DIVISION 3

CONCRETE

BUILDING WORK

DIVISION 3

CONCRETE

INDEX

SECTION 03050

BASIC CONCRETE MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes formwork, reinforcement, accessories, cast-in place concrete, finishing and curing.

1.2 SUBMITTALS

A. Shop Drawings: Indicate pertinent dimensioning, form materials, location of bracing and temporary supports, schedule of erection and stripping. Indicate reinforcement sizes, spacings, locations, and quantities, bending and cutting schedules, supporting and spacing devices. Indicate sidewalks, slabs-on-grade, and any other objects may be requested by the Engineer.

B. Design Data: Submit mix design.

PART 2 PRODUCTS

2.1 REINFORCEMENT MATERIALS

A. Reinforcing Steel: Use Reinforcing steel according to ASTM A615, ASTM A706, 276 and 414 MPa yield grade as detailed in drawings.

B. Welded Steel Wire Fabric: according to ASTM A185 deformed type, tying wire shall be No. 16 gauge soft annealed iron wire.

C. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for support of reinforcing; plastic tipped or non-corroding for supports in slabs forming finished ceilings or where supports are exposed to weather.

D. Fabricate concrete reinforcing in accordance with ACI 315, ACI 318 and ASTM A184.
Reinforcement shall be stored clear of the ground and adequately supported to prevent distortion.
Bar steel reinforcement shall be bent cold to forms and dimensions shown on the Drawings. No heating will be allowed to facilitate bending. Tack welding is not allowed to position bars crossing at right angles or for any other reason.
Reinforcement should be clean and free from loose mill scale, loose rust, oil, grease, tar, paint or other deleterious matter and shall be maintained free from concrete droppings up to the time of concreting.

2.2 CONCRETE MATERIALS

A. Cement: BS 12 or ASTM C150, Normal-Type I, ordinary Portland type.

B. Sulphate Resistant Cement:

C. Fine and Coarse Aggregates: Coarse and fine aggregates for concrete used in the permanent work shall comply with BS 812, (1983) or to ASTM C33. The Contractor shall inform the Engineer of any variation in quality.
The Contractor will carry out on site, upon the Engineer request, on Site the following tests in accordance with BS 812:

1. Sieve analysis
2. Clay, silt and fine dust
3. Specific gravity
4. Water absorption
5. Bulk density, voids and bulking
6. Moisture content
7. Organic impurities
8. Aggregate impact value
9. Aggregate crushing value
10. Ten percent fines value
11. Crushing strength
12. Aggregate abrasion value
13. Chemical properties (soluble salt content)

The Contractor shall provide the necessary apparatus required for carrying out the tests together with all necessary labor and materials used in conducting the tests. The Contractor shall be deemed to have included in his rates the costs of carrying out these test. The coarse aggregate whether of nominal maximum size 14 or 20 or 40mm shall be graded in accordance with the requirements for graded aggregate as given in Table 4 BS 882, (1983), except where otherwise ordered or agreed to by the Engineer. Fine aggregates shall comply with the requirements of BS 882, (1983), Table 5.

Aggregate for granolithic flooring shall be crushed granite 10mm down and in accordance with BS 882.

All aggregates supplied shall be subject to the approval of the Engineer, but certificates indicating their compliance with the relevant British Standard shall be provided by the Contractor before deliveries to Site. Sample loads of each grade of aggregate shall be delivered to the Site in sufficient time in advance of the commencement of concreting to allow for examination and testing and the preparation and testing of the concrete trial mixes.

Sample quantities of each grade of aggregate thus provided will be retained for comparison with subsequent deliveries. Any rejected sample or subsequent delivery of non-standard material shall be removed from the Site forthwith at the expense of the Contractor.

Aggregates delivered to the Site during the course of the construction shall conform to the sample loads.

D. Water: All sources of water to be used with cement whether for mixing or curing of concrete, or compaction of backfill around the concrete structures, should be approved by the Engineer. If at any time during construction, water from an approved source becomes unsatisfactory, The Contractor shall provide satisfactory water from other sources.

Water shall be clean fresh potable water free from injurious quantities of oil, alkali, organic matter and salt as determined by the Engineer.

