



STATE BANK OF PAKISTAN

SBP BANKING SERVICES CORPORATION (BANK),
Engineering Department, Head Office Karachi

RETROFITTING WORKS OF S.B.P B.S.C QUETTA OFFICE BUILDINGS

BIDDING DOCUMENTS

VOLUME-III (TECHNICAL SPECIFICATIONS)

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0 SECTION: GENERAL REQUIREMENTS

0.1 GENERAL DESCRIPTION

0.1.1 Location of Site

The site of the project is located in Quetta, Balochistan.

0.1.2 Work under This Contract

The work under this Contract comprises the retrofitting of existing buildings as specified by the Contract/ necessitated by the project requirements/ instructed by the Engineer.

The Contractor shall be required to plan and execute the works in a manner such that the project is completed within the time specified in the Contract and in conformity with the provisions contained in the documents of Contract. The Contractor shall furnish a detailed construction programme along with a list of plant and equipment with capacities and capabilities for the approval of the Engineer. The Contractor shall also be required to submit a site supervisory/ management chart.

0.1.3 Execution of Work

All Work shall be executed in accordance with the requirements and in a manner set forth in the documents of Contract and in accordance with the instructions of the Engineer or Engineer's Representative. The Contractor shall confine his operations to the areas that are actually designated, for the Works, by the Employer. The Contractor shall be required to supply and maintain his own storage facilities, site office, sanitary facilities, and all temporary connections for electricity, water, sewerage and telephone etc. at his cost, subject to the approval of the Engineer.

0.2 APPLICABLE STANDARDS

Unless specified otherwise in the Contract Documents, all the Work and materials shall conform to the requirements of American Society for Testing Materials (ASTM) Specifications, American Concrete Institute (ACI) and British Standard Specifications (BSS) and as per the Drawings and Specifications.

0.3 TEST LABORATORY AND TESTING

0.3.1 Testing unless specified otherwise in the Contract, shall be performed by an approved testing agency as proposed by the Contractor and at no extra cost to the Employer. The Engineer may require all testing to be carried out under his supervision.

0.3.2 The quality control testing shall be arranged and performed by the Contractor's competent personnel in accordance with a Site Testing and Quality Control Programme/Facility to be established by the Contractor, and approved by the Engineer. The Contractor shall keep complete record of all the quality tests performed including the date and time of testing and submit the same to the Engineer. All quality control and related tests shall be carried out in accordance with applicable standards and codes under the supervision of the Engineer. The Contractor shall establish a laboratory on site which shall have equipment for testing Compressive Strength of concrete, Sieve Analysis and Compaction Test, as per the instructions and to the satisfaction of the Engineer.

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0.4 STORAGE AND HANDLING FACILITY

The Employer shall assign the Contractor storage space for the storage of plant, equipment and materials for Contract Works. However the Contractor shall ensure that, on no account shall such temporary installation conflict/interfere with any of the permanent installations, services and any operational function of the Employer. The handling and storage of all plants, equipment and materials at Site shall be the responsibility of the Contractor and at no risk or cost to the Employer.

The Contractor shall protect all materials against corrosion, damage of any kind or deterioration during storage and also during erection on Site. The protection methods shall be to the approval of the Engineer.

0.5 TEMPORARY FACILITIES

The Contractor shall provide, erect/install, maintain, alter as and when necessary and remove on completion except as otherwise directed by the Engineer all temporary facilities and services as described hereinafter and/or in the Contract documents and/or as instructed and approved by the Engineer, all at his own cost and expenses.

0.5.1 Temporary Fencing & Lightning

The Contractor shall provide and maintain at his own cost all temporary lights, guards, fencing and watching to the approval of the Engineer for the safety and protection of the Works.

0.5.2 Temporary Services

a. First Aid

The Contractor shall provide and maintain First Aid Facilities on the Site.

b. Fire Fighting

The Contractor shall provide and maintain adequate firefighting facilities on the Site at his own cost.

0.6 PROJECT RECORD DOCUMENTS

The Contractor will submit shop drawings showing work sequence, work methodology, including location of construction joints, pouring sequences for the approval of Engineer prior to start of work on each stage of the project or at any time if requested by the Engineer.

The Contractor will maintain complete, accurate log of all construction work as it progresses through recording progress on the approved work-plan, progress reports and construction photographs stage wise.

The Contractor will submit weekly and monthly progress reports to the engineer, on approved format with photographs.

On completion of major construction milestones, prepare certified As-built drawing showing work done, dimensions, locations, angles and elevations of construction and site work.

0.7 MEASUREMENTS AND PAYMENT

No separate payment shall be made for the services and performance provided under this section of Specifications.

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The Contractor is deemed to have covered the costs of all related supplies and performance in the unit prices of other contract items.

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1 SECTION: SETTING OUT OF WORKS

1.1 SCOPE OF WORK

The Work covered by this section of Specifications consists of furnishing all labour, materials, necessary equipment, services, miscellaneous and necessary items, required to satisfactorily complete setting out of the Works, as indicated on Drawings, specified herein and subject to the terms and conditions of the Contract.

1.2 SETTING OUT OF WORKS

The Contractor shall set out the Works and shall be responsible for true and perfect levels and setting out of the same and for correctness of the direction, positions, levels, dimensions and alignments of all parts thereof. If any error in this respect shall appear during the progress of the Work, the Contractor shall at his own expense rectify such error to the satisfaction of the Engineer. Any checking by the Engineer shall not relieve the Contractor from his complete unshared responsibility for correct setting out of Works. The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Engineer.

1.3 MEASUREMENT AND PAYMENT

No separate payment shall be made for setting out of Works. The Contractor shall be deemed to cover the costs for this item of work in the unit price of other Contract items.

**** END OF SECTION****

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2 SECTION: PLAIN AND REINFORCED CONCRETE

2.1 SCOPE OF WORK

The Work covered by this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with plain and/or reinforced concrete work complete in strict accordance with this section of Specifications, applicable Drawings and subject to the terms and conditions of this Contract.

2.2 APPLICABLE STANDARDS

Latest editions of the following Pakistan, British and ASTM ACI Standards are relevant to these specifications wherever applicable.

2.2.1 **Pakistan Standards**

PS233	Portland Cement (ordinary & rapid hardening)
PS243	Natural aggregates for concrete
PS279	Abrasion of coarse aggregates by the use of Los Angeles machine.
PS280	Determination of aggregates crushing value
PS281	Organic impurities in sand for concrete aggregate.
PS282	Material finer than No. 200 BS test sieve in aggregates, method of test
PS283	For
PS284	Soundness test for aggregates by the use of sodium sulphate or magnesium sulphate.
PS285	Sampling aggregates for concrete
PS286	Sieve or screen analysis of fine and coarse
PS421	Description and classification of mineral aggregates
PS422	Sampling fresh concrete
PS560	Slump test for concrete
	Making and curing concrete compression test specimen in the field.
	Sulphate-resistant Portland cement type 'A' and sampling fresh concrete
PS612	in the laboratory.
PS716	Mixing
PS717	Compacting factor test for concrete
PS746	Definitions and terminology of cements
PS849	Making and curing concrete compression test cubes.

2.2.2 **ASTM (American Society for Testing and Materials)**

C33	Standard Test Method for Fine and coarse aggregates
	Organic impurities in sand for concrete.
C39	Standard Test Method for Compressive Strength of Cylindrical Concrete
C40	Specimens
C87	Effect of organic impurities in fine aggregates on strength of mortar.
	Soundness of aggregates.
C88	Ready mixed Concrete.
C91	Cement Standards and Concrete Standards
C94	Compressive strength of hydraulic cement mortars
C 109	Material finer than No. 200 (0.075mm) sieve
C 117	Light weight pieces in aggregates.
C 123	Concrete and concrete aggregates.
C 125	Specific gravity and absorption of coarse aggregate.
C 127	Specific gravity and absorption of fine aggregate.
C 128	Resistance to abrasion of small size coarse aggregate.

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C 131	Sieve or screen analysis of fine and coarse aggregate.
C 136	Clay lumps and friable particles in aggregates.
C 142	Slump of Portland Cement Concrete
C 143	
C150	Standard Specification for Portland Cement
C156	Water retention by concrete curing material
C171	Sheet material for curing concrete.
C185	Air content or hydraulic cement mortar.
C188	Density of hydraulic cement.
C191	Time of setting of hydraulic cement by vicat needle
C260	Air entraining admixture for concrete.
C289	Potential reactivity of aggregate.
C309	Liquid membrane forming compounds for curing concrete.
C387	Chemical admixtures for concrete.
C494	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
C535	Resistance to abrasion of large size coarse aggregates.
C75	Aggregate sampling.
C994	Preformed expansion joint filler for concrete.
C1190	Concrete joint sealer (hot poured elastic type).
C1715	Preformed expansion joint filler for concrete paving and structural concrete.
D1850	Concrete joint sealer (cold application type).
E11	Wire cloth sleeves for testing purposes.
E96	Water vapor transmission of materials in sheet form.
E154	Materials for use as vapor barrier under concrete slabs.
E337	Relative humidity by wet and dry bulk psychrometer.

2.2.3 ACI (American Concrete Institute)

211	Recommended practice for selecting proportions for normal and heavy weight concrete.
214	Quality control charts
301	Specifications for structural concrete for building.
304	Recommended practice for measuring, mixing, transporting and placing concrete.
305	Hot weather concreting.
308	Recommended practice for curing concrete.
309	Recommended practice for consolidation of concrete
315	Manual of standard practice of detailing reinforcement concrete structure.
318	
347	Building code requirement of reinforced concrete.
	Recommended practice for concrete formwork.

2.2.4 British Standards

BS 12	Specifications for Portland cement, ordinary and rapid hardening
BS 410	Specifications for Test Sieve
BS 812	Specification for aggregates from natural sources for concrete Method of testing concrete
BS 822	Test for water making concrete
BS 1881	Method for determination of Compressive Strength of Concrete Cubes
BS 1348	Rigid expanded polyvinyl chloride for thermal insulation.
BS 3837	Sulphate-resisting Portland cement
BS 4027	Specification for Sulfate-Resisting Portland Cement
CP 8110	

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CP 114 BS 4550 BS 8500	Specifications for Design and Construction of Reinforced and Pre-stressed Concrete The Structural Use of Reinforced Concrete in Buildings Methods of Testing Cement Concrete - Complementary British Standard
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In addition, the latest editions of other Pakistan and British Standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other Standards as may be specified by the Engineer for special Materials and Construction are also relevant.

2.3 GENERAL

- 2.3.1 Until and unless specified or directed otherwise by the Engineer, all materials and workmanship shall be based on the latest versions of applicable ASTM Standards in force at the time of inviting tenders.
- 2.3.2 Any defective work in the opinion of the Engineer shall be removed and reconstructed without undue delay to the approval of the Engineer and the Contractor shall bear all additional costs incurred.
- 2.3.3 Any previous checks by the Engineer shall not in any way relieve the Contractor of his responsibility in respect of quality and accuracy of Work.
- 2.3.4 Full care shall be taken to install embedded items. Embedded items shall be inspected and checks for reinforcements and other materials and items shall be completed and approved before concrete is placed.
- 2.3.5 The Contractor shall get the bar bending schedules of reinforcement checked and approved from the Engineer prior to the cutting of reinforcement.
- 2.3.6 The Contractor shall maintain an accurate record of ambient temperature of Site. Ambient temperature shall be measured using mercury thermometers or other thermometers acceptable to the Engineer.
- 2.3.7 Throughout the concrete work, the Contractor shall employ full time on the Works suitable number of qualified and experienced Engineers whose sole duties shall be as follows:
- Design of concrete mixes
 - Quality control of concrete
 - Supervision of mixing, transporting, placing, compacting, finishing, curing and protecting concrete.
 - Supervision of sampling and testing.
 - Preparation and submission of test certificates and reports.
 - Completion and keeping of record.
 - Such other duties as the Engineer may direct.
- 2.3.8 All concrete work including reinforcement etc. shall be carried out in accordance with the applicable requirements of ACI/ASTM/BSS Standards and to the instructions of the Engineer.

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2.4 MATERIALS

2.4.1 Cement

- a) Ordinary Portland cement shall be grey normal setting cement of approved make and source and of the specified gravity, fineness and chemical composition fully conforming to British Standard Specifications BS-12 and shall be capable of satisfying all tests such as the tensile strength tests contained therein.
- b) Sulphate resistant cement where required shall be sulphate resistant Portland cement of the approved make fully conforming to BS-4027 and satisfying the requirements for fineness, chemical composition, strength, setting time and soundness, etc.
- c) For all types of cement described in sub-clauses 4.03.1 (a) & (b) above, the cement shall have a tricalcium aluminate (C3A) content by weight not less than 5% and not more than 8%.
- d) For all types of cement described in sub-clauses 4.03.1 (a) & (b) above. The initial setting time shall not be less than 45 minutes and final setting time not more than 10 hours.
- e) The supply of cement must be so programmed by the Contractor that at no time the quantity of cement stock shall be less than that required for an average consumption of four weeks. Lorry or truck or other means of transportation for the conveyance of cement to the Site of Work shall be clean, dry, metal-lined and covered from top with water proof sheets, so that cement is sufficiently protected from any deterioration during transit.
- f) Cement shall be delivered in sealed bags and be stored in moisture-protected and well-ventilated sheds and each cement supply shall be stored separately.
- g) The Contractor shall provide at his own cost on the Site all necessary sheds which shall be perfectly dry, waterproof and adequately protected against ingress of water for the storing of cement to be delivered to the Work, to ensure adequate supplies being available for the Work.
- h) Cement, which is damp or contains lumps which cannot be broken to original fineness by finger pressure will be condemned irrespective of age and must be removed from the Site.
- i) If any time the Engineer considers that any batch of cement may have deteriorated on Site during storage for any reason, he will direct that tests shall be made and the batch of cement on the Site which may be in question shall not be used until it has been shown by test to be of satisfactory quality at a laboratory approved or appointed by the Engineer. The Contractor shall bear all costs of such testing. The Contractor without delay shall remove any rejected cement from the Site. Cement reclaimed from cleaning bags or leaking containers shall not be used in the Works and immediately be removed from the Site.

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- j) Cement shall be consumed in the sequence of its arrival at Site unless otherwise directed by the Engineer.

2.4.2 Aggregates

- a) All fine and coarse aggregates to be used shall be supplied from approved sources, which shall not be changed without permission in writing from the Engineer. Aggregates shall conform to the requirements of applicable ASTM C33-82.
- b) Fine aggregates, shall be from an approved source of supply of a uniform quality conforming to ASTM C-33-82 and shall be clean and sharp and free from clay, earth, vegetable and organic matters, alkaline or acid reactions or other deleterious salts or such harmful matters and impurities.
- c) Fine aggregates shall conform to the requirements of the relevant ASTM C- 33-82 Specifications, and shall be graded as follows;

<u>Sieve Number/Size</u>	<u>Percentage (by weight) passing</u>
9.5 mm (3/8")	100
4.75 mm (No. 4)	95 - 100
2.36 mm (No. 8)	80 - 100
1.18 mm (No. 16)	50 - 85
0.6 mm (No. 30)	25 - 60
0.3 mm (No. 50)	10 - 30
0.15 mm (No. 100)	2 - 10

- d) Coarse aggregates shall be approved river gravel or hard crushed stone from a source approved by the Engineer and shall be clean, inert, hard, non-porous and free from laminated particles, sand, dust, salt, lime, chalk, clay, organic impurities or other deleterious matter.
- e) Coarse aggregate shall also conform to the requirements of Table 2 of ASTM C-33 and shall be graded as follows:-

For Reinforced Concrete (Nominal Size of Graded Aggregates 20.0 mm to 2.36 mm)

<u>Sieve Number/Size</u>	<u>Percentage (by weight) passing</u>
25.0 mm	100
20.0 mm	90 - 100
9.5 mm	20 - 55
4.75 mm (No. 4)	0 - 10
2.36 mm (No .8)	0 - 5

- f) All aggregates shall be stored on properly constructed paving and in bins and there shall be a physical partition between the stockpiles of coarse and fine aggregates. No mixed up aggregates shall be used in any concrete. Under no circumstances aggregates shall be allowed to be in contact with ground.
- g) If required, aggregates shall be washed and screened to the sequence of receipt of supplies unless otherwise directed by the Engineer.

