to spread the load and floors beneath should be protected with polythene sheet, old carpet, or similar materials to prevent damage.

### **16.6. Ledgers and transoms**

These components should always be horizontal. Ledgers should be clamped to the standards with right-angle couplers. Joints in ledgers should be staggered and made with sleeve couplers. Transoms should be fixed to ledgers with right-angle couplers or, if not adjacent to a standard, with putlog clips and be at no more than 1.2 m centers. Where required to support boarding. In each bay, one transom should be not more than 300 mm from a standards.

### **16.7. Fixings to Masonry**

Where fixings are made to stone or brickwork it must be ascertained that the masonry is adequate for this purpose. All fixings made to the wall of an historic structure must be of stainless steel.

Guard rails, toe boards, and ladders

Guard rails should be between 914mm and 1143mm above the platform and toe boards must not be less than 150mm high. Ladders must be sound, securely fixed, and set at an angle of 4: 1. To prevent unauthorized access by vandals or children, lockable ladder boards should be used when the site is unattended.

### **16.8. Bracing**

Ledger bracing at right angles to the building should be fixed to alternate pairs of standards. Facade bracing should be to the full height, at an angle of 45 degrees, and at not more than 30m centers. Zig-zag bracing may be used for facade bracing. Joints in bracing should only be made with sleeve couplers, never with expanding joint pins.

Bracing connections should be made within 300mm of standard/ ledger /transom junctions. Bracing should always finish at ground level or at some adequately strong point on the permanent work as bracing that finishes one or two lifts above ground applies horizontal forces to the scaffolding that cannot be satisfactorily dissipated. Likewise, bracing should always go to the very top of the scaffolding structure.

### **16.9. Decking**

Boards should always be fitted with a hoop iron at each end. Boards should oversail their last support by at least 50mm but by less than 150mm. Precautions should be taken to hold boards down in high winds. Excessive loading on platforms should be avoided unless the scaffolding has been specifically designed to carry heavy loads.

Guard rails, Toe Boards and Ladders

Guard rails should be between 914mm and 1143mm above the platform and toe boards must not be less than 150mm high. Ladders must be sound, securely fixed, and set at an angle of 4: 1.

### **16.10. Shoring**

Account must be taken of wind, dead and superimposed loads, slenderness ratio of members, slenderness ratio of structure, bracing, foundations, fixing to permanent structure, permissible stresses of materials, safety factors, and any other relevant considerations. The main difficulty

With shoring historic buildings is to ensure that temporary works do not cause damage in the process of being installed.

### **16.11. Telescopic Props**

These may need bracing if they are over 2m high or if they carry heavy loads. They must be plumb and must be properly founded. It is common to find a missing support pin being replaced by a short piece of reinforcing bar or something even less satisfactory, such as a big nail. Only the manufacturers high tensile steel pin should be used.

**TABLE 1: CRITERIA FOR REPLACEMENT OF DECAYED/DETERIORATED AND HEAVILY DAMAGE STONES**

Loss of stone mass from > 65%	<p>Replace with new stone equivalent in texture, size and colour as per laboratory analysis.</p> <p>Its porosity/apparent density (measured in accordance with EN 1936) should be &lt;35% and &gt;1700 kg/m<sup>3</sup> respectively. The capillary absorption coefficient (measured in accordance with EN 1925) should be &lt;1000g/m<sup>2</sup>/s<sup>1/2</sup>.</p> <p>The stone should also be adequately resistant to salt crystallization (EN 12370) to fit the purpose of its use. The compressive strength (measured in accordance with EN 1926) of the replacement stone should exceed 5 Mpa</p>
Loss of stone mass > 25% but < 65%	Retain more original material. Cut out and piece in with new stone equivalent in size, colour and texture minimum depth 15cm and repair with appropriate mortar
Loss of stone mass <25%	Nothing will be done to the stone or if the Engineer deems necessary, minimum repair with appropriate mortar containing natural hydraulic lime NHL, natural pozzolans and insert siliceous material with a maximum Granulometry of 3mm

**TABLE 2: CRITERIA ON REPARING CRACKS**

Mimimal depth (Superficial cracks)	If the crack is smaller <4mm use of a material which has high resistance to sulfates, low water-soluble salt content, will be made out of hydraulic lime plaster such as Tectoria PMP or equivalent.
Bigger cracks	If the surface crack is wider >4mm correct the crack with use of a material such as Limepor 100 or Limepor IZ8 to fill crack and then tectoria PMP or equivalent to seal it .
Deep cracks	Insertion of a steel rods diagonally to the crack. Use injection to heal crack with the use of the material liquid two -component epoxy resin for structural injections. While grouting and sealing the cracks and gaps with a suitable hydraulic lime based mortar.