E. CONCRETE MIX: Concrete shall be mixed thoroughly in a batch mixer of an approved type and capacity. No hand mixing will be allowed unless authorized by the Engineer and only for small quantities.
Batching, whether by weight or by the equivalent volumetric proportions, shall be for whole bags of cement as approved by the Engineer. Mixing time shall not be less than one and one-half minute after all component materials, including water, are in the drum of a mixer with a capacity of one cubic meter or less.
The mixing time shall be increased by 20 seconds for each additional cubic meter (or fraction thereof) of mixer capacity.
The charging of water into the mixer shall be gauged from a calibrated container or from such other approved device as shall be capable of delivering the required quantities to within one liter of the gauged amount. Charging of water shall begin before the cement and aggregates enter the drum. During mixing, the drum shall be operated at the speed specified by the manufacturer.
Any concrete mixed for less than the specified time shall be dumped outside the work area and removed by the Contractor at his own expense.
No mixer with a nominal capacity of less than one bag shall be used.
The concrete should be mixed only in such quantities as are required for immediate use.
Re-tempering of concrete will not be allowed.
Concrete which is not of the required consistency at the time of placement should not be used. The entire contents of the mixer should be discharged from the drum before materials for a succeeding batch are placed therein.
Upon cessation of mixing for any considerable length of time, the mixer shall be cleaned thoroughly. Upon resumption of mixing, the first batch of concrete material placed in the mixer shall contain sufficient sand, cement and water to coat the inside surface of the drum without diminishing the required mortar contents of the mix.

F. Furnish concrete of the following strength:

Class of Concrete	General Application	Required Minimum Density Kg/cu. m	Minimum Cement Quantity Kg/cu. m Concrete	Maximum Water/ Cement Ratio by Weight	Required Minimum Cube Strength at 28 days N/mm^2	Maximum Aggregate Size (mm)
A	Reinforced concrete for walls, foundation, slabs on grade ... etc.	2355	350	0.55	30	20
		2355	300	0.60	25	20
B	Plain concrete	2340	250	0.65	20	20
C	Plain concrete for blinding	2340	200	0.70	15	20

2.3 STORAGE OF MATERIALS

A. Cement.

The Contractor shall provide a container or building for storing the cement at the Site. The container or building shall be dry waterproof and adequately ventilated. If more than one type of cement is to be used on the Works the container or building shall be suitably sub-divided to the satisfaction of the Engineer and great care shall be exercised to ensure that different types of cement do not come into contact with each other.

Cement in bags manufactured more than 3 months period prior to its proposed use on the site shall not be used, and cement in silo manufactured more than 6 months prior to its proposed use on the site shall not be used.

Bags of cement shall not be laid directly on a floor but on wooden slats or duckboards to allow the efficient circulation of air around the bags.

Each cement store shall be arranged to allow the cement to be used in the order in which the various consignments are delivered.

Cement shall not be kept in a temporary store except where it is necessary for efficient organization of the mixing plant and only when the prior approval of the Engineer has been obtained.

The Engineer's Representative shall be furnished with the means of identifying the several consignments of cement delivered.

The cement may, with the permission of the Engineer, be stored in a properly constructed bulk storage silo and delivered in approved bulk delivery vehicles.

The different types of cements shall be stored in separate compartments. If intermixing occurs all cement concerned will be condemned by the Engineer and shall be removed immediately from the Site.

No cement which, in the opinion of the Engineer, has deteriorated or hardened shall be used on the Works and such cement shall be immediately removed from the Site.

Cement manufactured more than 12 months prior to its proposed use on the Site shall not be used.

Any cement that is stored on the Site for a period in excess of 28 days shall be tested in accordance with the relevant Standard prior to use.

B. Aggregates

Adequate stocks of tested and approved aggregates shall be maintained on site and the capacity of the bins for each type and grading of aggregate shall be sufficient to hold the respective quantities required for the maximum amount of concrete which the Contractor is obliged or intends to pour in any continuous operation in one day. Stockpiles shall be built in layers of 1.50 meters maximum height and segregation of the aggregates prevented. Concrete block walls shall separate different grades of aggregates.

Dense concrete or bituminous slabs shall be laid with sufficient falls to cover all aggregate stockpile areas or bins and shall extend to cover all surrounding areas where aggregates are likely to be discharged or handled. These areas shall be swept and kept clean at all times to ensure that the aggregates are not contaminated by the adjacent ground through trafficking or otherwise, and are to be constructed with adequate drainage for surplus water.

Windbreaks shall be provided where aggregates might suffer excessive contamination by windblown materials. During periods of heavy rain the bins or compounds shall be covered by tarpaulins or other approved means.

C. Reinforcement

All bar or rod reinforcement shall be stored on suitable racks, each diameter and quality being kept separate. Fabric shall be stored on a level floor to prevent contamination by dirt or oil weatherproof and from undue exposure to the weather. High tensile rods or wire are to be stored in a damp resistant building to prevent rusting.

PART 3 EXECUTION

3.1 FORMWORK ERECTION

Erect formwork, shoring and bracing to achieve design requirements. Formwork be constructed to attain the required surface textures of the structures and be such that it remains rigid during the placing and setting of the concrete.

The Contractor shall design and construct formwork to avoid high intensity point loads and to withstand:

- Total weight of formwork, reinforcement and concrete.
- Construction loads including dynamic effects of placing compacting and construction traffic .
- Wind loads.

The Contractor shall advise the Engineer of construction load of each deck. He shall prop through decks if construction load on particular deck exceeds:

- Design loading, or
- Reduced loading agreed with the Engineer for decks cast less than 28 days.