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- h) All aggregates shall be subjected to the approval of the Engineer. Any aggregates not found to be of the required standard shall be rejected by the Engineer and shall have to be removed from Site without delay. Concrete structures executed with rejected aggregates shall be dismantled and rebuilt at the Contractor's expense.
- i) Special fine gravel of 9 mm. size shall be used if called for in the Drawings or as directed by the Engineer.
- j) Physical properties of aggregates shall be in accordance with Table 3 of ASTM C33.

2.4.3 Water

Water to be used in the Work shall be potable water and shall be free from all impurities whether suspended or dissolved. Further, the water shall not contain any chemical impurities, salts etc. of any kind. Water shall be tested for its fitness in Works in accordance with AASHTO Method T26-51.

2.4.4 Admixtures

- a) Suitable admixtures from BCR, Sika, Fosroc, Betocrete C-16or Master Builders or other approved manufacturers may be used in concrete mixes with the prior approval of the Engineer. The amount of admixtures added to each batch of concrete requires careful control and shall be added in the doses as recommended by the manufacturers and approved by the Engineer. The cost of the admixtures shall be deemed to be included in the rates.
- b) For use of an admixture, the information required by the Engineer shall be submitted to him for each admixture for his approval.
- c) BASF 700 or approved equivalent concrete retarding agent, may be used if required with the approval of Engineer

2.4.5 Epoxy Mortar

- a) Epoxy mortar shall be used as mentioned in drawings or approved equivalent with the approval of Engineer.
- b) For use of an epoxy mortar, the information required by the Engineer shall be submitted to him for his approval.

2.5 CLASSIFICATION OF CONCRETE

Classification of concrete to be used in various parts of the Works shall be as indicated on the Drawings and mentioned in the Bill of Quantities. Unless noted otherwise, all blinding concrete shall be of Class E. The concrete of various grades shall be proportioned as set out in Table-1 appended hereto.

Table-1 showing minimum required compressive strengths on 6" x 12" long test cylinders and minimum quantity of cement required per m3 of finished concrete for various mixes and under various conditions is given below:

TABLE – 1

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Class of Concrete	Minimum Qty. of Cement Kg/m ³	Work Cylinder Strength		Max. Water-Cement Ratio
		@ 7 days (psi)	@ 28 days (psi)	
D2	540	4200	6000	0.33
D1	400	3500	5000	0.40
D	385	3150	4500	0.42
A3	350	2800	4000	0.45
A2	325	2450	3500	0.47
A1	300	2100	3000	0.50
C	300	1750	2500	0.50
E	275	1400	2000	0.52
F	217	875	1250	0.55
G	159	600	850	-

Non-structural Concrete

Non-structural concrete (NS concrete) shall be used only for non-structural purposes where shown on the Drawing. NS concrete shall be compound of ordinary Portland cement and aggregates complying with this Specification.

The weight of cement mixed with 0.3 cubic meters of combined aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40 mm nominal.

The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water used shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

The concrete shall be compacted by hand towels or rammers or by mechanical vibration.

2.6 PROPORTIONING OF CONCRETE MIXES

All concrete shall be proportioned by weight for design of concrete mixes, unless specifically agreed by the Engineer to proportion them by volume, which permission shall be given only if the arrangements made at Site are satisfactory. The Contractor shall submit to the Engineer proposed mix designs for concrete to be used, based on preliminary laboratory tests to determine proportion of cement, aggregates and water in the concrete conforming to the quality and strength requirements specified herein. Preliminary test results of at least three different mixes of each class of concrete with varied water-cement ratio shall be submitted. The results of 7 days and 28 days cylinder tests shall be used to establish the ratio between 7 days and 28 days strengths of used concrete. The Engineer may make adjustments in the ratio of fine to coarse aggregates in the mix for a certain work. Preliminary design of mixes and testing shall be the responsibility of the Contractor at his own cost. The proportion of voids in between the coarse aggregate shall be controlled and if it exceeds 0.45%, the Contractor without any charge shall increase sand and consequently the cement. If the proportion is less than 0.45%, sand shall be decreased but not the cement.

The detailed data, calculations and test results shall be compiled in a report and the proposed mix be declared by the Contractor. The report shall be submitted to the Engineer in time before commencing the concrete works and all test results shall be to the Engineer's satisfaction.

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Lack of approval by Engineer shall not constitute a reason for an extension of time or additional costs.

2.6.1 No Fines Concrete

"No Fines" concrete shall consist of approved aggregate graded between 40mm and 20mm with not more than 5% passing the 20mm sieve.

The mix shall consist of 0.25 cu m of aggregate to 50kg cement. The aggregate is to be damp at the time of mixing and the water/cement ratio is to be strictly controlled to evenly wet the aggregate with grout.

The concrete is to be placed as quickly as possible after mixing and is to be lightly rodded to assist placing. The concrete shall not be vibrated or rammed.

2.6.2 Maximum Allowable Water Content

All concrete specimens shall be made, cured and tested in accordance with ASTM Standard. A curve representing the relation between the water content and the average 28 days compressive strength or earlier strength at which the concrete is to receive its full working load shall be established for a range of values including all the compressive strengths shown on the plans. The curve shall be established by at least four points, each point representing average values for at least four test specimens. The maximum allowable water content for the concrete shall be as determined from this curve and shall correspond to a strength 15% greater than indicated on the plans. However, the water cement ratio shall not exceed the value given in Table-1 above for the class/strength of concrete specified. No substitution shall be made in the materials used in the work without additional tests in accordance herewith to indicate that the quality of the concrete is satisfactory.

2.6.3 Slump Test

The slump for concrete, determined in accordance with ASTM C-143 Test for Concrete, shall be minimum 2" and maximum 4" provided the requisite strength is obtained. Corrective additions to remedy deficiencies in aggregate gradations shall be used only with the written approval of the Engineer. When such additions are permitted, the material shall be measured separately for each batch of concrete.

2.7 BATCHING AND MIXING

Concrete shall be mixed by a mechanical batch type mixing plant with adequate facilities for accurate measurements and control of each material entering the mixer and for changing the proportions to conform to varying conditions of the Work. The mixing plant assembly shall permit ready inspection of operations at all times. The plant and its location shall be subject to approval of the Engineer.

Water shall be measured for every batch with due allowance for water already present in aggregates.

2.7.1 Batching Units

Batching units shall be supplied with the following items:-

- Weighting unit shall be provided for each type of material to indicate the scale load at convenient stages of the weighing operations. Weighting units shall be

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checked at times directed by and in the presence of the Engineer and required adjustments shall be made before further use.

- b) Water mechanism shall be tight, with the valves interlocked so that the discharge valve cannot be opened before the filling valve is fully closed and shall be fitted with a graduated gauge.
- c) Discharge gate shall control the mix to produce a ribboning and mixing of cement with aggregates. Delivery of materials from the batching equipment to the mixer shall be accurate within the following limits:-

<u>Materials</u>	<u>Percentage by Weight</u>
Cement	+1%
Water	+1%
Aggregate smaller than 3/4"	+2%
Aggregate larger than 3/4"	+3%

2.7.2 Mixing Units

- a) Mixers shall not be charged in excess of rated capacity nor be operated in excess of rated speed. Excessive mixing requiring addition of water to preserve required consistency shall not be permitted. The entire batch shall be discharged and discarded before re-charging.
- b) Mixing time shall be measured from the instant water is introduced into the mixer drum containing all solids. All mixing water shall be introduced before one-fourth of the mixing time has elapsed. Mixing time for mixers of one cubic meter or less shall be not less than 2 minutes; for larger than one cubic meter capacity mixers, time shall be increased by 15 seconds for each additional half cubic meter or fraction thereof, which may be varied if the charging and mixing operations fail to result in the required uniformity in composition and consistence within a batch and from batch to batch. If an air-entraining agent is allowed to be used, additional mixing time shall be allowed so as to provide the specified air-content.
- c) Unless waived by the Engineer, device such as discharge-lock to lock the discharge mechanism, until the required mixing time has elapsed, shall be provided on each mixer. Mixing shall continue for at least 40 revolutions of mixer drum.
- d) No hand mixing under any circumstances even with extra cement shall be permitted. If during concreting, the mixing plant fails, the concrete already poured shall be removed, unless directed otherwise by the Engineer. Mixers, which have been out of use for more than 30 minutes shall be thoroughly cleaned before any further concrete is mixed.
- e) The mixing water shall be regularly sampled and tested for salt content and contamination.

2.8 SAMPLES AND TESTING

2.8.1 General

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Test cylinders of concrete shall be prepared and stored by the Contractor in accordance with the ASTM C-172, as and when directed by the Engineer. Test cylinders and the concrete materials shall be tested in an approved laboratory and the Contractor shall bear all charges for the same, including such other tests as may be determined by and acceptable to the Engineer.

2.8.2 Water

Water shall be tested in accordance with AASHTO Method of Test T26-51.

2.8.3 Cement

Cement shall be tested as prescribed in BS-12.

2.8.4 Aggregate

Aggregates shall be tested as prescribed in ASTM C-33. In addition, fine aggregates shall be tested for organic impurities in conformity with ASTM C-40.

2.8.5 Reinforcement

Reinforcement bars shall be tested as prescribed in BS 4449, BS-4461 and ASTM A- 615-82(S1) for deformed steel bars and mild steel plain bars. Refer clause 4.10 of this section for specification requirements of reinforcement works.

2.8.6 Testing of Concrete

2.8.6.1 Concrete Compressive Strength Test

a) Works Test Cylinders shall be made of all structural concrete incorporated into the works. Unless otherwise directed by the Engineer, one set of cylinder of any particular mix shall be taken from either :-

- Each 350 Cft or part thereof in columns
- Each 1050 Cft in walls and small foundations
- Each 1750 Cft in slabs, beams and large foundations, or
- each day's production

Whichever is the more frequent

b) Each set of the Works Test Cylinders shall comprise six 6"x12" Cylinders made from a single sample of concrete taken from the point of final deposition of the set concrete under the Engineer's supervision.

c) The sampling, making, curing and testing of Works Test Cylinders shall be carried out in accordance with ASTM C3 & C39. Test results shall be recorded on approved forms and submitted in duplicate to the Engineer immediately following the test.

d) A sample of concrete shall be taken at random on eight separate

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occasions during each of the first five days of using that mix. The number of samples per day and the times which they are taken shall be varied at random (thereafter at least one sample shall be taken each day the concrete of that particular mix is made).

- e) From each sample six Cylinders shall be made, two for test at seven days, and the other four for test at twenty-eight days.
- f) Specimens shall be cured under laboratory conditions except that the Engineer may require curing under field conditions in which case strength of field cured specimens shall not be less than 85% of that of companion laboratory condition cured specimens.
- g) All cylinder moulds shall be steel moulds perfectly true, having all internal and meeting faces machined to a smooth surface.
- h) If the strength tests of the laboratory cured specimens for any portion of the Work falls below the minimum allowable compressive strength at 28 days required for the class of concrete used in that portion, the Engineer shall have the right to order replacement of the affected work.
- i) All test specimens shall bear distinguishing mark showing number, date of casting, quality of concrete and place from where sample was taken. A proper daily record of test specimens made and test results obtained shall be maintained by the Contractor and weekly test results shall be submitted to the Engineer.

2.8.6.2 Testing for Chloride Ion Content

Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.15% by weight of cement. To determine water soluble chloride ion content, test procedures shall conform to ASTM C 1218.

2.8.7 **Concrete Members not complying with Specifications**

- (i) Where concrete in the Works does not comply with the Specifications, the Engineer may order any or all of the following or any other appropriate action to be taken:
 - a) The drilling of test cylinders in mass concrete and testing the cylinders to destruction by compression.
 - b) The carrying out of load tests or other non-destructive tests on concrete structure.
 - c) The cutting out and replacement of such volume as is considered defective by the Engineer.
 - d) Strengthening of the structure in accordance with the requirements and as proposed by the Engineer.
- (ii) The Contractor shall carry out all such tests, investigations, rehabilitation or

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replacement in coordination with and as acceptable to the Engineer at no additional cost to the Employer.

2.9 TRANSPORTING AND PLACING CONCRETE

2.9.1 General

- a) Concreting shall be conveyed and deposited as quickly as possible after mixing and shall proceed so that, as far as possible, a complete section of the Work is done in one operation. The concrete may be distributed in barrows, skips, and chutes and by any other method such as pumps, conveyor belts etc. all to the approval of the Engineer.
- b) Transportation of concrete shall be in a manner approved by the Engineer and shall be so as to avoid segregation or loss of ingredients of concrete.
- c) All foundations and portions of Work to be concreted shall be approved by the Engineer in writing before concrete is poured.
- d) All forms and reinforcement shall be completed, cleaned, inspected and approved before pouring of concrete. No concrete is to be deposited till the Engineer has inspected and approved in writing all reinforcement, foundations, forms, details, positioning of all fixtures and materials to be embedded in concrete, control levels and screeds, etc. and is satisfied with the arrangements the Contractor has made to efficiently proceed with the work such as sufficient labour, materials, plants etc. Such an approval will not relieve the Contractor from any of his obligations under this Contract. No concrete shall be deposited without the written permission from the Engineer who shall have no authority to waive off this condition. Any concrete without such written authorization shall be liable to be rejected.
- e) Placing of concrete shall not be permitted when, in the opinion of the Engineer the sun, heat, wind, cold, snow, or limitations or facilities furnished by the Contractor prevent proper placing, finishing and curing of concrete.
- f) All concrete shall be thoroughly compacted and consolidated by means of pneumatic or mechanical immersion type vibrators of suitable size having minimum frequency of 8000 RPM. Care shall be taken to avoid segregation due to excessive vibration. The Contractor shall maintain on Site at all times one or more standby vibrators. Tapping or other external vibration of forms shall not be allowed unless so directed by the Engineer. In that case formwork shall be adequate to withstand vibrations. Compaction shall be done until the whole mass assumes a jelly like appearance and consistency with water just appearing on the surface. Concrete shall be sufficiently tamped and consolidated around the steel bars, care shall be taken that the vibrator does not touch steel or formwork, and is worked into all parts of the moulds in order that no voids or cavities are left. Steel shall not be disturbed during operations of concreting. Concrete shall be brought up in even layers not more than 8" thickness and worked against side of forms to give a smooth and uniform surface. No surplus water shall be allowed to come out and lie on the surface of concrete. The concrete must be of such a consistency that when ramming, consolidating and tamping is completed, a thin film of water is just appearing on the surface. In vibrating, care shall be taken to avoid displacing the reinforcement.

