



CONSTRUCTION MATERIALS
QUALITY CONTROL GUIDELINES



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Construction Materials' Quality Control Guidelines

Revision History

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Ras Al Khaimah Construction Materials Quality Control Guidelines – RAKG-CMQC-2024
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Latest test methods and standards specifications references shall be always used.

مقدمة

نظراً للتطورات المتلاحقة في مجال التشييد والبناء والتي تشهد إماره رأس الخيمة في الآونة الأخيرة وظهور مواد بناء جديدة، قامت بلدية رأس الخيمة بوضع دليل إرشادي للاشتراطات والمعايير والمواصفات الفنية ذات العلاقة بضمان جودة مواد البناء الأساسية والمستخدمه في تنفيذ أعمال البناء لتكون مرجعية فنية علمية للمهندسين والمختصين في مشاريع البناء بالإماره بما يتماشى مع المواصفات القياسية العالمية والإقليمية وتناسب الظروف المحلية للإماره وتعمل على التأكد من خلو مواد البناء من العيوب وضمان سلامة المنشآت وتحسين كفاءة المباني مع زيادة العمر الافتراضي للمبنى والتقليل من أعمال صيانة المباني.

ومن هذا المنطلق، تم تشكيل لجنة إعداد الاشتراطات الخاصة بمعايير ضبط الجودة لتنفيذ المنشآت الخرسانية والمعدنية بالقرار الإداري رقم (1) لسنة 2018، والتي قامت بموجبه بإعداد الاشتراطات والمواصفات العامة ذات العلاقة بمنح الشهادات لمواد البناء وضمان جودتها بالإضافة إلى الاختبارات الواجب إجراؤها لمراحل البناء المختلفة ووضع دليل فني لها معتمد على المواصفات القياسية العالمية والإماراتية متى توفرت.

يحتوي هذا الدليل على الحد الأدنى من الاختبارات التي يجب أن يتم إجراؤها في المراحل المختلفة لعملية البناء، ولمهندسي دائرة البلدية والاستشاريين الحق في طلب المزيد من الاختبارات والإجراءات متى ادعت الضرورة وذلك لغرض منح الشهادات لمواد البناء على أن تكون هذا المتطلبات خاضعه لمواصفات البناء العالمية والمواصفات الإماراتية أو لاختبارات المواد وما يكافئها من المواصفات البريطانية أو الأوروبية أو الأمريكية أو غيرها كما يشير هذا الدليل.

والله ولي التوفيق.

I. Introduction

Considering the successive recent developments in Construction and Building Field witnessed by Ras Al Khaimah, and the emergence of new Building Materials, It was necessary for Ras Al Khaimah Municipality to set the Guidelines, and Technical Specifications Requirements to approve and ensure Main Building Materials' Quality used in the implementation of construction works. Further to being a Scientific Technical Reference for Specialists in Construction Projects in the Emirate in line with International and Regional/Emirates Standards Specifications so as to fit Local Conditions and Works to ensure that Building Materials are free of Defects, ensuring the safety of facilities, improving the efficiency of buildings while increasing Building Lifespan, and reducing their maintenance work.

Based on that, a committee was formed "Special Requirements for Quality Control Standards and Specifications Committee" for the Implementation of Concrete and Steel Structures by Administrative Decision No. (1) of 2018. According to which the Committee prepared the General Requirements and Specifications for approving and guaranteeing the Quality of Building Materials, in addition to the tests to be conducted for the various stages of construction and the development of a Technical Guide for them based on International and UAE Standards wherever possible.

These Guidelines provide the minimum quality control requirements for all relevant construction materials used on construction sites within the Emirate of Ras Al Khaimah. Its purpose is to facilitate the construction works in the emirate and support all relevant parties in their assigned duties for a better understanding of the needed testing for each construction materials.

Where the engineers of Ras Al Khaimah Municipality Department and those working in consultants' offices have the right to request more tests and procedures that may be necessary for the approval of Building Materials, provided that these requirements are based on the International Building Codes and UAE Specifications or to test methods of building materials or equivalent to British, European, American, or other codes as indicated in this Guide.

Currently, all industry sectors' quality control is part of the developing, engineering and manufacturing process in order to ensure that the designed and fabricated products meet the customers' expectations and stay within previously defined tolerances. Quality starts at the design stage.

These Guidelines require the attention and cooperation of all Consultants, Contractors, Supplier and Manufacturers/Producers to assure quality production and material. All concerned parties

in the field of construction should commit to implementation of these recommended guidelines in order to achieve its goals.