The Contractor shall submit to the Engineer for approval details of proposed:

- Prop bearings for checking the effects on the structure.
- Cambers to soffits of beams and slab with adequate allowance for deflection of formwork under weight of fresh concrete to achieve the agreed cambers.

The maximum permissible deflection of formwork under loads is not to exceed 3 mm or 1/600 of free span , whichever is less.

Formwork shall be fixed in perfect alignment and to the true shape and dimensions of the permanent work shown on the Drawings. Methods of support that would result in holes or tie wires extending the whole width of a member will not be permitted. Tie wires are permitted only for concealed or rendered surfaces in buildings.

Top shuttering is to be provided to concrete faces where the slope exceeds one in two and a half.

Before each concreting operation is commenced formwork should be carefully examined and cleaned out and the concrete contact faces of the shuttering shall be treated with an approved mould oil.

When so instructed, the Contractor shall submit the design and details of shuttering for the Engineer's approval.

No concreting shall be commenced until the Engineer has inspected and approved the erected formwork.

The minimum periods for retaining formwork in position before striking are as follows:

- Vertical formwork to columns, walls and beams	2 days
- Soffit forms to slabs with spans up to 10m	10 days
- Soffit forms to slabs with span over 10m	21 days
- Soffit forms to beams	21 days

A. Camber slabs and framing to achieve ACI 301 tolerances.

B. Provide bracing to ensure stability of formwork.

3.2 REINFORCEMENT PLACEMENT

A. Place reinforcement, supported and secured against displacement.

B. Ensure reinforcing is clean, free of loose scale, dirt, or other foreign coatings.
Reinforcement shall be placed in accordance with the Drawings and shall be supported and maintained in position by the provision of wire ties or clips at bar intersections and by spacers to maintain the reinforcement in its correct position. The spacers must be securely fixed to the reinforcement at the time of placing.
Cover spaces shall be of concrete made with 10mm aggregate and shall match appearance on surrounding concrete in exposed work. Proprietary plastic spacers may be used subject to the approval of the Engineer .The Contractor shall obtain

approval of type , size and position of cover spacers.
The Contractor shall adopt effective measures to ensure that reinforcement remains accurately in position during the placing, consolidation, and setting of the concrete.
In slabs provided with two or more layers of reinforcement the parallel layers of steel shall be supported in position by the use of steel chairs. Spacers shall be placed at each chair to support layers of reinforcement from the concrete carpet or formwork. The rates for reinforcement shall include for the provision and fixing of stools.
Reinforcement projecting from work already concreted shall be bent out of its correct position for any reason unless permitted by the Engineer and shall be protected from deformation or other damage.
Except where otherwise shown on the length of lap joints shall be not less than 40 times the diameter of the larger bar.
Except where otherwise shown on the Drawing the concrete cover to the nearest reinforcement exclusive of plaster or other decorative finish and concrete blinding shall be as follows:

(a) For external work, for work against earth faces and in liquid retaining structures - 50 mm
(b) For internal work in non-liquid retaining structures:
(i) For a beam - 40 mm
(ii) For a column wall or strut - 40mm.
(iii) For slab reinforcement in building - 20mm.
(iv) For slab reinforcement subject to chemical attack - 40 mm.

C. The distance between any two parallel bars shall not be less than 50 mm, or 4/3 maximum aggregate size, or 1/5 the minimum width of member whichever is greater.

D. No concreting shall be commenced until the Engineer has inspected and approved the placed reinforcement.

3.3 PLACING CONCRETE

A. The Contractor should obtain the approval of the Engineer to his proposed arrangements before commencing concreting.
The Contractor shall regard the compacting of the concrete as work of fundamental importance, the object of which shall be to produce watertight concrete of maximum density and strength.
Concrete should be thoroughly compacted during the operation of placing and shall be thoroughly worked around the reinforcement and any embedded fixtures and into corners of the shuttering and moulds.
Mechanical vibrators shall be of a design approved by the Engineer. A sufficient number of vibrators shall be used to handle the maximum rate of concrete production with an allowance for spares.
Concreting shall be carried out continuously to construction joints. The Contractor where required by the Engineer shall make all necessary arrangements to ensure continuity of concrete placing by working labor and plant in a shift system through day and night.
Concrete shall not be disturbed after compaction and placing in its final position.