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- g) Hardened concrete, debris and foreign materials shall be removed from interior of forms and from inner surface of mixing and conveying equipment.
- h) Runways and gangways shall be provided for wheeled concrete handling equipment and workmen, and such equipment shall not be wheeled over reinforcement, nor shall runways be supported on reinforcement.
- i) Concrete shall not be dropped freely from a height of more than 10 ½ ft. in columns and 4 ft. elsewhere. In cases where an excessive drop is inevitable, the Contractor shall provide spouts, down pipes, chutes, or side ports to forms with pockets, which will let concrete stop and flow easily into the form without any risk of segregation. The discharge of the spouts, down pipes or chutes shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 8" thick.
- j) Concrete is to be deposited as quickly as possible after mixing and to proceed continuously. Concrete which has attained its initial set or has contained its mixing water for more than 30 minutes shall not be allowed to be placed in the work.
- k) When concrete is laid on hard core, such as sub-grade for floor slabs, or other absorbent material, the surface is to be watered, consolidated and, where specified, blinded before the concrete is deposited.
- l) Fresh concrete shall not be placed on previously laid concrete or on old concrete surfaces until the latter has been cleaned of all dirt, scum and laitence by wire brushes. The clean surface shall then be thoroughly wetted and grouted with cement slurry as approved by the Engineer.
- m) Care shall be taken not to disturb newly placed concrete by vibrator, indirect loading or otherwise. No traffic or loading shall be allowed on the concrete until it has thoroughly set and hardened.
- n) Construction joints in concrete shall only be given at locations indicated on the drawings or as approved by the Engineer. If approved by the Engineer, the concrete at the end of the day's work shall be finished off against a temporary shutter stop, which shall be vertical and securely fixed. Such stops shall be removed within 24 hours of placing of concrete. Construction joints not shown on the Drawings shall be reinforced with steel bars or dowels, if deemed necessary by the Engineer, and shall be furnished by the Contractor without any additional cost.
- o) No concrete shall be placed during rains or inclement weather and all fresh concrete shall be suitably protected from rain fall and excessive heat or cold.
- p) Should any part of the exposed surface present a rough, uneven or imperfect appearance, when the shuttering is removed, it shall be picked out to such depth and refilled and properly re-surfaced and entirely redone as per directions and approval of the Engineer at the cost of the Contractor.
- q) On removal of the forms and before the concrete skin has had time to harden, all faces of the concrete inside and outside to be kept exposed (i.e. unplastered) shall be rubbed over with carborundum stone, and washed with cement to remove all marks, projections, hollows, or any other defect. No extra payment shall be made for this work.

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- r) All exposed surfaces and lines of the concrete work are to be true and fair without cracks, bends, windings and distortions of all kinds, without any extra charges by the Contractor. All concrete work to remain exposed and unplastered is to be fair faced, smooth, pleasing and to the entire satisfaction of the Engineer.
- s) A float or screed is to be worked over the exposed surfaces of all concrete work on the flat or curve, so as to render the surfaces perfectly smooth, clear and to the necessary slopes or falls or as required to receive the floor or roof finishes according to the Drawings and as directed by the Engineer without any extra charge by the Contractor.

2.9.2 Temperature

No concrete shall be mixed or placed while the temperature is above 35 degrees centigrade (°C) on a rising thermometer or above 40 degrees centigrade (°C) on a falling thermometer. The Contractor shall supply an accurate maximum and minimum thermometer and hang it in an approved position in the Works.

The Contractor shall plan the day's concrete in such a manner as to ensure that each bay or panel is completed at a proper construction joint before the temperature rises above the permissible limit.

The Contractor shall allow in his rates for any additional expenses incurred by complying with this Clause in order to complete the works within the "Time for Completion".

2.9.3 Hot Weather Concreting

Hot Weather Concreting Operation should conform to the provisions of ACI Standard 305-72 "Recommended Practice for Hot Weather Concreting". The following precautions should be adopted as necessary to comply with the above limit:-

- a. Shading of aggregate stock piles.
- b. Insulation of water tanks and pipelines and formwork.
- c. Refrigeration of mixing water.
- d. Addition of ice to mix to lower temperature.
- e. Shading of formwork and reinforcement from the sun and drying winds.
- f. Cooling of formwork and reinforcement prior to and ahead of casting of the concrete by mist spraying.
- g. Covering and spraying with water of hardening concrete surfaces.
- h. Concreting during the cooler part of the day.

2.10 PROTECTION AND CURING

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature change and mechanical injury or injury from rain or flowing

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water for a period of at least seven (7) days. Curing shall be started as soon as the concrete has hardened sufficiently for the surface not to be marked. Curing shall be done either by covering with sand, hessian, canvas or other approved fabric mats, which shall be kept continuously wet. If required and so directed by the Engineer, formed surface with forms in position shall also be cured by keeping all forms continuously wet. As an alternative, curing of concrete on all exposed surfaces which could not be kept covered, such as sides of the beams, under side of the slabs, may also be done by sealing concrete surface with liquid membrane-forming curing compounds white pigment type conforming to ASTM C-309 or equal so as to arrest loss of moisture from concrete, with the approval of the Engineer. Care shall be taken so as to spray the compound/chemical on all the exposed faces of concrete so that no loss of moisture takes place. The Contractor shall take special care that curing of concrete is satisfactorily carried out and in accordance with methods specified herein and/or as instructed by the Engineer.

Any negligence in this regard may result in total rejection of such concrete works, which in the opinion of the Engineer have not been adequately cured. Period of curing for any concrete shall be 7 days or more as directed by the Engineer. All concrete pours and concrete structures shall be clearly marked with non-washable paints to indicate the date of placing concrete. During hot weather, curing shall be done even at night. It shall be obligatory on the part of the Contractor to obtain a certificate from the Engineer that the curing has been properly done. A suitable format shall be printed and kept on Site to be signed by the Engineer for every part of the Work.

For sections 5 ft. or more thick, the Contractor shall ensure that the temperature differential between the inner and outer surfaces shall not exceed 20°C and shall submit to the Engineer his proposals to control and monitor this.

2.11 CONSTRUCTION JOINTS

Construction joints shall be located as indicated on the Drawings and/or as approved or directed by the Engineer. Prior to construction of any structure, the Contractor shall submit a proposal showing location of construction joints and sequence of construction to suit his concreting programmed for the approval of the Engineer. Joint in columns shall be made at the underside of the deepest beam framing thereto. Beam stems and slabs shall be poured monolithically unless allowed otherwise by the Engineer in writing. Joints not specified or shown on the Drawings if so required and approved by the Engineer, shall be so located as to least impair the strength and appearance of the Work. Except and where indicated on the Drawings, no jointing shall be made in footings or foundations without written approval of the Engineer. Construction joints shall be at right angles to the member and shall be formed against firm stop boards. The stop board shall be removed as soon as possible after placing the concrete but without the risk of movement of the concrete and the concrete surface shall be well brushed with a hard brush and washed off with a spray of water, two to four hours after casting, to expose the aggregate and provide key for the next pour.

In all water retaining structures and other substructure pits and trenches, P.V.C. or any other approved water stops shall be provided at the construction joints in the manner shown on the Drawings and/or approved by the Engineer.

Whenever a section of concrete is left unfinished, for any reasons with the approval of the Engineer, leaving surface which will be hard-set before additional concrete can be joined to it, such dovetails, grooves or other bonds shall be provided as may be necessary to ensure a good bond with the new work, at the cost of the Contractor. Before deposition fresh concrete upon or against any concrete which is already set, the surface of the set concrete shall be roughened with a cutting tool, any laitance removed, thoroughly cleaned from all

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foreign matter, well-watered and covered with approved bonding agent and cement grout, and special care shall be taken to ram the fresh concrete thoroughly up and against the set concrete; and, if deemed necessary by the Engineer, the joints shall be reinforced with steel bars or dowels to be all furnished and done by the Contractor without any additional cost.

2.12 CONCRETE FLOOR SLAB FINISHING

Concrete slabs shall be finished as described herein. In preparation for finishing, floor slabs shall be struck off to the required level at or below the elevation or grade of the finished floors as shown on the Drawings. Floors shall be leveled with a tolerance of 1 mm in 1m. Where drains occur, the floor surface shall be pitched to the drains as indicated on the Drawings or as directed by the Engineer.

2.13 MONOLITHIC FINISH

All concrete surfaces in floors, except where other finish is specified, shall be finished by steel floats or straight edges to bring the surface to the required finish level as shown on the Drawings. While the concrete is still green, but sufficiently hardened to bear a man's weight without deep imprint, it shall be wood floated to a true even plane with no coarse aggregate visible. Sufficient pressure shall be used on the wood floats to bring moisture to the surface. The concrete shall then be hand trowelled to produce smooth impervious surface free from trowel marks. If necessary, the process shall be repeated so that the final finish shall produce ringing sound from the trowel. No separate payment shall be made for finishing floor slabs in the aforementioned manner.

2.14 CONCRETE TOPPING

Where indicated on the Drawings, base slab under concrete topping shall receive a screeded finish. After the base slab is thoroughly cured and when directed, concrete topping shall be laid to the thickness as indicated on the Drawings in alternate panels of suitable sizes as directed by the Engineer.

2.15 ANCHOR BOLTS, INSERTS, SLEEVES, CHASSIS, RECESSES, STEEL FRAMES

The Contractor shall provide chases and openings required for other sections of the Works and will cooperate and coordinate with other trades in placing their pipes, ducts, recesses and other built-in items as the Work proceeds, entirely at his own cost and risk.

The Contractor shall furnish and place in position accurately, as shown on the Drawings, all inserts, sleeves, chases, recesses, etc., supplied by the Contractor, subcontractors or other contractors, as directed. Full cooperation and coordination shall be maintained with other contractors, subcontractors in this regard.

2.16 WATERPROOF CONCRETE

Waterproof concrete shall consist of structural concrete as specified herein and with the addition of an approved waterproofing additive. This shall be mixed in accordance with the manufacturer's instructions and as detailed in the Bill of Quantities.

Contractor's attention is drawn to the special care required for casting roof framing, ponds,

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swimming pools and all underground structures including basement floor, retaining walls, sumps, pits, etc. These are all designed to BS 8007, British Standard for water retaining structures. The contractor shall ensure that workmanship and curing is up to the required standard. The crack widths in such structures shall not exceed 0.2mm.

The Contractor shall take full responsibility for ensuring that the resulting construction is completely watertight and free from penetration of moisture.

When in the opinion of the Engineer, damp patches and/or leakage of water in the finished work are due to failure of the Contractor to comply with this specification, the affected work shall be made good at the Contractor's expense.

Water-stoppers shall be provided in all construction joints and the type of Water-stoppers will be as specified or to the approval of the Engineer. All Water-stoppers will be joined by welding strictly in accordance with the manufacturer's recommendations and all multiple joints and special intersections shall be manufactured by the supplier.

Before commencement of work, the Contractor shall obtain the Engineer's approval of the methods to be used to support and maintain the Water-stoppers in the correct location while the concrete is placed and also the layout and form of all additional construction joints other than those shown on the drawings. Unless indicated otherwise on the drawings, all construction joints in waterproof concrete shall be formed incorporating Water-stoppers to Engineer's approval.

All service holes cast in shall incorporate sleeves with puddle flanges and temporary openings for services should incorporate Water-stoppers.

Care shall be taken at all times to ensure that Water-stoppers are not perforated or damaged in any way and the concrete shall be carefully placed and compacted around the Water-stoppers to ensure void free impervious concrete.

All kickers or starter plinths to walls (if used) on the periphery of the watertight construction shall be cast monolithically with the base.

The formwork shall comply with this Specification and in addition any bolt or fastening embedded in or passing through the concrete shall be to the approval of the Engineer and not impair the water tightness of the structure. The use of through bolts and sleeves is strictly prohibited.

Special attention shall be given to the elimination of shrinkage or thermal cracking. The size of any bay or slab or wall and sequence of pouring shall be such as to minimize cracking.

Slotted inserts or sockets cast into the structural concrete shall be provided for all fixings including services. The cutting of holes in watertight concrete is strictly prohibited.

The Contractor is completely responsible for making all basements and swimming pools absolutely watertight. If any leakages or moist patches occur, the cost of any repairs, etc. to make the basement and swimming pool fully watertight will be borne by him. The Contractor is to give a ten year guarantee for water tightness, reckoned from the date of completion of roof framing, basement and swimming pool. The form of guarantee is to be to the satisfaction of the Client. Should any leaks or dampness occur during the Guarantee period of ten years, the Contractor shall, at no cost to the Client, immediately re-waterproof

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the defective area or areas and make good all damages to surface finishes such as plaster, painting, paneling, tiling, etc. electrical or other installations or other property, caused by leaks or dampness or reimburse the Client for making good such damages.

Water tightness of swimming pools shall be inspected and tested in accordance with BS 8007:1987 and/or ACI-350.

2.17 CLEANING AND REMOVAL OF RUBBISH

On completion of Works herein, the Contractor shall remove all concrete debris, rubbish, shuttering materials, scraps etc., from the vicinity of the structures completed. All areas shall be cleaned to the satisfaction and approval of the Engineer. The rubbish shall be disposed of within or outside the Site premises, free of cost as directed by the Engineer.

2.18 MEASUREMENT AND PAYMENT

- a) Concrete works shall be measured and paid for as per theoretical volumes calculated on the basis of the Drawings, or as otherwise approved by the Engineer and paid at per cubic foot at the rates entered in the Bill of Quantities.

Recesses (e.g. openings in slabs, break-through and the like) with an individual volume of more than 1 sq. ft. or 2 cft shall be deducted.

- b) The prices for concrete works shall include all cost for the complete work and are not limited to the cost of formwork, its support, anchoring's, chamfers, construction joints etc., the required scaffolding, false work, temporary works, post-treatment and, if necessary, repair of concrete, all preliminary and routine tests, as well as the required statical checks and drawings for Temporary Works in connection with the concrete works.
- c) The cost for special finishing of exposed concrete surfaces such as fair-faced finish etc. shall be included in the unit price applicable to the respective structural member and will not be compensated for separately.
- d) The cost of all concrete admixtures and additives shall not be paid for separately and is deemed to be included in the unit rates of respective items of the BOQ.

Joints

- a) Expansion Joints

Expansion joints will be paid per number, according to the Drawings. The prices shall include all costs for the different materials and performances relative to the laying and sealing of the joints.

- b) Dummy Joints

Dummy joints required by the Contractor with the Engineer's consent for the sound execution of the Works will not be paid for separately, but the costs involved are deemed to be covered by the concrete prices applicable to the respective structural member.

- c) Construction Joints

Construction joints will be measured and paid for as below:

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The Contractor is deemed to have covered the costs for all related supplies, laying, formation and performances of construction joints included in the respective concrete prices. However, the cost of PVC water stoppers and or swell bars shall be measured and paid for separately per running foot of accepted lengths.

If the approved pouring sequence has not been followed by the contractor. Any increase in quantity of materials (pvc water stoppers, swell bars, rear guards, sealants, SBR etc.) associated with the construction joints and or additional reinforcement required shall be paid for by the Contractor at his own cost.

Tamping of Equipment and Grouting of Recesses

The costs resulting from materials and performances in connection with the tamping of installed items or the grouting of recesses are deemed to be included in the prices for the supply and/or installation of the respective items, and will therefore not be separately compensated for.

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3 SECTION: REINFORCEMENT STEEL

3.1 SCOPE OF WORK

The work covered by this subsection of the Specifications consists of furnishing all materials, tools, labour and in performing all operations in connection with the providing, straightening, cutting, bending, fixing, binding including binding wire, chairs, pins, spacer blocks complete in strict accordance with this subsection of the Specifications, the applicable Drawings, approved bar bending schedule, and the terms and conditions of the Contract.