Quality control system will quantify, by means of precise measurement, the production capability (including measurement capability) of the organization. This will facilitate improved tolerance for functionality of the product, the identification of areas of capability associated with specific tolerance (customer) demands. Simply put, measurement is the tool that is used to quantify the capabilities of the people, the processes, the tools, the machines and therefore the organization. The correct application of the above will greatly facilitate right-first-time manufacturing.

Quality cannot be tested nor inspected into a product, it must be built in. These guidelines outline the basic and minimum requirements for building a simple but effective system for controlling the quality of work and basic materials used in construction.

These guidelines are based on the belief that:

- Quality is controlled by adequate advance planning, coordination, supervision, and technical direction; proper definition and a clear understanding of job requirements and procedures; and the employment of appropriately skilled personnel.
- Quality is verified through checking, reviewing, and monitoring of work activities, with documentation by experienced, qualified individuals who are not directly responsible for performing the work.
- Quality is achieved by providing proper training of personnel and ensuring that all personnel remain current on the knowledge and skills needed for their positions.
- Quality is achieved by focusing on preventing problems or errors rather than reacting to them.
- Quality control should ensure that the work is done correctly the first time.

II. Compatibility with Existing Regulations

These Guidelines complement the RAK Municipality General Building Regulations and Specification for the Emirate of Ras Al Khaimah for projects within the jurisdiction of RAK Municipality.

The provisions of these Guidelines shall supersede the provisions of any pre-existing similar guidelines in case of conflict, without any effect on the continuing validity of the remaining non-conflicting provisions of the pre-existing regulations.

When the requirements of the Construction Materials Quality Control Guidelines differ from the special requirements of Ras Al Khaimah Civil Defense Department for specific materials, the requirements of Ras Al Khaimah Civil Defense Department will prevail.

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VI. Definitions

| | Item | Description |
|----|-----------------------------------|--|
| 1 | Authority | Shall mean Ras Al Khaimah Municipality |
| 2 | Emirate | Emirate of Ras Al Khaimah (RAK) |
| 3 | Client | Natural or corporate person in whose name the plot of land or building is registered whether in his /its capacity as landlord or possessor or tenant |
| 4 | Employer Representative/ Engineer | Means the person appointed by the Employer & authorized by the RAK Municipality to prepare the design and supervise the construction work |
| 5 | Consultant | A registered consultant holding a valid consulting Engineer's license from the Rak Municipality |
| 6 | Contractor | A registered contractor holding a valid Contracting Engineer's from the Rak Municipality |
| 7 | Sub-Contractor | One that enters into a subcontract and assumes some of the obligations of the primary contractor |
| 8 | Quality | The degree to which a product or service meets or exceeds customer's requirements and expectations |
| 9 | Quality Control | A system for ensuring the maintenance of proper standards in manufactured goods, especially by periodic random inspection of the product |
| 10 | Regulations | Construction Materials Quality Control Guidelines and other regulations issued by authority |
| 11 | Hydraulic Cement | Cement that sets and hardens by chemical interaction with water and is capable of doing so underwater, for example, Portland cement and ground granulated blast-furnace slag are hydraulic cements |
| 12 | Portland Cement | A hydraulic cement produced by pulverizing Portland- cement clinker, usually in combination with calcium sulfate |
| 13 | Ordinary Portland Cement | The term used in the UK and elsewhere to designate the equivalent of American normal Portland cement or Type I cement |

| | Item | Description |
|----|-----------------------|---|
| 14 | Cementitious | Materials having cementing properties such as GGBS among other materials |
| 15 | Admixture | A material other than water, aggregates, hydraulic cement, and fiber reinforcement, used as an ingredient of a cementitious mixture to modify its freshly mixed, setting, or hardened properties and that is add to the batch before or during its mixing. |
| 16 | Aggregate | Granular material, such as sand, gravel, crushed stone, crushed hydraulic-cement concrete, or iron blast-furnace slag, used with a hydraulic cementing medium to produce either concrete or mortar. |
| 17 | Lightweight Aggregate | Aggregate of low density, such as: 1) expanded or sintered clay, shale, slate, diatomaceous shale, perlite, vermiculite, or slag; 2) natural pumice, scoria, volcanic cinders, tuff, and diatomite; and 3) sintered fly ash or industrial cinders, used in lightweight concrete. |
| 18 | Natural Sand | Sand resulting from natural disintegration and abrasion of rock. |
| 19 | Water | A clear, colorless, odorless, and tasteless liquid, H ₂ O, essential for most plant and animal life and the most widely used of all solvents. Freezing point 0°C (32°F); boiling point 100°C (212°F); specific gravity (4°C) 1.0000; weight per gallon (15°C) 8.338 pounds (3.782 kilograms). |
| 20 | Water-Cement Ratio | The ratio of the mass of water, exclusive only of that absorbed by the aggregates, to the mass of Portland cement in concrete, mortar, or grout, stated as a decimal. |
| 21 | Reinforcement | Bars, wires, strands, or other slender members that are embedded in concrete in such a manner that they and the concrete act together in resisting forces. |
| 22 | Concrete | A composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregates, usually a combination of fine aggregates and coarse aggregates; in Portland-cement concrete, the binder is a mixture of Portland cement and water, with or without admixtures. |