Concrete that has partially set before final placing shall not be used and shall be removed from the site. Cold joints in the concrete shall not be allowed to occur.
Concrete shall be handled from the place of mixing to the place of final deposit as rapidly as practicable by methods which will prevent the segregation or loss of any ingredient.
Wherever practicable the concrete shall be emptied from a mixer directly into a skip. The skip shall then be transported to the place of final deposit and the concrete tipped as nearly as practicable into its final position to avoid rehandling or flowing. No concrete shall be thrown or dropped from a height.
The time elapsing between the concrete leaving the mixer and being finally placed in position shall not exceed 30 minutes.
Should the Contractor propose to use concrete pumps for the placing of concrete he shall submit full particulars of the equipment and methods he proposes to adopt to the Engineer for his approval. In the event of the Engineer approval being obtained, placing concrete by pumping methods shall comply with Title No. 68-33 by ACI Committee 304. The Contractor shall also pay particular attention to elimination of shock transferred from the pipe line to the formwork and previously placed concrete and he shall provide alternative means of supply and transport so as to cater for the possible breakdown of the pump or pumps during concreting operations. The initial discharge from a pump shall not be incorporated in the permanent works. When concreting slabs or similar structures by means of pumps the point of discharge shall be moved at intervals of about 15 minutes.
Where the concrete is conveyed by chuting or pumping the plant shall be of such a size and design as to ensure continuous flow in the chute or pipe. The slope of the chute or pressure at the pump shall be such as to allow the concrete to flow without the use of any water additional to that ordered by the Engineer to produce the required consistence and without segregation of the ingredients. The delivery end of the chute or pipe shall be as close as possible to the point of deposit. The chute or pipe shall be thoroughly flushed with water before and after each working period; the water used for this purpose being discharged outside and away from any permanent works or irrigation conduit.

B. Protection and Curing of Concrete

Concrete shall be cured in such manners and for such periods as the Engineer may direct having regard to the climatic conditions prevailing at the time of placing any individual batch of concrete.
The following requirements shall be strictly complied with by the Contractor except in those instances where the Engineer shall issue separate instructions modifying such requirements, or where the Contractor has obtained the prior approval of the Engineer to a modification thereto.

(a) Top Surfaces of Horizontal Slabs etc. (Other than concrete carpets).
Covering the surface with a 50mm carpet of sand kept constantly wet or spraying the whole surface with water continuously or pounding of the surface with water to a minimum depth of 20mm for a period of 14 days after casting.

(b) Sloping Unshuttered Surfaces. In cases where the Engineer considers the ponding of slopping surfaces to be impracticable on account of the degree of the slope, such surfaces shall be covered with a carpet of wet sand or sprayed with

water as above specified or treated with membrane curing compound provided such compound is applied immediately after casting of the concrete member in compliance with ASTM C309, and protected by such additional methods as the Engineer may consider necessary having_regard to the climatic conditions. These may include shading of the workduring the warmer season.

(c) Undersides of Horizontal and Sloping Members. Spray the whole surface with water immediately after the formwork is struck.

(d) Timber or Steel Shuttered Vertical and Sloping Surfaces. (Other than undersides). Drape the formwork with hessian during setting in the warm season and drape the concrete with hessian immediately after striking the formwork. Spray the concrete surface and the hessian continuously with water from sparge-pipes or from a trough accurately set to level for a period of 21 days during the summer months (April to October inclusive) so as to produce a continuous film of water on the surface of the concrete. During other seasons the same procedure shall be adopted but the Engineer may permit a reduction in the period of spraying if conditions in his opinion justify such a procedure.

(e) Concrete Test Cubes or Cylinders:
The Contractor shall establish a small locked room for storing concrete test cubes or cylinders prior to testing and the key shall be in the custody of the Engineer. Cubes shall be stored in water in this room unless the Engineer should direct that cubes be stored in conditions simulating those under which the concrete of which the concrete of which the cubes are representative is maturing.

No placing or traffic of materials, passage of men, further construction or temporary works shall be allowed on any concrete until it has matured sufficiently to permit such placing or traffic without detrimental effect on the concrete.

(f) Concreting in Extreme Weather Conditions.
No concrete shall be mixed at an air temperature of less than five degrees C unless proposals to counteract the effect of cold weather have been submitted by the Contractor and agreed in writing by the Engineer. Exposed surfaces of concrete shall be efficiently protected to maintain its temperature above five degrees C until it has hardened.

The Contractor shall provide a thermometer suitable for measuring the temperature of aggregates and a maximum and minimum thermometer that shall be hung in a position indicated by the Engineer.

The Contractor shall take great precautions during hot weather to prevent the cracking or crazing of concrete and if evidence of cracking should appear he shall so organize his programs as to arrange for concrete pouring to take place during the early morning or late evening. He shall also arrange for the formwork to be shaded from direct exposure in the sun both prior to the placing of the concrete and during its setting. Particular regard shall also be taken to the curing of concrete as herein specified.

When the air temperature in the shade is expected to exceed 32 degrees C, the Contractor shall schedule his operations to place and finish the concrete during the hours that the air shade temperature will be below 32 degrees C. This should preferably be in the latter part of the day after the maximum temperature has been reached, and subject to the approval of the Engineer.