3.2 GENERAL

- a) The Contractor shall procure reinforcing steel only from reputable manufacturers/ suppliers duly approved by the Engineer.
- b) Verification of the source of supply shall be prepared by the Contractor and submitted to the Engineer along with necessary certificates and test reports.
- c) The Contractor shall prepare detailed bar cutting and bending schedules on the basis of the working Drawings and in consideration of BS-4466 and of any requirement resulting from the applied bar bending process.
- d) The Contractor shall inform the Engineer of the completion of any reinforcement in time, in order to facilitate its inspection and check of conformity with the working Drawings well before the concreting. Relevant formalities shall be agreed upon between the Contractor and the Engineer at the appropriate time.
- e) Reinforcement bar sizes have generally been shown on the Drawings in the form of designated bar numbers.

3.3 MATERIAL

- a) Reinforcement shall be deformed reinforcement, except that plain reinforcement bars are permitted for spirals. Reinforcing steel bars (Plain and deformed) shall be from the new billet stock of mild steel and shall conform to the British Standard Specifications mentioned below and as indicated on the Drawings and Bill of Quantities.
 - (i) Hot rolled deformed bars conforming to ASTM A-615 / BS 4449
 - (ii) Cold worked deformed bars to conforming to BS 4461 (revised 4449-1988)
 - (iii) Plain round steel bars to conforming to BS 4449
- b) For each consignment, the Contractor shall furnish to the Engineer the manufacturer's mill test certificates to guarantee that the steel supplied meets all the requirements of the relevant specifications and further meets the requirements of specified characteristic strength and minimum tensile strength requirements given as under:-

High Yield Deformed Steel Bars:

- i. Specified Characteristic Strength:

up to 16 mm (5/8")	460 N/mm ² (66,700 psi)
over 16 mm (5/8")	425 N/mm ² (61,625 psi)

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- ii. Tensile Strength:
Minimum Tensile Strength shall be 10% greater than the Specified Characteristic Strength.
- iii. Minimum Elongation
 - up to 16 mm (5/8") 12%
 - over 16 mm (5/8") 14%

Mild Steel Plain Steel Bars:

- (i) Specified Characteristic Strength 250 N/mm² (36,000 psi)
- (ii) Tensile Strength:
Minimum Tensile Strength shall be at least 15% more than the Specified Characteristic Strength.
- (iii) Minimum Elongation 22%

a) Bendability

All the bars shall be capable of being bent cold through 180 degree round a pin without cracking on the outside of the bent portion as per ASTM-A615.

- b) 18 gauge galvanized wire to BS 4482 shall be used for binding the steel reinforcement.
- c) Samples shall be tested for above requirements in an approved laboratory before starting the cutting of bars or when so required by the Engineer; and all cost of such tests shall be borne by the Contractor.
- d) All reinforcing steel bars shall be free from loose mill scale, loose rust, oil, grease, dirt or other harmful substances.

Wire Gauze

General

Unless otherwise specified the wire gauze shall be of best quality approved uniformly, woven wire webbing of 12 x 12 meshes to 645 mm square (one Sq. Inch) made from 22 gauge galvanized iron wire. All panels shall be in one piece and no joints shall be allowed.

Fixing

Wire gauze shall be fixed as shown on the drawings or as directed. The gauze shall remain tight to the fill width without any sag.

3.4 STORAGE

Reinforcement bars shall be stored on platform sufficiently above ground surface and be free from scales, oil, and structural defects prior to placement in Works. Rusted or dirty steel bars shall not be used in the Works unless brushed and cleaned by proper steel wire brushes and after being approved for use by the Engineer.

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3.5 REINFORCEMENT CUTTING AND PLACING

All reinforcement steel shall be cut and bent cold in strict accordance with bar bending schedules prepared by the Contractor and approved by the Engineer. The Contractor shall prepare bar bending schedule from approved structural working Drawings and as per instructions of the Engineer. The bending schedules shall be drawn on approved forms and submitted to the Engineer for checking and approval. The steel reinforcement shall be cut and bent to sizes as per Drawings and approved bending schedules. In case, any bars cut, bent or even fixed in position are found incorrect in dimensions, size and shape and are not according to the requirements of the Drawings or instructions of the Engineer, notwithstanding any previous approval of the Engineer, the Contractor shall replace such steel bars, cut, bent or fixed in position, by correct sizes bars at his own cost and no extra payment shall be made to the Contractor on such account. Suitable spacers, chairs as approved by the Engineer shall be used for the purpose of supporting and spacing of bars. In case, any bars are bent or displaced they shall be straightened or replaced prior to pouring. All reinforcement bars within the limit of a day's pour shall be in place and firmly tied with 18 gauge wires. Bars with kinks or bends not shown on the Drawings shall not be used. Reinforcement bars shall not be used for supporting the workmen and concreting work. Separate supporting system shall be used for this purpose.

Concrete cover to all reinforcement bars shall be provided as shown in the Drawings using steel chairs and concrete spacer blocks.

The concrete spacer blocks shall be cast from cement sand mix in a ratio of 1:2 in suitable required sizes. These shall be well cured and dry before use in the Works. The spacers shall meet the specified requirements of water absorption. All spacers shall be properly fixed in their required positions and as directed by the Engineer.

For any structural member which shall receive fair-faced concrete surfaces, special spacers shall be used while do not impair the specified appearance of concrete surfaces.

3.5.1 Laps and Splices

No splicing of bars shall be allowed at positions other than shown on the Drawings. All lap lengths shall be of the minimum sizes as indicated on the Drawings and in accordance with ACI 318-95. Splices of adjacent bars shall be staggered, unless approved otherwise by the Engineer. All reinforcing steel fixed in position shall be inspected by the Engineer and no concrete shall be poured until steel placement has been approved in writing by the Engineer. For inspection purposes, the Contractor shall give to the Engineer reasonable notice before the scheduled pouring time. Clear concrete cover to reinforcement steel shall be as specified or indicated on the Drawings.

3.5.2 Mesh Reinforcement

- a) Where indicated mesh shall be of the sizes as shown on the Drawings and conform to BS 4482 or 4449 with mesh sizes to BS 4483 or ASTM A-185 (Welded Steel Wire Fabric for Concrete Reinforcement). Mesh reinforcement when used in slabs shall be supported at proper elevations by standard accessories. In slabs on ground (porous fill), precast concrete spacer blocks may be substituted for chairs.

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- b) Overlaps in fabric reinforcement shall be a minimum of two meshes, except where otherwise shown on the Drawings, correctly aligned and at least 50% of the wire intersections shall be tied with 18 gauge tying wire. Laps shall be staggered in adjacent rows of sheets.

3.6 MEASUREMENT AND PAYMENT

Reinforcing bars will be measured as per Drawings in consideration of the volumetric weight of 7.85 t/m³, without additions for rolling tolerances, deformations, waste lengths and binding wires and paid per ton at the unit rate entered in the Bill of Quantities.

The prices shall include all costs involved with the supply, transportation, storage and protection, the cutting, bending and placing, inclusive of concrete spacers, supports, stands, tying into position, etc.

Assembly stands, spacers etc., whether designated in the Drawings or not or otherwise demanded by the Engineer will not be measured and paid for separately.

If installed reinforcement must be dismantled under certain circumstances or where additional reinforcing bars are to be provided on Engineer's instruction, the Contractor is not entitled to any compensation, if such additional supplies and/or performances are required and demanded by the Engineer due to the Contractor's faulty execution of the respective work.

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4 SECTION: FORMWORK

4.1 GENERAL

The formwork shall be inclusive of all labour, material, workmanship and alike. All formwork and supports thereto shall be designed by the Contractor and relevant drawings shall be submitted to the Engineer for approval before the Work is put in hand. Such an approval shall not relieve the Contractor from all or any of the obligations of the Contractor or give rise to any claims.

4.2 MAKING FORMS

The formwork for columns, beams, slabs, foundations, pits, lintels, fins, panels, purdees, parapets and all other works whether to be precast or cast-in-situ shall be of steel plates, scaffolding pipes and joints or other approved material and shall be rigidly formed and designed by the Contractor to the shapes and forms as per Drawings in accordance with the best of the existing practices, so as to be able to withstand without displacement, deflection or deformation or movements of any kind, the pressure of the moist concrete and all other loads. No plank timber formwork will be accepted at any location. Only system formwork will be accepted.

4.3 FAIR FACED FINISH

a) Facing Material

The form facing material shall produce a smooth, hard, uniform texture on the concrete. It shall be M.S. steel sheets, plywood, tempered concrete grade hardboard, metal or plastic, or other approved material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surface, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface, shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

b) Shop Drawings

Shop Drawings shall be submitted by the Contractor for Engineer's approval, showing grooves, joints etc. if indicated on the Drawings or instructed by the Engineer before taking up the job of formwork in hand.

c) Repair

No repair of surfaces designated 'fair faced' shall be allowed. Any concrete failing to achieve the desired finish or with defective surfaces shall be removed and replaced at Contractor's expense. The Engineer may reject any defective concrete surface and order it to be cut out in part or in whole and replaced at the Contractor's expenses.

4.4 RIGID WITH ALLOWANCE FOR CAMBER & BULGES

The formwork shall be fabricated and erected in position, perfect in alignment, levels and true to plumb and shape and securely braced so as to enable it to withstand all weights, dead and live, to be endured during placing of concrete and its subsequent hardening till the formwork is struck. It shall be sufficiently rigid as not to lose its shape and shall be made to

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compensate for bulging, and deflection to give the finished concrete the required lines, plumb, size and shape.

4.5 EXPOSED SURFACES LEFT UN-PLASTERED

In addition to the provision made elsewhere, for all the concrete work covered in this Contract which are to remain exposed in the finished work and left un-plastered, the formwork shall be smoothly faced by using M.S. steel sheets or lining the shuttering with smooth G.I. sheets or non-absorbent material like Formica sheets or in any manner as approved by the Engineer so as to make a perfectly smooth surface of the finished concrete. Where any surface defects on the exposed concrete surfaces occur and which do not impair the structural performance, being in excess of the designed surfaces and the architectural appearance of the Work in the opinion of the Engineer such defects may be removed by guniting and grinding with carborundum stone or in any other approved manner, at the cost of the Contractor, otherwise the whole or part of the Work shall be removed and made good by the Contractor, at his own cost. For precast concrete members, the forms shall be rigid, exact and smooth.

4.6 MATERIALS AND LABOURS

The Contractor shall supply all materials runners, and labour, necessary for a good and speedy erection of formwork such as steel plates, shuttering planks, struts, bolts, stays, gangways, boards, fillets etc. and shall do all that is essential in executing the job in a workman-like manner to the satisfaction of the Engineer.

4.7 FORMWORK NOT TO INTERFERE OR INJURE WORK

The formwork shall be so designed and arranged as to not unduly interfere with concrete during its placing and easy to be removed without injuring the finished concrete. Wedges, clamps, bolts and rods shall be used, when permitted and where practicable, in making the formwork rigid and in holding it to true position.

4.8 OPENINGS IN FORMWORK

Wherever concreting is required to be carried out within forms of depth exceeding 6.5 feet, temporary openings in the side of the form shall be provided to facilitate the pouring and consolidation of the concrete. Small temporary openings shall be provided at bottom of the forms to permit the removal of rubbish etc. but the same shall be suitably closed before pouring.

4.9 OPENING AND OTHER DETAILS

Provision shall be kept in the formwork such as openings, recesses, holes, pockets, fillets, etc. for housing services and other architectural details in the finished concrete or on its surface and edges as shown on the Drawings or as directed by the Engineer and to fix all necessary inserts, dowels, pipes, holdfasts etc. in concrete as shown on the Drawings or as directed by the Engineer.

4.10 JOINTS IN FORMWORK

All joints in the formwork shall be sufficiently closed to prevent leakage of mortar from concrete for concrete surfaces not to be exposed in the finished work. The joints in the finished work shall be close jointed and perfectly smooth so as not to allow any leakage of the mortar from the concrete and show any appearance of leaking mortar on concrete

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surfaces.

4.11 TREATMENT AND INSPECTION OF FORMS

All rubbish particularly chippings, shavings and saw dust shall be removed from the interior of the forms, before placing concrete. Forms shall be coated with approved shuttering oil before reinforcement is placed. Surplus oil on forms and any oil thus applied on reinforcing steel shall be removed. If the forms are not used within 24 hours, a fresh coat of oil shall be given before placing of concrete.

4.12 STRIPPING SHUTTERING

Formwork should not be removed until the concrete has developed sufficiently strength to support all loads placed upon it. The time required before formwork removal depends on the structural function of the member and the rate of strength gain of the concrete. The grade of concrete, type of cement, water/cement ratio, temperature during curing etc. influence the rate of strength gain of concrete.

No struts or timbering which serve the purpose of supporting the shuttering or centering shall be struck and removed without permission from the Engineer in writing and the work of striking and removal after the receipt of such permission shall be conducted under the personal supervision of the competent foremen in the employment of the Contractor and the Contractor even after the permission from the Engineer shall hold himself fully responsible for any consequences whatsoever.

In all cases the Engineer will direct and control the minimum period of time for which the forms, shuttering or centering shall remain in place before being struck; but, for the general guidance of the Contractor, the following are to be considered as the minimum periods for the main classes of Work.

Type of Formwork	Normal Weather	Cold Weather
Footing Sides	24 hours	36 hours
Vertical sides of Beams, Walls and Columns (unloaded)	24 hours	36 hours
Slab soffits (up to 15 ft span)	10 days	14 days
Slab soffits (> 15 ft span)	14 days	21 days
Beam soffits (up to 15 ft span)	14 days	21 days
Beam soffits (> 15 ft span)	21 days	28 days

The Engineer may require, however, that any walings, soldiers, struts or other timbers or supports, the removal of which may cause the transference of load to the finished work, to be kept in place for three weeks after the placing of the concrete.

The formwork parts and connections should be arranged in a way that makes formwork removal easy and simple, prevents damage to concrete and formwork panels so that it can be reused without extensive repair.

The formwork removal procedure should be supervised by the engineer to ensure that quality of hardened concrete in structural member, i.e. it should be free from or has minimum casting defects such as honeycombing, size and shape defects etc. These defects in concrete influence the strength and stability of structure. Thus immediate repair works can be done or the members can be rejected.

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The separation of forms should not be done by forcing crowbars against the concrete. It may damage the hardened concrete. This should be achieved by using wooden wedges.

Beam and joist bottoms should remain in place until final removal of all shoring under them are done.

Joist forms should be designed and removed so that the shores may be removed temporarily to permit removal of joist forms but must be replaced at once. The shores and joists will be dismantled beginning from the middle of the member's span, continuing symmetrically up the supports.

The approval from the engineer should be obtained for the sequence and pattern of formwork removal, prior to start of removal.

4.13 INJURY OR DAMAGE

The Contractor shall be responsible for any injury to the Work and any consequential damages caused by or arising from the removal and striking of forms, centering and supports, due to striking too soon. Any advice, permission or approval given by the Engineer relative to the removal and striking of forms, centering and supports shall not relieve the Contractor from the responsibilities herein defined.