| | Item | Description |
|----|------------------------|---|
| 23 | Fresh Concrete | Concrete that possesses enough of its original workability so that it can be placed and consolidated by the intended methods. |
| 24 | Cast-in-place Concrete | Concrete that is deposited and allowed to harden in the place where it is required to be in the completed structure, as opposed to precast concrete. |
| 25 | Precast Concrete | Concrete that has been cast into form before being put into position. |
| 26 | Curing | Action taken to maintain moisture and temperature conditions in a freshly placed cementitious mixture to allow hydraulic cement hydration and (if applicable) pozzolanic reactions to occur so that the potential properties of the mixture may develop. |
| 27 | Concrete Block | A concrete masonry unit, usually containing hollow cores. |
| 28 | Mortar | A mixture of cement paste and fine aggregate; in fresh concrete, the material occupying the interstices among particles of coarse aggregate; in masonry construction, joint mortar may contain masonry cement, or may contain hydraulic cement with lime (and possibly other admixtures) to afford greater plasticity and workability than are attainable with standard Portland cement mortar. |
| 29 | Steel | A generally hard, strong, durable, malleable alloy of iron and carbon, usually containing between 0.2 and 1.5 percent carbon, often with other constituents such as manganese, chromium, nickel, molybdenum, copper, tungsten, cobalt, or silicon, depending on the desired alloy properties, and widely used as a structural material. |
| 30 | Sub-Structure | The supporting part of a structure; the foundation. |
| 31 | Waterproofing | Treatment of concrete or mortar to retard the passage or absorption of water, or water vapor, either by application of a suitable coating to exposed surfaces, by use of a suitable admixture or treated cement, or by use of a preformed film such as polyethylene sheets placed on grade before placing a slab. |

| | Item | Description |
|----|----------------|---|
| 32 | Yield strength | The maximum stress that can be applied along Material axis before begins to change its shape (deformation). |

Chapter 1: Quality Control for Construction Material

1. Quality Control (QC)

(Quality Control Requirements, Submittals, Inspections, Tests, Quality Control Reports)

1.1 Quality Control Requirements

- A. Ensure equipment and materials conform to the applicable requirements of each section of the specifications.
 - Maintain specified quality in all areas of the work including *but not limited to*:
 - Design and construction of structures
 - Inspection
 - Testing
 - Packaging, shipping, handling, and storage of materials
 - Site construction activities
- B. Establish procedures to prevent deficiencies from occurring.
 - Identify discrepancies when they do occur and then take corrective action.
 - Instruct workers, sub-contractors, material suppliers, and other personnel involved in the project on the correct procedures to follow.
- C. Assign specific responsibility for implementing the quality control program.
- D. Systematically verify compliance with the specified requirements using quality control audits for sub-contractors and suppliers.
 - Record results in formal reports.
 - Establish corrective action logs to track all actions.
- E. Assist employer representative in auditing quality control activities.

Employer representative's audits may be either pre-planned or random as warranted by general quality trends (Announced or unannounced audits).
- F. Inspect and test all work under the contract.
 - Maintain records of such inspections and tests.
 - Prepare and submit signed checklists for all work offered for the approval of the employer's representative.