The temperature of the concrete at the time of placing shall not be permitted to exceed 32 degrees C. Concrete materials shall be stored in a cool shaded position away from the direct rays of the sun and be kept cool. Concreting water shall be stored in a tank that is kept cool by efficient lagging, air conditioning or chilling or located underground. Both water and aggregate shall be cooled if necessary prior to mixing and ice water shall be used if ordered by the Engineer's Representative. The forms and reinforcing steel shall be cooled to a temperature of not more than 32 degrees C by spraying them with water.

The time available for handling and placing of concrete during periods of high temperatures may be considerably reduced and the Contractor must take appropriate precautions. Concrete should be protected during transportation by use of damp hessian or similar means. No additional water may be added at the time of mixing without the approval of the Engineer as this may lead to additional shrinkage of the concrete. On no account shall water be added during transportation or placing of the concrete. Retarding admixtures or water reducing and retarding admixtures shall conform to BS 5075 or ASTM C 494 and shall be used if required and approved by the Engineer.

Hot weather concreting shall conform to the requirements of "Recommended Practice for Hot Weather Concreting" (ACI 305, latest edition).

C. Removal of formwork

Formwork shall only be removed with the permission of the Engineer and the work of striking after the receipt of such permission shall be carried out under the personal supervision of a competent foreman. Great care shall be exercised during the removal to avoid shocks or reversal of stress in the concrete.
In cases where the Engineer considers the Contractor's proposal for the removal of shuttering to be premature either on account of the weather or for any other reason he may order the Contractor to delay such removal and the Contractor shall have no claim for delay in consequence thereof.
Notwithstanding any advice, permission or approval given by the Engineer, the Contractor shall be responsible for any injury to the work and any consequential damage caused by or arising from the removal of shuttering.

D. Repair of Surface Defects

Surface defects, including tie-holes, unless otherwise specified by the Contract Documents, shall be repaired immediately after form removal.

The defected area to be patched and an area at least 150 mm wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A

bonding grout shall be prepared using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface. Particular care shall be taken to color match patches with the bulk concrete.

E. Construction Joints

The Contractor shall submit for approval by the Engineer the proposed dimensions of concrete pours and his proposals for the position of construction joints having due regard to any that may be shown on the Drawings.

Where construction joints are required in slabs or beams these shall be made at one-third of the span and at right angles to the member except where otherwise approved by the Engineer. Where slabs are supported by beams then both beams and slabs shall be constructed in one operation.

In all cases vertical stop boards of a form to be approved by the Engineer shall be provided at the end of each section of work which is to be concreted in one operation and the concrete shall be thoroughly consolidated against these stop boards.

Where slabs, beams and walls are divided by construction joints they shall be constructed in alternate bays and an interval of seven days shall elapse before the concrete is placed in the intervening bays.

Construction joints in slabs and beams shall be of the vertical butt type. Provision shall be made for transfer of shear and other forces through all construction joints.

Before placing new concrete against concrete, which has already set, the latter shall be treated to expose the aggregates over the full section and leave a sound irregular surface. This should be done while the concrete is still green by means of water spray and light brushing with or without the use of a retarding agent approved by the Engineer.

Immediately before the fresh concrete is placed, all foreign matter shall be thoroughly cleaned away and the surface moistened.

Before continuing concreting against or on top of the face previously cast the vertical faces of construction joints shall be covered with a thick grout of neat cement and the horizontal faces shall be covered with a layer of 1:1 cement and sand grout approximately five mm thick immediately prior to placing new concrete against the joints. New concrete shall be thoroughly tamped into the grout or mortar layer. In the case of a joint between new concrete and a surface other than concrete similar treatment as specified above shall be carried out.

F. PVC Water-stops: The PVC waterstops should be nailed to forms prior to concreting and butt joint accordance with the manufacturer's instructions.

G. Joint Filler

The joint filler shall be compressible cellular and resilient and shall not become brittle in cold weather.

Joint filler for use in potable water service reservoirs shall be of granulated cork bound insoluble synthetic resin. For other water retaining structures the joint filler shall be granulated cork bound with bitumen. For all other structures joint filler is bitumen-impregnated fiberboard.

3.4 FIELD QUALITY CONTROL

All testing shall be done in the presence of the Engineer either on Site or in an approved testing laboratory as directed.

The frequency of testing shall be noted in the Clauses of this Division and whenever required by the Engineer.

The work test cubes shall be made as follows depending on whichever is more frequent:

(a) At least three times weekly per mixing plant.
(b) At least once for each individual part of the structure as defined by the Engineer.
(c) At least once per 60 cubic meters of concrete.

For concrete blinding the rate shall be once per each 100 cubic meters or fraction thereof.

At least six cubes shall be made at one time in accordance with BS 1881: "Methods or Testing Concrete". Two of the six cubes are to be cured as specified and tested at seven days, two others cured as specified and tested at 28 days and the last two cured under the same field conditions as the concrete structures and tested at 28 days.

Strength tests shall be made in accordance with the relevant part of BS 1881.