4.14 TREATMENT AFTER REMOVAL OF FORMS

Any minor surface honey-combing or other irregularities are to be properly made good immediately upon the removal of the formwork and the surface made good to the satisfaction of the Engineer at the Contractor's own expense. Any small voids shall be neatly repaired with cement mortar consisting of one part of cement to two parts of sand and the whole surface rubbed over with carborundum stone and cement wash to bring the whole to a smooth and pleasing finish and uniform colour.

4.15 TOLERANCES

The structure shall be built to dimensions and levels shown on the Architect's drawings. Deviation from true positions and/or levels will be accepted only if they do not affect the finished dimensions, positions and levels as shown on the Architect's drawings.

Permitted tolerances shall be in accordance with the current issue of BS 5606, Code of Practice for Accuracy in building with up-to-date amendments.

Construction Tolerances of Structural Elements Supporting curtain walls or surfaces affecting curtain wall set out:-

- Maximum deviation vertically from defined position immediately after stripping of formwork +12mm.
- Maximum deviation laterally from defined position immediately after stripping formwork and prior to any pre-stressing (if used) +12mm or building height/4000 whichever is greater. This laterally out of position tolerance includes all local deviations in edge of slab or edge beams as well as overall building tolerance.

NOTE: All structural tolerances given above are for curtain walls (if used) and for all external structural faces of building affecting set out of masonry, windows and other

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cladding/finishes.

4.16 EXTERNAL EXPOSED CONCRETE SURFACE

All external exposed concrete surfaces of cast-in-situ or precast units shall be given smooth or pattern finish as shown in the Drawings schedule or as directed by the Engineer.

4.17 MEASUREMENT AND PAYMENT

All costs for formwork must be included in the concrete prices and will not be measured and paid for separately.

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5 SECTION: STRUCTURAL STEEL WORKS

5.1 SCOPE OF WORK

The work covered by this section consist of general requirement of structural steel work, its fabrication, erection and painting methodology, precautions and other general requirement incidental to structural steel work.

5.2 GENERAL

The applicable requirements of this section as determined by the Engineer shall apply to all structural steel works under this Contract. The work covered by this section consists of supply of necessary material, labor, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embedded parts, etc., fabrication and erection in accordance with the Specifications and as per drawings and as directed by the Engineer.

5.3 APPLICABLE STANDARDS

Latest edition of the following standards are relevant to these specifications, wherever applicable:

AISC	Code of standard practice
AISC	Specifications for Architecturally exposed structural steel
ASTM	Specifications for Structural joint using ASTM A325 or A490 bolts.
ASTM	Specifications for Material
AISC	Specifications
SSPC-SP6	Steel structural council-surface preparation specifications
AWS	Specifications for Welding of steel structures
BS 449	Use of structural steel in buildings

5.4 DRAWINGS

5.4.1 Design and Working Drawings

Design and working drawings shall be prepared by the Engineer and shall be supplied to the contractor. These shall contain main dimensions, sizes of members, and typical details of joints. Forces in members may be specified on the drawings to facilitate design/detailing of connections by the Contractor. However if not specified all connections shall be designed to have full strength capacity equal to that of member being connected.

5.4.2 Shop drawings

Shop drawings shall be prepared by the Contractor from the working drawings taking into consideration the the sizes (sections) of members/parts of the structure shall be standard rolled steel sections according to German/British/American or approved standards. The contractor, before, tendering, shall prepare material requirement list, ensure its availability at the time of actual fabrication and in case certain sections are not available, he will select suitable available alternatives subject to the approval of the Engineer.

Workshop drawings shall be prepared by taking into consideration the points enumerated below:

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- (i) Fabrication in convenient sub-assemblies and each shop assembly to be given an erection mark.
- (ii) Milling (machining of bases of supporting plate) for erection without adjustments.
- (iii) Provision of basic elements with erection devices.
- (iv) In-keeping with the requirements of computed strength of all connections and joints of structures not foreseen in the design and in the working drawings.
- (v) Other requirements having an influence on the methodology of fabrication, transportation and erection of steel structures.
- (vi) Uniformity of elements and parts of the steel structures should be maintained for mass fabrication.

5.4.3 Contents of Shop Drawings

Shop drawings shall consist of:

a. An erection scheme drawing having the following information:

- Location of erection elements in respect of axes and marks as well as picking points of these elements with respect to each other or with the existing steel or reinforced concrete structures.
- Erection joints showing erection welding thickness and lengths, bolts or rivet diameter and numbers.
- Chart showing list of assembling marks having columns such as mark, description, and quantity, weight of each mark, total weight and remarks with grand total in the end.
- Chart showing list of erection bolts, nuts and washers in tabulated form, showing information such as size, quantity weight and notes and the grand total.
- The mark for shop assemblies of each erection scheme shall have a different index, for example scheme of trusses, purlins etc. shall have marks A1, A2, A3 onwards and another scheme of columns, beams etc. shall have marks B1, B2, B3 and onwards. While marking on the plans, elevation, sections and details, the index shall be omitted.
- Except in special cases, all scheme drawings shall be made in single fairly thick lines.
- Erection scheme shall contain the following notes;
- Erection shall be done using the erection welding and bolts of normal sizes and accuracy according to the joints of the scheme.
- Quality and type of electrode.
- Measures against unscrewing of bolts.
- Erection shall be carried out according to the standard for fabrication and erection of steel structures.
- Painting instructions.
- References to design and working drawings.

b. The working drawings shall contain the following information:

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- Each Shop Assembly (Mark) shall be drawn separately showing necessary lines, elevations, sections with reference to axis, center lines, location of holes, cleats, plates, lugs, etc. fully dimensioned with part numbers.
- Bolts, holes sizes and symbols, holes diameter for metric size bolts shall be 2mm larger than bolt diameter and for inch size the same shall be 1/16" larger.
- Welding thickness (general)
- Material quality of steel used.
- Type and quality of electrodes to be used.
- Tests for welding, if any.
- Reference to related erection scheme drawings.
- Reference to design and working drawings.
- Material list.

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Except otherwise stated in the drawings, the material specifications shall conform to the following. Wherever necessary the contractor may use equivalent alternative material subject to approval of the Engineer.

5.5.1 Structural Steel

Structural steel for structures not requiring welding shall conform to the requirement of ASTM A7 (for bridges and buildings) and ASTM A36.

Structural steel shall conform to the requirement of ASTM A36 or equivalent.

5.5.2 High Strength low Alloy Steel

High strength low alloy steel shall conform to the requirements of ASTM A441 or equivalent.

5.5.3 Sheet Steel

Steel sheet for structures where no welding is required shall conform to the requirements of ASTM A36 (for cold rolled carbon steel sheets commercial quality) or ASTM A415 Standard specifications for cold rolled carbon steel sheets, commercial quality). For structures where welding is required sheet steel shall conform to the requirements of ASTM A425.

5.5.4 HD Grade Steel

HD Grade Steel used with vault area reinforcement shall conform to the requirements of ASTM J93005 (ferritic stainless steel)

5.5.5 Steel Forging

Steel forgings shall conform to the requirements of ASTM A235 (Tentative specifications for carbon steel forgings for general industrial use) class of forging shall be indicated on the drawings.

5.5.6 Steel Casting

Steel casting shall conform to the requirements of ASTM A27 standard.specifications for Mild to Medium strength carbon steel castings for general applications) and ASTM A148 (Standard specification for high strength steel castings for structural purposes). Grade of casting shall be shown on the drawing.

5.5.7 Filler Metal for Welding

Welding electrodes for manual shielded metal arc welding shall conform to the specifications for mild steel covered Arc-welding electrodes, AWS A5.1 latest edition or the specifications for low-alloy steel covered Arc-welding electrodes, AWS A 5.5 latest edition. Equivalent locally manufactured electrodes may also be used subject to the approval of the Engineer.

Welding electrodes shall be E70xx. All welding shall be carried out by qualified welder only using approved and qualified welding procedures.

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5.5.8 Bolts, Nuts and Washers

Unless otherwise specified anchor bolts and nuts shall conform to the requirements of ASTM A307 (Standard specification for low alloy carbon steel) externally and internally threaded standard fasteners). Bolts shall be of grade A for general application.

5.5.9 High Strength Bolts

All shop connections, except as noted herein or on the drawings, shall be made with high strength bolts in slip critical connections, or by welding.

High strength carbon steel bolts including nuts and washers shall conform to the requirements of ASTM A325 (Standard specification for high strength bolts for structural steel joints including nuts and plain hardened washers). The dimensions shall conform to the requirements of USASI B18.2965 (square and hexagon bolts and nuts for regular semi-finished hexagon bolts and heavy semi-finished hexagon nuts).

5.5.10 Cast Iron

Cast iron shall conform to the requirement of ASTM A48 (standard specifications for gray iron castings).

5.5.11 Connections

Unless noted otherwise, all connections shall be designed and detailed for forces shown on the drawings or for 100% of the effective capacity of the member. At least two bolts or equivalent welding shall be used for each connection.

5.6 ALLOWABLE STRESSES

Allowable stresses for steel shall be calculated in accordance with AISC specifications for the design, fabrication and erection of structural steel for building.

Allowable stresses for rivets, bolts and threaded parts shall be calculated in accordance with AISC specifications or tabulated allowable loads specified shall be followed.

Allowable stresses for welds shall be calculated in accordance with AISC specification.

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5.7 **FABRICATION**

5.7.1 **Straightening Material**

All material, before being worked upon, must be straightened within tolerances by ASTM specifications A6. Straightening necessarily shall be done by mechanical means or by the application of a limited amount of localized heat. Temperature of heated areas, as measured by approved methods, shall not exceed 1100 F for A514 steel or 1200 F for other steels.

5.7.2 **Cutting**

As far as possible, cutting must be done by shearing. Oxygen cutting shall be done where shear cutting is not possible and shall preferably be done by machine. All edges shall be free from gauges, notches or burs. If necessary, the same shall be removed by grinding.

5.7.3 **Holes Punching Drilling**

Holes may be made by drilling or punching. Holes shall be punched where thickness of the material is not greater than the diameter of bolt + 3mm. where the thickness of the material is greater, the holes shall either be drilled or sub-punched and then reamed to size. The die for all sub-punched holes and the drill of all sub-drilled holes shall be at least 2mm smaller than the nominal diameter of bolt. Holes for A 514 steel plates over 1/2" thick shall be drilled.

5.7.4 **Welding**

- a. **General:** The execution and inspection of welding shall be done in accordance with the provisions of the American welding society code/Specifications for welding in building construction, D1.0.
- b. **Automatic Submerged Arc Welding:** For all build-up members, i.e. sections fabricated from plates and flat bars or compound rolled sections and plates, where long continuous, welding is to be done, should be executed by Automatic submerged arc welding process in accordance with relevant AWS specifications.
- c. Maximum and minimum size and lengths of fillet welds shall be done in accordance with AISC specifications.
- d. Surface to be weld shall be free from loose scale slag, rust, grease, paint or any other foreign matter except mill scale, which withstands vigorous wire brushing.

5.7.5 **Tolerances**

A variation of 1mm is permissible in the overall length of members with both ends finished for contact bearing. The bearing surface is to be prepared to a common plane by milling. Members without end finished for contact bearing, which are to be framed to other steel parts of the structure, shall have a variation from detailed length not greater than 3mm.

5.7.6 **Test Assembly**

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Fabricated shops assemblies of all components shall be test assembled together after fabrication, prior to painting/galvanizing.

Test assembly work and procedure should be planned during fabrication process. Major fabrication work of locating of gussets etc. marking and drilling of holes for inter connecting joints, spliced connection leveling, placing of bracing, should be done simultaneously with test assembly.

Each test assembly will be inspected by the Engineer's representative and shall be dismantled only after his approval in writing.

5.8 SURFACE PREPARATION/PAINTING/GALVANIZING

5.8.1 Surface Preparation for Painting and Coating:

- After fabrication and test assembly the surface preparation for painting or coating of all components shall be done conforming to SSPC – SP10 (near white metal) by means of sand blasting.
- The sand used for this purpose shall be free from earth, dirt, clay and moisture.
- The size of sand particles, air pressure and size of the hose nozzle shall be correlated to give a proper and acceptable surface.

5.8.2 Painting

Painting of all steel, forged or cast components shall be done in 5-coats as under:

- Surface Preparation:
- Near white metal surface according to SSPC SP-10.
- First and Second Coat:
- Two pack anti corrosive Epoxy primer of 50 microns dry film thickness for each coat.
- Third, Fourth and Fifth; Finishing Coat:
- Two packs Epoxy resin enamel pigmented suitably for resisting highly corrosive and chemical influences and for withstanding abrasion and erosion.
- Each coat shall have 50-micron dry film thickness.
- Paint Selection/application
- Paints of manufacturers of repute shall be selected. The complete 5-coat paint system of any one of the manufacturers shall be used.
- The application of each coat of paint shall be done in accordance with the paint manufacturers recommendations, printed in their authentic printed catalogue.

5.8.3 Engineer's Approval:

The contractor shall submit 2 or more proposals containing the following for Engineer's approval:

1. Manufacturers name along with authentic painted catalogue.
2. Relevant 5-coat paint system with manufacturer trade names.
3. Any other details of relevance.

5.8.4 Steel Work/Surface not to be Painted

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- i. Steel work to be encased/embedded in concrete or surface in contact with concrete or grout shall not be painted, but shall be given a cement wash after sand blasting.
- ii. Machined finished surfaces shall not be printed but shall be coated with rust preventive compound, approved by the Engineer immediately after finishing. Such surfaces shall be also protected with wooden pads or other suitable means for transportation. Unassembled pins, keys, and bolt threads shall be greased and wrapped with moisture resistant paper.
- iii. Contact surfaces of connections using high strength bolts in friction type connections shall not be painted. Such surfaces of all components after fabrication shall be cleaned free of paint, grease, burrs slag by means of sand blasting. No coating whatsoever then be applied to such surface.

5.8.5 Zinc Coating (Galvanizing)

Components shall be galvanized after complete fabrication i.e. welding, drilling etc. The process should consist of removal of rust and mill scale by pickling in hydrochloric acid or sulphuric acid followed by water wash and prefluxing with ammonium chloride. The fluxed components should then be passed through a drying oven prior to immersion in a bath of virtually pure molten zinc.

The zinc coating shall be applied in a manner and of a thickness and quality conforming to the requirements of ASTM A123, standard specification for zinc (hot galvanized) coating on products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips.

5.9 INSPECTION AND TESTS

Manufacturer's work test certificate for all material used shall be furnished by the Contractor for Engineer's scrutiny and approval.

- a. Rolling tolerance of all shapes and profile shall be in accordance with the provisions of the American Society for Testing and Material Designation A.6. These shall be checked by the contractor before being worked upon and shall be rejected if found not within limits.
- b. The contractor shall arrange for analysis and test of all material rolled locally at a testing laboratory selected by the Engineer.
- c. Nevertheless, neither the fact that the material have been tested nor that the manufacturers work test certificates have been furnished, shall affect the liberty of the Engineer to reject, after delivery, material found not according to these specifications.

5.10 ERECTION

5.10.1 Bracing

The framing of steel skeleton buildings shall be carried up true and plumb within the limits defined in Section 7(h) of the AISC code of standard practice and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected including the equipment and the operation of the same. Such bracing shall be left in place as long as required for safety.

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5.10.2 Alignment

No riveting, permanent bolting or welding shall be done at site during erection until as much of the structure as will be stiffened thereby has been properly aligned.

5.10.3 Joints using High Strength Bolts

All structural joints using high strength bolts shall be executed and inspected in accordance with "AISC specification for structural joints" using ASTM A325 or A490 bolts.