- G. Arrange for factory inspections or auditing and tests when required by the contract documents or local regulations.
- H. Provide equipment, instruments, qualified personnel, and facilities necessary to inspect the work and perform the tests required by the contract documents.
- I. Repeat tests and inspections after correcting non-conforming work until all work complies with the contract requirements. All re-testing and re-inspections shall be performed at no additional cost to the Employer.
- J. The employer representative may elect to perform additional inspections and tests at the place of the manufacture, the shipping point, or at the destination, to verify compliance with applicable specifications.
- Inspections and tests performed by the employer representative shall not relieve the Contractor of his responsibility to meet the Specifications.
 - Inspections and tests by the employer representative shall not be considered a guarantee that materials delivered subsequently might be acceptable.
- K. Non-conforming materials, whether in place or not, might be rejected by the employer representative.
- The contractor shall be notified in writing to correct or remove the defective material from the construction site.
 - If the Contractor fails to respond, the employer representative may order correction, removal, and/or replacement of defective materials by others.
 - The contractor shall bear all costs for such work.
- L. Materials accepted on the basis of a certificate of conformity may be sampled and inspected/tested by the employer representative at any time.
- M. The fact that the materials were accepted on the basis of a certificate of conformity shall not relieve the contractor of his responsibility to use materials which will consistently comply with the specifications.
- N. Contractors shall impose all of the specified QC requirements (including inspection and test procedures) upon Suppliers and Sub-Contractors.
- O. Failure to Perform
- In the event the contractor fails to adequately perform any or all of the provisions of this Section, the employer, at his sole discretion, reserves the right to have the employer representative perform any or all of the

provisions of this section and back-charge the contractor for the actual cost of such work and any administrative charges deemed necessary.

- This remedy for the contractor's failure to perform shall be in addition to any other right or remedy available under the contract.

1.2 Submittals

Contractors shall be submitting List of Proposed Suppliers and Sub-Contractors include the following:

- Material to be supplied by each supplier and sub-contractor.
- Model or catalogue numbers.
- Specifications.
- Inspection and test requirements.
- Manufacturer's performance data.
- Anticipated inspection and test dates.
- Name and location of quarries and procedures for work in quarries.
- List other pertinent information as appropriate.
- Submit test results, certificates of compliance, and certified material test reports to the employer representative.

1.3 Inspection and Test Results

- All relevant construction materials delivered to the site shall be sampled and tested as per requirements of project specification, local regulations and international standards, test results to be submitted at least (7) calendar days prior to incorporating material into the work.
- Report results to the Employer Representative indicating compliance or failure immediately upon receipt.

1.4 Quality Control Reports

- A. The contractor's quality control manager shall provide a daily quality control report to the employer representative. This report shall be comprehensive, and it should include all QC activities on the project.
- B. The contractor shall perform regularly scheduled internal audits to verify that his quality control procedures/his main Sub-Contractors ensure total compliance with the specifications and referenced standards.
 - Schedule quality control audits not less than monthly and document findings in a report.

- Maintain records of internal audits as quality records and make them available to the employer representative upon request.
 - Provide the employer representative with access to the audit records upon request.
 - Allow the employer representative to observe the contractor's internal audit upon request.
 - Provide the employer representative with a copy of the audit report.
- C. The RAK Municipality-Certification Department will make the necessary arrangements with the applicant (Construction Material Factories/Suppliers) for carrying out the initial assessment, external audits of the factory quality, production lines and factory production control (FPC), and initial testing/evaluation of the product based on sampling.

Additionally, RAK Municipality may perform regular scheduled/unscheduled audits/inspections/sampling/testing on the main building materials in order to verify that their quality control procedures ensure comprehensive compliance with the specifications and reference standards.

Chapter 2: Building Material Specification and Tests

2. Building Material Testing Standards

2.1 Cement, Cementitious Materials & Admixtures

Table 01: Schedule of Standard Specification for Cement, Cementitious Materials & Admixtures.

| | Title | Conforming to Standard | Frequency |
|---|---|---|---|
| 1 | Cement | BS EN 197-1, ASTM C 150/C150M, GSO 1914 or Equivalent | - First delivery from new source + periodic thereafter with specified frequency (At Least once every 6 months); and In case of doubt after visual inspection - Certificate of Analysis of cement & cementitious materials shall be provided from the manufacturer for each delivery. - Technical Data Sheets (TDS's) shall be provided for liquid admixtures. |
| 2 | GGBS (Ground Granulated Blast Furnace Slag) | BS EN 15167-1, BS EN 15167-2, ASTM C 989 or Equivalent | |
| 3 | Fly ash | BS EN 450, ASTM C618 or Equivalent | |
| 4 | Silica Fume | BS EN 13263, ASTM C1240 or Equivalent | |
| 5 | Liquid Admixtures | BS EN 934-2 or Equivalent | |

Notes:

- All cements and cementitious materials shall conform to the physical and chemical requirements of the pertinent standard specifications. The required tests shall be made to verify the compliance with the standards for all used type of Portland Cement.
- For cements and cementitious materials, regular sampling shall be made from each delivery for random testing.
- Additional testing might be conducted at the request of the Engineer and/or Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Above tests shall be performed in an approved third-party laboratory and compliance to the schedule is under the responsibility of the end user i.e. contractor or read-mix concrete supplier where the material will be mixed.