Whenever the result of the seven-day test is unsatisfactory, the Contractor may elect to remove and replace the defective concrete without waiting for the 28-day test. If the result of the 28-day test is unsatisfactory all concreting shall be stopped at the Contractor's expense and shall not proceed further without the written permission of the Engineer.

When concrete fails to conform to the requirements of laboratory cured specimens or when tests of field-cured specimens indicate a deficiency in protection and curing, then the Contractor shall, in accordance with the instructions of the Engineer, remove and test cores or conduct in-situ load tests on suspect portions of the Works. Concrete that is judged by the Engineer to be defective shall be cut out, removed and replaced at the Contractor at his own expense.

Procedure used for drilling and testing cores should comply with ASTM C42: 1968 or BS 1881 Part 4. Evaluation of adequacy of concrete in area represented by core tests shall comply with ACI 318-83 Section 4.7.4.4

Static load tests shall be carried out and evaluated in accordance with ACI 318-1983 Part 6- Chapter 20 or BS CP 110: Part 1 Section 9.6.

In the event of strengths consistently higher than those specified being obtained, a reduction in the number of tests may be authorized by the Engineer.

Not withstanding anything contained in this Clause, the Engineer may at any time request samples for testing at a government or independent laboratory.

Testing of cement aggregates, steel or other, material used in concrete shall be according to the appropriate British Standard.

Slump shall be kept to the minimum compatible with placing requirements, but in no case shall exceed 10cm when tested in accordance with ASTM C143.

3.5 DEFECTIVE CONCRETE

A. Modify or replace concrete not conforming to required lines, details and elevations, as directed by Engineer.

END OF SECTION

DIVISION 4

MASONRY

BUILDING WORK

DIVISION 4

MASONRY

INDEX

SECTION 04810

UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes concrete masonry units. This work should consist of the supply of all materials and the execution of all concrete block and partition construction, including the forming of all openings for doors, windows, etc., in accordance with the Drawings, Specifications and Bill of Quantities.

PART 2 PRODUCTS

2.1 UNIT MASONRY ASSEMBLIES

The cement, lime, water, sand and aggregate used shall meet the same requirements as for Concrete Work (Section 3050 hereto) and shall comply with the following grading:

Sieve designation	Percentage Passing by Weight
1/8 inc.	95 – 100
No. 7	75 – 100
No. 14	55 – 90
No. 25	35 – 59
No. 52	8 – 30
No. 100	0 – 100

2.2 MANUFACTURE OF BLOCKS AND BRICKS

Blocks and bricks, whether solid or hollow, shall be of precast concrete and may be manufactured on or off the Site under the supervision of the Engineer. Blocks or bricks from an approved manufacturer may be accepted at the discretion of the Engineer.

The casting of all blocks or bricks shall be made in approved moulds and to the required dimensions, and thoroughly rammed and consolidated by mechanical tamping and vibration. All blocks shall be sound, square-edged, true to shape and size, and free from cracks and other defects.

2.3 COMPOSTING AND MIXES

The composition of the blocks shall be of ordinary or white Portland cement as specified, and of approved quality of fine and coarse aggregates graded to a maximum size of 10 mm.

The strengths of the following types of cement blocks shall be not less than 35 kg./cm.

a) Wall Blocks:

Blocks for walls shall be made of 1:2:4 mix. The quantity of cement shall not be less than 225 kg. for one (1) cubic meter of concrete, and shall be made in the following dimensions and used as shown on the Drawings:

Dimensions	Block Type
40 x 20 x 20 cm. wide	Hollow
40 x 20 x 15 cm. wide	Hollow
40 x 20 x 10 cm. wide	Hollow or solid
40 x 20 x 7 cm. wide	Solid

2.4 CURING

After casting, blocks shall be kept well wetted with water for a period of ten (10) days, and are not to be used before thirty (30) days from their manufacture. After building, concrete walls shall be kept well wetted for a period of seven (7) days.

2.5 MORTAR

The mortar for concrete block shall be as follows:-

a) The sand for mortar shall meet the same standards as mentioned in Item 2.1 hereto.
b) The mortar for building block walling shall be of 1:4 mix (one part of ordinary Portland cement to six parts of sand).
c) The mortar for building external walling shall be of 1:4 mix (one part of white Portland cement to four parts of sand).
d) Mortar, if not mixed by a mechanical mixer, shall be thoroughly mixed two times when dry and two times after adding water on a clean watertight platform. Mortar will be mixed in small quantities and used fresh. Mortar which has begun to set or has been mixed for more than 30 minutes shall not be used or remixed.

2.6 LAYING OF CONCRETE BLOCKS

All blocks or bricks for walling shall be thoroughly soaked with water before use, and shall be well-bedded in a full mortar and hammered down to squeeze out joints.