5.11 MISCELLANEOUS STEEL WORK

5.11.1 General

The work covered shall include furnishing, fabricating, painting and installing miscellaneous steel work including the following:

- a. Steel Stairs
- b. Steel Ladders
- c. Steel Pipe handrails
- d. Steel protection angles
- e. Steel doors, windows, gates, ventilators/louvers.
- f. Steel fencing.
- g. Grating and chequered plate covering.
- h. Embedded plate, anchor bolts and other miscellaneous items.

5.11.2 Steel Stairs

General: Structural steel stairs complete with grating treads or chequered plate treads, landings, supporting structures, handrail, supports etc. shall be furnished and installed in accordance with working drawings. All components shall be galvanized to maximum extent practicable as shown on the drawings.

Material: Except otherwise indicated in the working drawings materials shall conform to the requirements of ASTM A36 (Tentative specifications for structural steel).

5.11.3 Steel Ladders

Steel ladder shall be welded assemblies with or without safety cages fabricated in accordance with the drawings. Material and standard of fabrication shall be the same as specified for stairs.

5.11.4 Steel Pipe handrails

Steel pipe handrails consisting of posts, handrail, knee rails and toe rail shall be fabricated in suitable units having two posts or three posts in one unit with erection joints between handrail and knee rails. Handrail of platforms galleries etc. of considerable length may not be shop fabricated as complete units consisting of posts etc. in case of such handrails the posts may be fabricated of the required height having one end with necessary arrangement for fixing to the platform or floor

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beams etc. and other end shop prepared to take the top handrail. Top handrail, knee rail and tow rail may be brought at site in stock length. The same may then be cut and welded at site. Locally manufactured pipes, M.S. or G.I may be used for the hand railing. These shall however conform to the requirements of ASTM A53 or shall be of equivalent requirements.

5.11.5 Steel Protection Angles

Steel protection angles required for the protection of concrete work shall be erected true to line and level. Steel angles shall be fixed in position by using anchors.

5.11.6 Steel door, windows, ventilators, louvers and gate frames:

Frames shall be fabricated from locally available hot rolled angle, tee, channel or pipe sections as specified in the drawings. Material shall however conform to ASTM A36.

Shutters:

Shall be made of any of the sections noted above with skin plate of at least 18 S.W.G. as shown in the drawings.

Accessories such as hinges, anchors, bolts, locks and handles shall conform to the requirements shown on the drawings or as directed by the Engineer.

5.11.7 Steel Fencing

Steel fencing shall be made from wire mesh bolted on the steel angles or channel frame as shown on the drawings or as directed by the Engineer.

Surface Preparation and Painting

Surface preparation painting and galvanizing of all miscellaneous steel work shall be done in accordance with clause 10 herein.

5.12 MEASUREMENT AND PAYMENT

5.12.1 General

Except otherwise specified herein or elsewhere in the contract documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

- a. Bolts, nuts, washers, screw, rivets, heads, fillets, welds and welding rods.
- b. Galvanizing and painting.
- c. Glass and glazing.
- d. All embedded parts unless otherwise specified in the Bill of Quantities
- e. Painting
- f. Steel grills and fly proof of shutters
- g. Locks, handle, hinges, hold fast, stopper etc.

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**5.12.2 Structural Steel Works and Miscellaneous Steel Work****Measurement**

Item of work of structural steel for which the unit rates have been quoted on weight basis and for which detailed workshop drawing have not been made shall be measured net as installed at site as per sketches and instruction of the Engineer. After measurement the theoretical weight shall be calculated from standard tables of section and weight in the manner followed in the preparation of shop drawings.

Items of works of structural steel for which the unit rates have been quoted on weight basis and for which the detailed shop drawings have been prepared, measurement shall be made at site to verify whether the items fabricated, supplied and erected in position are in conformity with the shop drawings. If the same is so verified to the satisfaction of the Engineer the weights given in shop drawing shall form basis of payment of bill. Any deviation found during the verification the same shall be checked from design and specifications point of view and shall be incorporated in the shop drawing and consequently the weights shall be revised.

Payment

Payment shall be made for acceptable measured quantity of all structural steel works on the basis of unit rate quoted in the Bill of Quantities and shall constitute full compensation for all the recovery related to the item.

5.12.3 Steel Embedded Part**Measurement**

Measurement of acceptable completed works of steel embedded parts will be made on the basis of weight of steel parts provided and embedded in position as shown on the drawings or as directed by the Engineer.

Payment

Payment shall be made for acceptable measured quantity of steel embedded parts on the basis of unit rate per metric ton quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the items.

**** END OF SECTION****

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6 SECTION: PLASTERING AND RENDERING

6.1 SCOPE OF WORK

The Work covered by this section of the Specifications consists of furnishing all plant, labour, appliances/ equipment and materials for performing all operations in connection with lathing, plastering and rendering, complete in all respect; in strict accordance with this section of the Specifications and the applicable Drawings and subject to the terms and conditions of the Contract.

6.2 APPLICABLE STANDARDS

Latest editions of following Pakistan, British & ASTM standards are relevant to these specifications wherever applicable.

Pakistan Standard

PS 232 Ordinary Portland Cement

ISO (International Organization for Standardization)

- R 597 Definitions and terminology of cement.
- R 679 Method of testing strength of cements, compressive and flexural strength of plastic mortar (Rilem - Embureau method).
- R 680 Chemical analysis of cement & main constituents of Portland cement.
- R 681 Chemical analysis of cements-mixer Constituents of Portland cement.
- R 682 Chemical analysis of cements - determination of Sulphur as Sulphide.

ASTM (American Society for Testing and Material)

- C 144 Aggregate for Masonry mortar
- C 631 Bonding compounds for interior plastering

BSI (British Standards Institution)

- 812 Methods for sampling and testing of mineral aggregates, sands and fillers.
- 1199 Sands for external renderings internal plastering with lime and Portland cement and floor screeds.
- 1369 Metal lathing (steel) for plastering.
- 5262 External rendered finishes.
- 5492 Internal plastering.

6.3 GENERAL

Except as may be otherwise shown or specified, all interior & exterior plaster shall be cement plaster in specified thickness shown on Drawings & BOQ. Plastered ceilings and walls shall include partitions, piers, columns, beams, ceilings, plastered jambs and other returns, reveals, and backs of recesses and alcoves, and joints and heads of windows and doors, unless otherwise specified or shown on the Drawings. Plaster on walls shall be carried down to dado, skirting and projected bases. Plasterwork shall also include all plasterwork on and under concrete surfaces and masonry. Concrete surfaces to be left exposed and concrete not specified to be left fair faced, as indicated on Drawings.

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A 3/8" render coat shall be applied to walls with a slightly roughened surface where wall finishes of applied nature, such as ceramic tiles, marble tiles, granite tiles, textured paint etc., are to be installed over wall surfaces.

Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that other contractors carry out all such work before starting of plasterwork. Chiseling and repairing of cement plaster shall not be permitted without the approval of the Engineer.

6.4 **MATERIALS**

- a. Cement for plaster shall be Ordinary Portland Cement (BS 12 or PS 232) or Sulphate Resisting Cement (BS 4027 or P.S. 612) as specified and shall conform to requirements specified in the section "Plain and Reinforced Concrete".
- b. Sand for plaster shall comply with the requirements of BS 1199, BS 1200, ASTM C-33 and/or the Pakistan Standard "Sand for Plaster" as directed by the Engineer.
- c. Water shall be clean and free from oils, acids, alkalis, salts and organic or other injurious matter and as described in section for "Plain and Reinforced Concrete".
- d. All materials and workmanship for plaster not explained in these Specifications, shall comply with the requirements of relevant BS CP 211 and CP 221 as directed by the Engineer.
- e. External rendered finishes should comply with appropriate clauses of BS 882.
- f. Mortar plasticizer shall comply with BS 4887 and shall be used in accordance with the manufacturer's instructions.
- g. Pigments to be used shall comply with BS 1104.
- h. Galvanized metal angle beads and plaster stops shall be as manufactured by the Expanded Metal Co. Ltd., London or other equal and approved.

6.5 **MIXING OF PLASTER**

Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the Drawings or as directed by the Engineer. Mixing shall be continuous until all ingredients are evenly distributed and thoroughly mixed. Only limited water shall be added for proper workability and such quantity of mortar shall be prepared which can be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited. Re-tempering shall not be permitted and all mortar, which has begun to stiffen, shall be discarded.

Except where hand mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for the mixing of plaster. Frozen, caked, or lumped materials shall not be used. Mechanical mixers, mixing boxes and tools shall be cleaned after mixing each batch and kept free of plaster from previous mixes. Plaster shall be thoroughly mixed with the proper amount of water until uniform in colour and consistency.

Re-tempering will not be permitted, and all plaster which has begun to stiffen shall be

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discarded. Plaster ingredients shall be thoroughly mixed either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.

Water Proofing Plaster 3/4 inch. (20mm) thick 1:4 cement sand plaster mixed with approved water proofing agent.

Re-tempering will not be permitted, and all plaster which has begun to stiffen shall be discarded.

6.6 PROPORTIONING OF PLASTER ON INTERNAL AND EXTERNAL WALLS

All plaster shall be Portland cement plaster, all coats of which shall be mixed in the following proportions by volume:

- One part cement and 4 parts sand or specified otherwise.
- One part cement and 3 parts sand only for RCC roof slab soffits.

All coats of plaster in water retaining structures shall be waterproofed by the addition of an approved waterproofing additive/admixture from BCR, Sika, Fosroc, Betocrete C-16or Master Builders or approved imported equivalent.

External plaster shall be pigmented plaster in the shades/ colors to the approval of the Engineer.

6.7 PREPARATION OF SURFACES OF PLASTER

- a. Surfaces to receive plastering shall be brushed to remove all loose particles, dust, laitence, efflorescence, etc. and any projecting fins on concrete surfaces shall be hacked off.
- b. Glossy or greasy surfaces shall also be suitably cleaned and chipped off to remove all traces of mould oil.
- c. Where unduly smooth in-situ concrete surfaces are encountered, such surfaces must be hacked properly before applying plaster.
- d. Surfaces shall thoroughly be sprayed with water and all free water allowed to disappear before plaster is applied.
- e. Irregularities in the surfaces to be plastered shall be filled with cement mortar 24 hours before plastering is commenced.
- f. Before plastering is commenced, all junctions between differing materials shall be reinforced. This shall apply where walls join columns and beams particularly where cracks are likely to develop and places directed by the Engineer. The reinforcement of such joints shall consist of a strip of galvanized expanded metal lathe/mesh, at least 6" wide, which shall be plugged, nailed or stapled to the surfaces to be plastered at the intervals not exceeding 12". The joints in mesh shall be lapped minimum 6".
- g. Metal angle beads shall be fixed with plaster dabs at 24" centers applied to the wall on either side of the arise and the wings of the beads pressed well in.
- h. The Plaster stops shall also be fixed in a similar manner or plugged, nailed or stapled to the surfaces to be plastered to the approval of the Engineer.

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- i. Metal angle beads and plaster stops shall be fixed at places shown on the Drawings or as directed by the Engineer.
- j. It shall be responsibility of the Contractor to ensure that all electrical conduits, pipes, concealed or embedded items, ducts, brackets, doors, window and ventilator frames, and all other fixtures on walls, ceilings, columns or required elsewhere have been fixed in position before the plastering is commenced.
- k. Cuttings and chasings in the block work shall be repaired as per the instructions of the Engineer at least twenty four hours before the plastering is commenced.

6.8 APPLICATION OF PLASTER

The Contractor shall not start any work till the surfaces are inspected by the Engineer. In case, any plaster work is done without obtaining the consent of the Engineer, the Engineer shall have the right to order removal of all such work and cleaning and preparation of the surfaces to his full satisfaction and the Contractor shall comply with such orders without any delay.

All surfaces to be plastered shall be treated with cement slurry as a base coat for proper bond. Any approved bonding agent may also be used as an alternative to cement slurry.

Plaster to internal and external surfaces shall be applied in the thickness shown on the Drawings or specified elsewhere. In any case, the plaster thickness shall not be less than the specified thickness.

Plaster shall be applied in two (2) coats on masonry and concrete surfaces where thickness is more than 3/4". The thickness of each coat shall not exceed 3/4".

- a. In case of 2 coats, the first coat or the under coat shall be full and thick and shall be applied with sufficient force to form good keys. The under coat shall be roughened and cross-scratched upon attaining its initial set to provide a proper bond to the next coat and shall be kept damp with a fog spray.
- b. Finish coat shall not be applied until the under coat has seasoned for 2 days. Just before application of the finish coat, the under coat shall again be wetted evenly with a fog spray.
- c. Finish coat shall be smooth finished.
- d. The finish coat shall be kept moist with a fog spray for at least 2 days and thereafter shall be protected against rapid drying until properly and thoroughly cured.

Plastering shall be executed in a neat workmanlike manner and shall be finished off with a wood or steel float, straight and plumb and shall not have wavy surface. The surface shall be of even texture and entirely free from all marks. The edges and corners shall represent a straight line. All arises shall be rounded to 6 mm radius unless otherwise specified.

Plastering shall neatly be made good around pipes or fittings.

As far as practical, plastering shall not be commenced until all mechanical, electrical and plumbing items, conduits, pipes, fittings and fixtures have been installed in their sequence of operations.

Plaster is to be maintained in moist condition for at least four days after it has developed

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enough strength not to be damaged by water.

Plaster stops and angle beads of expanded metal shall be used for protection of arises, edges and plaster ends as shown on the Drawings and as directed by the Engineer.

Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such defective plaster rejected by the Engineer shall be removed and replaced in conformity with these Specifications by the Contractor at his own cost to the satisfaction and approval of the Engineer.

6.9 SAMPLING OF PLASTER

Samples may be taken by the Engineer at any time from plaster work in place. Areas represented by samples which show over sanding will be rejected.

6.10 PATCHING

Plaster containing cracks, blisters, pits, checks, or discoloration will not be acceptable. Such plaster shall be removed and replaced with plaster conforming to this Specification and approved by the Engineer. Patching shall match with existing work in texture and colour.

6.11 CONCRETE / MASONRY JOINTS

All joints of concrete and block walls shall be specially treated as described here or as shown on Drawings. A 150 mm wide approved expanded metal shall be fixed at the joints and then plaster shall be applied. The expanded metal shall be with a weight of 3.0 lbs./sq. yd.

6.12 CLEANING AND PROTECTION

Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer. As each room or space is completed all Rubbish, debris, scaffolding and tools should be removed to leave the room clean.

Prior to plastering all aluminum windows, finished metals should be covered by sheet of plastic or tarpaulin to protect it from damage.

Protect finished plaster from injury by any source. Contractor shall also protect walls, floors and work of other trades from plaster materials.

6.13 TOLERANCES

The work shall be carried out while maintaining the following tolerances:

- Surfaces of plaster work shall be finished with a true plane to correct line and level unless otherwise specified and with walls and reveals plumb and square.
- Maximum permitted tolerances shall not exceed 1/8 inch. (3mm) in 6ft. (2 meter), but not exceeding 12 mm, maximum over the length of the building.
- Variation from plumb or level in any exposed line or surface and 1/16 inch (1.5 mm)
- Variation between planes of abutting edges or ends 1/16 inch (1.5 mm)
- Maximum permissible Offset at joints is 1.5 mm maximum

6.14 MEASUREMENT AND PAYMENT

Plaster shall be measured and paid per square Meter/feet, complete and approved, at the

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unit rates entered in the Bill of Quantities, including preparations, junction reinforcements, angle beads, plaster stops, framing and metal furring, metal lathe, chamfered edges, rounding off corners etc. and in the thickness as specified in Bill of Quantities.