Any blocks or bricks which fracture shall be replaced with whole blocks. Vertical and horizontal joints are not to exceed 1 cm. in thickness. Walls and partitions shall be well-toothed and bonded at ends into walls, and tightly pinned in cement mortar against slabs and beams at heads. The ends of every third course of block and brick work shall be properly bonded into abutting walls to a depth of 10 cm. in accordance with the Detail Drawings.

Where the structure is of reinforced concrete frame with block or brick filling walls, the Contractor shall at his own expense provide for each wall at least one (1) tie every 40 cm. (two courses) made of steel ties 3.0 mm. thick, shot at the column and protruding at least 50 cm. along the mortar bed. Ties shall be as specified in Item 4.09 hereto.

Concrete block shall be laid plumb, true to line, with level and accurately spaced courses (each course breaking joints with the next course below it).

Walls shall be constructed course by course in a uniform manner. All block and brick surfaces to be plastered are to have joints raked out to a depth of 1 cm. to form key, and those block and brick surfaces which must remain unplastered shall be pointed flush in a neat manner while building.

All perpends, quoins, joints, etc., shall be kept strictly true, square and plumb, and courses shall be truly horizontal.

Bats, broken blocks or bricks shall only be used where strictly required for good and proper bonding.

All openings above doors and windows shall be made with reinforced concrete lintels 40 cm. high, and of the reinforcement shown hereunder, unless otherwise indicated on the Drawings: 3 dia. 16 bottom, 2 dia. 14 top, dia. 8 at 20 cm. stirrups.

2.7 ELECTRO-GALVANIZED STEEL CRAMPS AND DOWELS

Cramps or dowels shall be electro-galvanized (zinc-plated) as described in this Item.

Galvanizing of the metal shall be zinc by electroplating, so as to provide a thin, uniform and ductile protective coating. Small holes and threads shall be satisfactorily coated. The ductility of the zinc coatings shall be such as to allow for bending of the components without causing any damage. The galvanizing gauge and process shall be in compliance with BS 1706: 1960.

a) Marble to Brickwork or Concrete Cramps:

This shall be a stainless steel cramp 10 cm. long and 2.5 cm. wide, 3 mm. thick, with a half-twisted at 1/3:2/3 distance and fish tail back, and including a dowel made of stainless steel 5 mm. diameter x 4 cm. length.

b) Block to Column Tie:

This shall be electro-galvanized steel ties laid along courses 10 cm. long, bent at the column edge to a 90 degree angle with a hole for expanding bolt fixation to column. The total length of the tie shall be 25 cm., i.e. 15 cm. along the course and 10 cm. along the column, with a fish tail 2.5 cm. wide x 3 mm. thick.

c) Block to Concrete Wall Ties:

This shall be electro-galvanized steel ties laid between block courses to face of concrete walls.

The total length of the ties shall be in accordance with space between the block and concrete walls bent at the concrete wall face to a 90-degree angle with a hole for expanding bolt fixation to concrete wall.

Width of ties shall be 10 cm. x 3 mm thick.

Ties to be laid every 3 meters horizontally and every four courses vertically.

END OF SECTION

SECTION 04853

STONE ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes stone works for exterior and interior walls.

1.2 SUBMITTALS

A. Samples:

1. 500-mm minimum square samples of each type of material proposed for use.
2. Submit samples in sufficient quantity to show extreme variation which may reasonably occur in each kind of stone, regarding color, texture and quality. Engineer reserves the right to approve more limited range of variation. Samples must be submitted by the contractor to the Engineer for approval within 30 days of the commencement of the contract.
3. Samples of each type of anchor proposed.

B. Complete shop and setting Drawings.

PART 2 QUALITY ASSURANCE

2.1 Perform work in accordance with The **General Specifications** issued by the "Ministry of Public Work and Housing".

PART 3 PRODUCTS

3.1 Stone shall be "Class-A" as per clause 503.1 of the General Specifications and shall be of locally sources known as:

1. "Ajloun" Stone.
2. "Travartine" stone.
3. "Hebroun Yatta" marble skirting and floor tiles.
4. "Karak" for big stone pieces of observation point as mentioned in the B.O.Q.
5. "Ajloun acid itched".

3.2 Stone shall be obtained from the best quarries and as detailed in the drawings and in the BoQ which have and not restricted to the following properties:

A. Sound and free from defects that would materially impair strength, durability or appearance.

B. Uniform in texture, free from freak coloration's.

C. Non-absorbent, free from reads rifts, seams, spalls, chips and minerals which by weathering would tend to discolor, deteriorate, streak or stratify.

3.3 Product Delivery, Storage and Handling:
During transport and storage, separate units from one another by wood strips or wedges, rest units on wood or other approved types of material.
Stone are not allowed to be rest on earth at any time and should be handled carefully.
Store should be done in vertical position, so that markings corresponding to setting drawings are easily discernable.

Stone should be covered with waterproof covering and protect from weather and dirt.

PART 4 EXECUTION:

4.1 Stone cutting, forming and fixing shall follow the "Special category" designated in subsections 504, 505, 507, 508 & 511 of the General specifications.