**** END OF SECTION****

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7 SECTION: FLOOR AND WALL FINISHES

7.1 SCOPE OF WORK

The work under this section of the Specification consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in connection with the laying of cement concrete floors and floor finishes including bases, skirting and dado, complete in strict accordance with this section of the specifications and the applicable drawings and in accordance with the terms and conditions of the Contract.

7.2 APPLICABLE STANDARDS

Latest editions of following Pakistan, ISO, British & ASTM standards are relevant to these specifications wherever applicable.

Pakistan Standard

P.S. 232 Ordinary Portland Cement

ISO (International Organization for Standardization)

R 680 Chemical analysis of cements Main constituents of Portland Cement.

R 681 Chemical analysis of cements Minor constituents of Portland cement.

ASTM (American Society for Testing and Materials)

C 482 Bond strength of ceramic tile to Portland cement.

C 648 Breaking strength of ceramic tile.

C 650 Resistance of ceramic tile to chemical substances.

C 798 Color permanency of glazed ceramic tile.

E 84 Surface burning characteristics of building materials

BSI (British Standards Institutions)

882 Pt.2 Course and fine aggregates from natural sources.

1199 Sands for external renderings, internal plastering with lime and Portland cement and floor screeds.

1201 Pt.2 Aggregates for granolithic concrete floor finishes.

1281 Glazed ceramic tiles and tile fittings for internal walls.

5442 Classification of adhesives for use in Construction pt-1 Adhesives for use.

203 Tile flooring

204 In-situ Floor Finishes.

209 Pt.1 Care and Maintenance of floor surface, wooden flooring.

7.3 GENERAL

7.3.1 Samples and Approval

- a. All applied floor finishes materials such as terrazzo tiles, marble imported or

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local, imported Porcelain Tiles and ceramic tiles etc. to be used in the Works shall receive prior approval of the Engineer.

- b. Samples of all the materials to be used shall be submitted to the Engineer for his selection and approval before their use in the Works. The Contractor shall strictly follow the instructions of the manufacturers and the floor finishes shall be laid accordingly.
- c. Floor finishes shall be laid true to the line and level in approved manner satisfactory to the Engineer.
- d. Any work covered under this section of the Specifications not conforming to the requirements of the specified quality and workmanship will not be acceptable and shall be rejected and the Contractor shall be required to remove and replace such work at his own cost as per the instructions of the Engineer.

7.3.2 Floor Screed Beds

- a. All floor finishes of an integral nature such as cement concrete flooring, waterproof flooring shall be laid direct on to structural or site reinforced concrete slabs. In these cases, the slabs must first have been fully cured, then hacked, chipped or otherwise roughened to provide a good adhesion key, then brushed, hosed and cleaned thoroughly of all loose concrete, dirt, dust, grease, oil and other impurities. The surfaces shall then be thoroughly wetted for a period of at least a day before the application of the floor finish, and given a thin brush applied cement slurry grout. The floor finishes of integral nature shall then be laid as described in their respective subsections.
- b. All floor finishes of an applied nature such as terrazzo tiling, ceramic/marble tiling, etc. shall be laid on a floor screed as described below at 7.03 or as per the instructions of the Engineer. The floor screed shall be laid to a thickness calculated to be the overall nominal floor thickness less the actual thickness of the applied finish.
- c. Care is to be taken to relate finished floor levels to specified floor levels. The screed is to be completely flat, level and smooth, with no projections, low or high areas, etc., and finished with a wood float. Where required, the screed shall be laid to falls as shown on Drawings or as directed by the Engineer.

7.4 CEMENT SAND SCREED

7.4.1 Preparation of Base

- a. The laitance on the base shall be entirely removed by complete chipping, hacking & exposing the clean coarse aggregate. All loose concrete and dirt should be removed by thorough washing or hosing. The Contractor shall not undertake any finishing work until the surfaces are approved by the Engineer.
- b. The base concrete shall be wetted thoroughly for a period of at least a day before the application of floor finishes and any excess water is brushed off before laying the screed.
- c. Just before the screed is to be laid, a neat grout should be brushed into the base. The grout should consist of water and cement mixed to the consistency of a thick fluid. An approved bonding agent may be used as an alternative to the

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grout. Excess of the grout shall be removed by thorough sweeping just prior to placing the topping material.

7.4.2 Laying of Screed

- a. Cement sand screed up to a thickness of 40 mm shall be mixed in the proportions of 1:3 by volume with fine aggregate of approved size and gradation. Screeds over 40 mm thick should be mixed in the proportions of 1: 1 ½ :3 (cement: sand: aggregate) to the approval of the Engineer.
- b. Where specified, Aqua guard or an equal approved waterproofing additive shall be mixed in the waterproof cement sand screed in the ratio as per manufacturer's instructions or as directed by the Engineer and shall be finished with a steel float.
- c. Where screeds are to receive terrazzo or marble tiles etc. the screeds shall be finished with a slight rough finish to accept the cement paste and tiles. The mortar bed shall be spread and tamped to an even thickness over an area no greater than that, which can be tiled before the mortar reaches its initial set. However, ceramic tiles shall be bedded over a hard set cement sand floor screed laid earlier and well cured.

7.5 TERRAZZO TILES

7.5.1 Description

- a. Terrazzo Tiles shall generally comply with the requirements of BS 4131 and shall be as approved by the Engineer.
- b. Terrazzo tiling shall be locally manufactured, from an approved manufacturer, specialist in terrazzo tile making. Tiles shall be cast with a cement/sand base, and a pigmented terrazzo topping, cast integral, all in heavy metal moulds under pressure, all to the required sizes and thickness shown on Drawings and to Engineer's detailed approval.
- c. Tiles shall be selected by the Engineer from colours and patterns as prepared by the approved manufacturer from samples, the cost of which shall be deemed to be included in the rates. The approved samples shall be retained by the Engineer to form standards against which all deliveries will be judged.

7.5.2 Materials

- a. Portland cement conforming to BS 12.
- b. White Cement conforming to relevant BS Specification.
- c. Sand and aggregates shall comply with requirements of ASTM C-33.
- d. Water shall be clean potable drinking water, free from oils, acids, alkalis, salts, and organic or other injurious matter.
- e. Marble chips of approved shade, color, size and quality and shall have an abrasive hardness of not less than 16.

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- f. Marble powder shall be clean and should be of approved quality.
- g. Pigments to be used shall comply with BS 1014.

7.5.3 Tile Mixes

- a. Tile mixes shall be as under:
 - Backing shall consist of Portland cement and fine sand in proportions of 1:5; mixed with a minimum of clean potable water.
 - Terrazzo topping shall consist of white Portland cement and granulated marble chips of approved sizes, shade, colour and quality, mixed in proportions dependent on the exact terrazzo selected but average 1:2.
- b. The backings shall be placed first into the moulds, then the toppings to a minimum depth of 10 mm; the tiles cast under pressure and filled, ground and polished before delivery to Site. Bottom faces of tiles shall be cast with an approved incised key pattern.
- c. All the terrazzo tiles shall be cast to the sizes shown on the Drawings or as approved by the Engineer, perfectly square, with sharp square edges, and consistent in color and texture throughout the Contract for the color/ pattern selected and approved.
- d. Curing shall be effected by continuous wetting for a minimum period of 3 days.

7.5.4 Bedding and Finishing

- a. Terrazzo Tiles shall be bedded on the wet screeding described above at 7.02.2(b) and 7.03 by applying a thin layer of neat cement paste on to the screed bed and the tiles placed in position and tamped down gently with a wooden mallet to be level with other tiles. The tiles shall be laid in the manner so that they align perfectly to the specified lines and levels and are square. The tiles joints shall be as thin as possible but not more than 2 mm wide and shall be regular and perfectly straight, and setting out shall be carried to ensure a minimum of cut tiles. Any tiles requiring to be cut shall be saw-cut by approved tools. Tiles pattern shall be square to the spaces floored, and any patterning by tile jointing, alternating colors, etc. is to be carried out as indicated on the Drawings and as approved by the Engineer.
- b. The surface during laying shall be frequently checked with a straight edge at least 2m long to obtain a true surface with dead level or slope, as directed.
- c. All tile joints shall be grouted up solidly with a grout comprising of white Portland cement and water; all surplus to be cleaned off immediately.
- d. Once bedded, curing shall be carried out by covering in hessian and continuous wetting for a minimum period of 3 days and the floor kept clear of traffic for at least 48 hours.
- e. When cured, the terrazzo tiling shall be machine polished to the approval of the Engineer. Polishing must be evenly and carefully carried out and a perfect

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smooth surface produced.

7.6 **MARBLE FLOOR TILES**

7.6.1 **Description**

- a. The Work included under this subsection shall comprise of providing and fixing marble tiles in floors at locations shown on the Drawings in approved shades and colours. Unless otherwise specified, all marble work shall be in conformity with the latest British Code of Practice for this Work.
- b. The marble tiles shall be from approved local source, uniform in color, texture, shade and quality.
- c. Generally, marble tiles shall be 12"x12"x 1/2" and 24" x 24" x 3/4" or of size and thickness specified in the Drawings and Bill of Quantities.

7.6.2 **Materials**

- a. Marble
 - Marble shall be best quality Boticina marble, compact, dense, metamorphic rock of lime stone origin from quarries in Pakistan or elsewhere. It must be evenly grained with sugar like appearance. The shade and colors shall be to the approval of the Engineer.
 - All marble tiles shall be totally free from cracks, defects, fissures etc. and shall have adequate strength to perform as required with good resistance against abrasion and shall have an abrasive strength not less than 20.
- b. Portland cement conforming to BS 12.
- c. White Cement conforming to relevant BS Specification.
- d. Sand and aggregate shall comply with requirements of ASTM Specifications C-33.
- e. Water shall be clean potable drinking water, free from oils, acids, alkalis, and salts and organic or other injurious matter.
- f. Pigments to be used shall comply with BS 1014.

7.6.3 **Samples**

- a. The Contractor shall provide samples of marble tiles to be used for this item of Work showing the entire range of variation and colour for the selection and approval of the Engineer. The samples shall be in finished sizes and shape, the cost of which shall be deemed to be included in the rates. The approved samples shall be retained by the Engineer to form standards against which deliveries will be judged.
- b. The samples supplied shall conform to the ASTM standards stated below for the determination of the following:

Weight % Absorption

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Modules of Rupture	ASTM C-99
Compressive Strength	ASTM C-170
Resistance to Abrasion	ASTM C-241-51
Flexural Strength	ASTM C-8880-78

7.6.4 Bedding & Finishing

- a. The Contractor shall employ skilled and trained marble workers for doing this job. The Contractor may be allowed to employ an approved specialist subcontractor for this item of Work. All Work shall be of the highest quality in conformance with the Contract requirements and to the approval of the Engineer. Any substandard work shall be rejected and the Contractor shall remove and replace the same at his own cost.
- b. The surface over which the marble tiles are required to be fixed shall be clean of all dirt and dust and should be properly hacked so that the mortar sticks well to the surface.
- c. The Contractor shall ensure that all the edges of tiles supplied at Site are at right angles to each other, unless other angles are required due to design requirements. The Contractor shall also ensure that all sizes are adequate for the Work as specified.
- d. Damaged tiles or tiles with broken edges shall not be acceptable and in no case shall be used in the Work & shall immediately be removed from the Site.
- e. Marble tiles shall be bedded on the wet screeding described above by applying a thin layer of neat cement paste on to the screed bed and the tiles placed in position and tamped down gently with a wooden mallet to be level with other tiles. The tiles shall be laid in the manner so that they align perfectly to the specified lines and levels and are square. The tile joints shall be as thin as possible but not more than 2 mm wide and shall be regular and perfectly straight, and setting out shall be carried to ensure a minimum of cut tiles. Any tiles requiring to be cut shall be saw-cut by approved tools. Tiles pattern shall be square to the spaces floored, and any patterning by tile jointing, alternating colors, etc. is to be carried out as indicated on the Drawings and as approved by the Engineer.
- f. The surface during laying shall be frequently checked with a straight edge at least 2m long to obtain a true surface with dead level or slope, as directed.
- g. All tile joints shall be grouted up solidly with a grout comprising of white Portland cement and water, all surplus to be cleaned off immediately.
- h. Once bedded, curing shall be carried out by covering in hessian and continuous wetting for a minimum period of 3 days and the floor kept clear of traffic for at least 48 hours.
- i. When cured, the marble tiling shall be polished with chemical polish to the approval of the Engineer. No wax polish shall be allowed. Polishing must be evenly and carefully carried out and a perfect smooth surface produced.
- j. The marble shall be chemical polish finished to a glossy surface that will reflect light to emphasize the color and marking. All finished surfaces shall be of

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uniform texture, color and appearance.

7.6.5 Dado

- a. Dado in all marble tiled areas are to be in marble to match the floor tiling to the area concerned, unless specified otherwise. The dado shall be produced in an identical manner as for tiling. The dado shall normally be fixed to the walls up to heights shown in the Drawings with top edges arris-rounded or as shown on the Drawings or as approved by the Engineer.
- b. The dado tiles shall be fixed to walls on a plastered backing having a slightly rough surface with neat cement paste. The back of each tile shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet so that the tile faces are set in one plane. The tiles shall then be grouted and polished with chemical polish as for marble floor tiling.

7.6.6 Marble Tread and Risers

Stair tread and riser slabs shall be provided in local "Boticina" marble or imported marble in approved color and shade and to sizes and profiles as indicated on the Drawings. Treads to be 1" thick in single pieces as shown on Drawings, length to suit stair widths, one long edge arris-rounded and polished, risers shall be ½" thick in single pieces of sizes to suit stair widths; ends polished. Treads and risers shall be bedded in screed as for tiling, of thickness as indicated, all level and square or to profiles shown on Drawings, chemical polished and finished.

7.6.7 Marble Counter Tops

Marble slabs to kitchen counters, toilet counters or others shall be provided to sizes and profiles as indicated on the Drawings. The marble tops shall be provided in configurations to suit the built-in cabinets as per approved shop drawings in approved shade and color, delivered to Site polished and finished to the approval of the Engineer. Marble tops for toilets shall be recessed to provide wash hand basins, where required.

7.7 PORCELAIN FLOOR TILES

7.7.1 Description

The Work included in this subsection shall comprise of providing and fixing in position imported porcelain floor tiles of approved size, color and pattern at locations shown on the Drawings and mentioned in the Bill of Quantities.

7.7.2 Materials

- a. Imported non-skid Porcelain Ceramic Floor Tiles shall be from RAK Ceramics, UAE, or equal approved to the approval of the Engineer in the specified size, color and pattern.
- b. The tiles shall be bedded with neat cement paste or as recommended by the manufacturer and approved by the Engineer.
- c. Joint filler grout shall be from the same manufacture. The grout which shall be non-shrinking, stain resistant, permanent in color, and shall not inhabit fungus

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and bacterial growth. It shall be odorless and non-toxic, of smooth consistency for easy preparation and neat, rapid installation, and shall not contain any metallic material or ingredients. The joint floor grout shall be water resistant and shall not washout underwater.

- d. Portland cement conforming to BS 12.
- e. White Cement conforming to relevant BS standard.
- f. Sand & aggregate shall comply with ASTM C33.
- g. Water shall be clean potable drinking water, free from oils, acids, alkalis, salts and organic or other impurities and injurious matter.
- h. Pigments to be used shall comply with BS 1014.

7.7.3 Samples

The tile samples for the imported porcelain floor tiles shall be furnished from various product ranges of different manufacturers in sizes, patterns and colors for the selection and approval of the Engineer. The approved samples shall be retained by the Engineer to form standards against which deliveries will be judged.

7.7.4 Bedding, Laying & Jointing

- a. Porcelain Tiles shall either be bedded on the hard set floor screeding described above at 7.02.2(b) and 7.03 by applying a thin layer of neat cement paste on the screed bed and the tiles placed in position and tamped down gently with a rubber mallet to be level with other tiles. The tiles shall be laid in the manner so that they align perfectly to the specified lines and levels and are square. The tile joints shall be as thin as possible but not more than 2 mm wide, and shall be regular and perfectly straight, and setting out shall be carried to ensure a minimum of cut tiles. Any tiles requiring to be cut shall be cut by approved tools. Tiles pattern shall be square to the spaces floored, and any patterning by tile jointing, alternating colors, etc. is to be carried out as indicated on the Drawings and as approved by the Engineer.
- b. The surface during laying shall be frequently checked with a straight edge at least 2m long to obtain a true surface with dead level or slope as directed. Tiles that are out of true plane or placed incorrect shall be removed and reset.
- c. All tile joints shall be straight, level and of even width throughout. The tile joints shall be grouted up solidly in matching color with approved tile joint filler and water; all surpluses to be cleaned off immediately.
- d. Once bedded, curing shall be carried out by covering in hessian and continuous wetting for a minimum period of 3 days and the floor kept clear of traffic for at least 48 hours.
- e. When cured, the floor shall be washed and cleaned to the approval of the Engineer.

7.7.5 Skirting

- a. Skirting in all porcelain ceramic floor tiled areas are to be of porcelain tiles to

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match the floor tiling to the area concerned, as specified or shown on Drawings. The skirting shall be provided in an identical manner as for tiling. The skirting shall normally be 4" high with top edges arris-rounded or in the size and shape as shown on the Drawings or as approved by the Engineer.

- b. The skirting shall be fixed to walls on a plastered backing having a slightly rough surface with neat cement paste. The back of each skirting tile shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall over rendered backing with a rubber mallet so that the tile faces are set in one plane. The skirting shall then be grouted and finished as for porcelain tiling.

7.7.6 Protection

The completed Works or parts thereof shall be protected by the Contractor against any damage. The Works shall be handed over in perfect condition. If any damage is incurred then the Contractor shall remove and/or replace the same at no additional costs. The Contractor shall exercise all care to protect the works executed by other trades and not covered by his Contract. Any damage to these shall be made good and the works restored at no additional cost.

7.8 MEASUREMENT AND PAYMENT

Floor tiling works covered by this section of Specifications, complete and approved, will be measured and paid for per square meter, at the individual item rates entered in the Bill of Quantities and generally in accordance with the applicable terms and conditions of the Contract.

Skirting, treads and risers shall be measured and paid for per running meter at the individual item rates entered in the Bill of Quantities, as per terms stated above.

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8 SECTION: PAINTING

8.1 SCOPE OF WORK

The work under this section of the Specifications consists of furnishing all materials, plant, labor, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting concrete works, gates, grills, frames, walls, ceilings and all such surfaces as shown on the Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

8.2 APPLICABLE STANDARDS

Latest editions of following British Standards are relevant to these specifications wherever applicable.

BSI (British Standards Institution)

BS 245	Specification for mineral solvents (white spirits and related hydrocarbon solvents) for paints and other purposes.
BS 2521	Lead-based priming paint for woodwork.
BS 2522	Lead based priming paint for iron and steel.
BS 2569	Sprayed metal coatings. Paint colors for building purposes
CP 231	Painting of building
CP 3012	Cleaning and preparation of metal surfaces.

8.3 GENERAL

- 8.3.1 Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.
- 8.3.2 The Contractor shall repair at his own/expense all damaged or defective areas of shop-painted metal work and structural steelwork. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned to being embedded in concrete.
- 8.3.3 Except as otherwise specified, all concrete and plastered surfaces are to be painted.
- 8.3.4 The Engineer will furnish a schedule of colors for each area and surface. All colors shall be mixed in accordance with the manufacturer's instructions.
- 8.3.5 Colors of priming coat (and body coat where specified, shall be lighter than those of finish coat. The Engineer shall have unlimited choice of colors.
- 8.3.6 Samples of all colors and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Engineer for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer's satisfaction, without additional expense to the Employer, samples of each type of paint shall be on separate 1 ft. x 1 ft. x 1/8 inch tempered hard board panels. Manufacturer's color chart shall be submitted for color specifications and selection.

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8.4 MATERIALS AND EQUIPMENT'S

- 8.4.1 All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of approved manufacturers.
- 8.4.2 Colors shall be pure, non-fading pigments, mildew-proof, sun-proof, finely ground in approved medium. Colors used on plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Engineer's approval.
- 8.4.3 Approved quality Distemper paint shall be used for painting where specified on the drawings as directed by the Engineer.
- 8.4.4 The plastic emulsion/weather shield paint or similar as approved by the Engineer shall be used where specified on the drawing as directed by the Engineer.
- 8.4.5 Other materials/ equipment's to be used are;
- Cement primer, Turpentine, Putty, Polish paper, Wood primer, Emery polish paper and Water
 - Drop cloth and polythene sheets of suitable size & quality shall be used to protect other materials and surfaces.
 - The masking material where-ever necessary shall be used in sufficient quantities to avoid falling of paint on unwanted surfaces.
 - Grinding / buffing wheels, wire brush & emery paper.
 - Electrical distribution panels switch boards & hand lamps.
 - Kerosene, thinners, acetone etc. to remove oil / grease etc.
 - Painting brush:
 - Good quality brushes with long and flexible bristles free from any paint residue shall be used.
 - Neat, clean & painted scaffoldings of good quality.
 - Good quality ladders, platforms etc.
 - Safety gears to be used by personnel like respirator, face mask, hand gloves, protective clothing etc.

All material shall be delivered to site in their original unbroken containers or packages and bear the manufacturer's name, label, brand and formula and will be mixed and applied in accordance with his directions.

8.5 DELIVERY STORAGE AND CONTAINER SIZES

Paints shall be delivered to the site in sealed containers which plainly show the type of paint, color (formula or specifications number) batch number, quantity, and date of manufacture, name of manufacturer and instructions for use. Pigmented paints shall be supplied in containers not larger than 20 liters. All materials shall be stored under cover in a clean storage space which should be accessible at all times to the Engineer. If storage is allowed inside the building, floors shall be kept clean and free from paint spillage.

8.6 SURFACE PREPARATION

- a. All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scrapping, chipping, blasting, wire brushing or other effective means as

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approved by the Engineer.

- b. All the surfaces to be painted shall be free from dust, dirt, fungus, lichen, algae etc. old paint, varnish and lime wash should always be removed by scraping and washing.
- c. All surfaces shall be made smooth, prior to the application of primer by rubbing with Bathy (silicon carbide rubbing brick) and/ or sand paper, filling the voids putty (Zinc/ Chalk/ Plaster of Paris mixture).
- d. In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, re-cleaning will be done by the Contractor at no additional cost.
- e. No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

8.7 APPLICATION

All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workman like manner, leaving the finished surface free from drips, ridges, waves, laps, and brush marks. All paints shall be applied under dry and dust free conditions, Unless approved by the Engineer paint shall not be applied when the temperature of the metal or of the surrounding air is below 7 degrees centigrade, Surfaces shall be free from moisture at the time of painting.

All primary paint (Alkali Resistance) shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operation.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment.

A priming coat shall be applied to the cleaned and smooth surfaces first. Unless otherwise specified in the BOQ or approved by the Engineer, all surfaces shall have at least 3 coats of paint in addition to the priming coat.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation. Only as much material should be mixed as can be used up in one hour. Over-thinning will not be permitted. After the first coat the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight.

- a. Where shown on Drawings all exterior finishes shall be painted with weather resistant paint in approved colors as per manufacturer's specifications.
- b. For Interior finishes on concrete, masonry, door, windows, cabinets, grills etc. any of the listed types of paints, i.e.; Whitewash, Oil, Plastic or Matte Emulsion, Cement-based, Enamel, Distemper, Textured, Bituminous, Epoxy, Anti-condensation, Luminous (fluorescent), Latex, Lead, Metallic, Rubber, Aluminum, Silicone, Zinc rich, Anti- corrosive, Fungicidal Paint of the approved make and shade shall be applied to surfaces as shown on Drawings or as specified by the Engineer.

Walls, floors & ceiling and adjacent equipment's and piping shall be satisfactorily protected by drop clothes. Other precautionary measures should be taken during spray / brush painting to ensure at surrounding area /equipment is not affected.

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The application should be as per manufacturer's instructions / specifications. Before opening the packed drum, it should be rolled on the floor and after opening the drum paints shall be stirred well so that no material/ pigments remains settled at the bottom. Suitably of the the paint shall be checked as per requirement before opening.

The choice of method of application i.e. by brush or by spray gun will be decided by the Engineer. However, adjacent equipment / structures shall be suitably protected and care shall be taken to prevent intoxication of the surrounding area. The method of paint application depending upon the area shall be jointly discussed and decided with Engineer. Paint thickness (DFT) shall be as per the item scheduled. In case the dry film thickness of finish paint is observed less than the specified values, additional coat shall have to be applied free of charge.

Polishing

After fine sanding by a skilled operator, one coat of clear polish should be rubbed in by hand using a cloth or pad, be allowed to dry and buffed up with worn fine sand paper or steel wool to remove raised grain. A second coat of clear polish should then be applied.

8.8 JOB CONDITIONS

- 8.8.1 Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 degree C or above and less than 43 degree C. No painting shall be done above 90% relative humidity.
- 8.8.2 Adequately protect all finished work.
- 8.8.3 Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items.
- 8.8.4 In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified

8.9 INSPECTION & CHECK :

All the work is subject to the inspection of the Engineer or his authorized representative which shall be carried out in a manner, satisfactory to the Engineer. The contractor shall rectify any short comings pointed out by the said representative. The general inspection requirements are as follows:-

- a. No paint shall be applied until the authorized inspection has ascertained that all prepared surfaces are satisfactorily cleaned and are in a condition to ensure the proper receipt of and adhesion of the coating.
- b. The contractor shall furnish all gauges, instruments and the necessary measuring equipment's required for inspecting the work, test pieces, samples etc. at site and in the shop. The Engineer's authorized representative is intended to ensure that the material and workmanship are in accordance with this specification, but it will not relieve the contractor for any of his responsibilities for the ultimate workmanship and performances.

8.10 QUALITY ASSURANCE

All paint for any one surface shall be top quality, of one manufacturer of the specified. Deep tone accent colors shall be used and the unavailability of final coat colors may be the basis for rejecting materials for any one surface.

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8.11 MEASUREMENT AND PAYMENT

All the painting and finishing on all surfaces, other than timber and steelworks which shall be deemed to be inclusive of painting and finishing in their own items of works, shall be measured per square Meter/ft in accordance with standard method of measurement and paid for at the unit rates entered in the Bill of Quantities and in accordance with the terms and conditions of this Contract.

Where separate quantities are not shown in the Bill of Quantities, these shall be deemed to have been included in the rate of the relevant items to be finished and painted and no separate payment shall be made for painting/finishing works of such items.

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9 SECTION: DEMOLITION OF EXISTING STRUCTURE/RCC WORK

9.1 SCOPE OF WORK

This Section specifies the labor, materials, equipment, and incidentals required for the demolition, relocation, and/or disposal of all structures, walks, concrete slabs, retaining walls, trees and bushes, and including foundation, walls, columns, floors, piers, partitions, boundary walls, stoops and any other structures to the level of the demolition grade; to be removed as shown on the Drawings, as directed by the Engineer in charge in writing due to any defect/ damage/ reconstruction and as specified herein.

Site clearance will consist of the removal, disposal of demolition material; filling of all excavations to the existing ground elevation; and the grading and smoothing of the site.

9.2 METHOD

The Contractor shall examine the various Drawings, visit the site, determine the extent of the Work, the extent of work affected therein, and all conditions under which he is required to perform the various operations.

All demolition work will be done under the inspection of Engineer in charge. Contractor shall notify the Engineer in charge in writing prior to beginning any demolition work.

When the work of demolition is substantially complete, the Contractor shall again notify the Engineer in charge that the work will be ready for final inspection.

Before commencing demolition work, all structure relocation, bypassing, capping, and/or modifications necessary will be completed. Actual work will not begin until the Engineer in charge has inspected and approved the prerequisite work and authorized commencement of the demolition work.

Demolition operations shall be conducted in such a way as to minimize damage by falling debris or other causes to adjacent buildings, structures, roadways, other facilities, and persons. Interior and exterior shoring, bracing, or support to prevent movement or settlement or collapse of structures to be demolished and adjacent facilities to remain, shall be provided by the contractor, if needed, or if directed by the engineer in charge, at his own cost.

The Contractor shall be responsible for all damage to private or public property as a result of his fault or negligence in connection with the prosecution of the work and shall be responsible for the proper care and protection of all work performed until completion and final acceptance.

Arrangements shall be made with the Police Department to prohibit parking of vehicles in the near vicinity of the actual demolition.

In order to prevent the blowing of dust and dirt, the Contractor will be required to wet down and keep wet the structures before and during wrecking operations, all rubbish and debris stockpiled on the site, and all rubbish or debris is being loaded for disposal. All obstructions shall be adequately barricaded and lighted at night.

The Contractor shall comply with applicable laws and ordinances governing the disposal of materials, debris, rubbish and trash off or on the project area; and shall commit no trespass on any private property in the disposal of the materials without permission of the property

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owners involved.

No explosives shall be used at any time during the demolition. No burning of combustible material will be allowed.

The Contractor shall fill and compact all voids left by the removal of pipe, structures, etc. with materials described herein to a grade that will provide for positive drainage of the disturbed area to drain run-off in direction consistent with the surrounding area. The Contractor shall provide all fill materials to the site as needed. Compaction of fill shall match the compaction of adjacent undisturbed material.

Once the demolition is started, it shall be continued until completed

Contractor shall notify utility companies or local authorities furnishing gas, water, electrical, telephone, or sewer service to remove any equipment in the structures to be demolished and to remove, disconnect, cap, or plug their services to facilitate demolition.

9.3 **DISPOSAL OF MATERIAL**

All salvageable or useable material or equipment and other products of the demolition, to be retained by the Engineer, as indicated in writing by the engineer in charge, shall be moved to a designated area by Contractor for later use. The Contractor shall promptly remove all other materials from the site as instructed.

All material, equipment, rubble, debris, and other products of the demolition not retained by the Engineer shall become the property of the Contractor for his disposal, off-site, in accordance with all applicable laws and ordinances at the Contractor's expense. The sale of salvageable materials by the Contractor shall only be conducted off-site

The proper transport and disposal of all material shall remain the responsibility of the Contractor. On-site storage of items is prohibited.

9.4 **MEASUREMENT & PAYMENT**

Measurement for payment for demolition work will be done in similar units in which these items were paid, if constructed. No additional payment will be made for pumping or other difficulties encountered due to water.

The rate shall include cost of all such operations mentioned above including necessary labour, materials, transport, scaffolding, stacking the serviceable materials, disposing the unserviceable materials within the lead specified, all as directed by the Engineer-in-charge.

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