4.2 Stone cutting and forming shall only be done at the mill using mechanical sawing conforming to the allowable dimensional tolerances as given in subsection 504 of the General specifications.

4.3 Stone forming on site shall be limited to the making of stone face patterns, roughening of sawn surfaces and drilling of inserts holes and slots.

4.4 Dressing:

A. Stone shall be mechanically fine or rough bushammered (Mattabeh).

B. Make arises sharp and true with edges slightly eased.

C. Perform cutting, dressing, drilling, fitting and other preparations of stone.

D. Include work as required to accommodate or fit work of other trades, such as cutting and fitting for pipes, conduits, structural work, etc.

E. Do not cut stone until shop drawings are approved.

F. Completely cut and finish before delivery to site except as necessary for fitting.

G. Cut accurately to shape and dimensions with butt joint. Joints shall be straight, at right angles to face.

H. Except as otherwise indicated, saw or dress backs parallel to wall face.

I. Where bonding occurs, arrange backs to fit lay of masonry backing.

J. Shape beds for stone resting on structural work to fit support.

K. Back check stone coming in contact with structural steel solidly.

L. Do not impair strength of stone bearing capacity.

M. Cut holes and sinkages in stone for anchors, dowels or cramps specified or required executing work properly.

4.5 Laying:

A. When ready for setting, clean all stones, removing any dirt or foreign matter from all edges and surfaces. Do not use wire brushes.

B. Securely place all anchors.

C. Embed anchors in mortar filled holes or saw cut channels 18 mm deep in edges of veneer slab and hook into recesses cut or drilled in backing wall.

D. Take care to avoid soiling or defacing stone surface, immediately remove any mortar from face and wash stone clean.

4.6 Protection and Cleaning:

A. Box and maintain projecting stone sills and stone work.

B. Just before project is completed, remove boxing and clean with fiber brushes, mild detergent and water.

C. Remove and replace units having stains that cannot be removed by cleaning.

D. Remove and replace units requiring patching or repairing.

4.7 Stone Cladding:

A. The contractor shall submit method statement shop drawings and any structural calculations for stone cladding and fixing system, according to drawings and details to be approved by the Engineer.

B. Stone cladding shall be fixed on fair face concrete walls or solid block walls by using stainless steel L-strap anchor with dowels, anchor bolts and shims.

C. L-strap anchors with dowels should be placed horizontally at joint faces between stone units with minimum two anchors for each stone unit, and two stainless steel pins vertically.

D. Stone units shall satisfy the following dimensions:
1. Minimum thickness of 5 cm.
2. Uniform height of 50 cm.
3. Uniform length of 100 cm except in restricted or limited areas.
4. Stone angle length not less than 200 mm.

E. Stone cladding shall be constructed without pointing and cement mortar between joints or behind stone units.

F. First stone coarse shall be fixed either on structural concrete beam or by using special anchors and straps.

4.8 Stone Tiling:

A. Joint Filler Mortar:

A water-repellent additive approved by the Engineer shall be used in the mix of joint filler mortar. A colour pigment (white colour) shall be used in the joint filler mortar to obtain a colour of mortar consistent with the colour of Stone.

B. Stone Tiling:

1. Stone used in floor tiling shall be classified as "Class A" as per clause 503.1 of the General Specifications and shall be as shown in the drawings and in B.O.Q.

2. Stone face pattern shall be type (a) MATABBEH as specified in Clause 504.2 of the General Specifications. The Matabbeh pattern shall be of the fine texture.

3. The dimensions of stone tiles shall be as shown on the drawings and B.O.Q.

4. The workmanship of stone tiling shall be in accordance with "Special Category" as given in the same sub-clause of the General Specifications.

5. Isolation joints shall be provided along the ends of tiled floor areas where tiles are discontinued at vertical surfaces of walls, parapets ... etc. Such isolation joints shall be 20 mm wide and shall be filled with clean sand for the full depth down to the gravel bedding and shall be sealed with a white colour polysuphide sealant to a depth of 15 mm from the top.

6. Stone floor tiling shall be laid to the slopes shown on the drawings. Stone shall have minimum thickness of 50 mm for treads and 30 mm for risers, steps shall be constructed according to the drawings.

4.9 Mock-Up:

The Contractor shall following the Engineer's approval of Stone samples and source and at least (4) weeks prior to the start date of Stone fixing prepare for the approval of the Engineer a 2x2 meter mock-up wall to be executed out of the building's limit and within the building site.

The mock-up shall demonstrate the following work items and only approved Stone shall be used in the execution of the mock-up:

a. Mechanical fixation method and accessories.
b. Stone face patterns.
c. Overall stone cladding workmanship.

This mock-up once approved by the Engineer shall represent a reference for all stone work in the project.

All cost for provision of mock-up shall be borne by the Contractor.

END OF SECTION