Table 02: Minimum Tests for Cement & Cementitious Materials. For More details, refer to (Appendix -4-).

| | Minimum Required Tests/ الاختبارات المطلوبة | Conforming to Standard |
|---|---|---|
| 1 | Initial setting time قياس زمن الشك الابتدائي | BS EN 196-3, ASTM C191/ ASTMC266 or Equivalent |

| | Minimum Required Tests/ الاختبارات المطلوبة | Conforming to Standard |
|---|---|--|
| 2 | Final setting time قياس زمن الشك النهائي | |
| 3 | Compressive Strength Test by Standard concrete cube مقاومة الضغط للمكعبات الخرسانية | BS EN 196-1, ASTM C109 or Equivalent |
| 4 | Fineness النعومة | BS EN 196-6/ ASTM C204 or Equivalent |
| 5 | Soundness Characteristics of Portland Cement-Fly Ash Mixtures الأصالة | ASTM C311 or Equivalent |
| 6 | Sulphate content تعيين نسبة الكبريتات | BS EN 196-2, ASTM C563 or Equivalent |
| 7 | Chloride content تعيين نسبة الكلوريدات | BS EN 196-2 or Equivalent |
| 8 | Loss on ignition الفاقد من الوزن بالحرق | BS EN 196-2, ASTM C114+ ASTM C25 or Equivalent |
| 9 | Chemical Analysis: Insoluble residue - Silicon Dioxide - Aluminum Oxide - Iron Oxide - Calcium Oxide - Magnesium Oxide الاختبارات الكيميائية للإسمنت نسبة المواد الغير ذائبة - ثاني أكسيد السيليكون - أكسيد الألومنيوم - أكسيد الحديد - أكسيد الكالسيوم - أكسيد الماغنسيوم | BS EN 196-2/ ASTM C114/ GSO 938 or Equivalent |

2.2 Aggregates

Table 03: Schedule of Standard Specification for Aggregates. For More details, refer to (Appendix -4-).

| | Title | Conforming to Standard | Frequency |
|---|--|--|--|
| 1 | Standard Specification For Concrete Aggregates | GSO ASTM C33/C33M, BS EN 12620 or Equivalent | As per specification |
| 2 | Grading | BS EN 933-1 or Equivalent | First delivery from new source + periodic thereafter with specified frequency (At Least Monthly); and In case of doubt after visual inspection |
| 3 | Material finer than 75 Micron sieve | BS EN 933-1 or Equivalent | |
| 4 | Water Absorption and Specific Gravity | ASTM C127, C128, BS EN 1097-6 or Equivalent | |
| 5 | Elongation and Flakiness | EN 933-3 or Equivalent | |
| 6 | Moisture Content in Fine Aggregates/Sand | ASTM C566 or Equivalent | Daily for washed aggregates / sand |
| 7 | Clay Lumps and Friable Particles | ASTM C142/ C142M or Equivalent | |

| | Title | Conforming to Standard | Frequency |
|----|---|---|--|
| 8 | Lightweight Particles | ASTM C123/C123M or Equivalent | First delivery from new source + periodic thereafter with specified frequency (At Least once every 6 months); and In case of doubt after visual inspection |
| 9 | Organic Impurities | ASTM C40/C40M, ASTM C87 / C87M/ BS EN 12620 or Equivalent | |
| 10 | Sand Equivalent | ASTM D2419 or Equivalent | |
| 11 | Acid Soluble Chlorides | BS EN 1744-5 | |
| 12 | Acid Soluble Sulfates | BS EN 1744-1 | |
| 13 | Soundness by Use of Sodium Sulfate or Magnesium Sulfate | ASTM C88/C88M/ BS EN 1367-2 or Equivalent | |
| 14 | Drying Shrinkage | BS EN 1367-4 or Equivalent | |
| 15 | 10% Fines Value (10%TFV) | BS EN 1097-2 or Equivalent | |
| 16 | Los Angeles Abrasion Test | ASTM C131/C131M/ BS EN 1097-2 or Equivalent | |

Notes:

- All the tests shall be done before the start of the work and whenever the source is changed.
- Additional testing might have conducted at the request of the Engineer and/or Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Above tests shall be performed in an approved third-party laboratory and compliance to the schedule is under the responsibility of the end user i.e. contractor or read-mix concrete supplier where the material will be mixed.

Table 04: Minimum Tests for Aggregates. For More details, refer to (Appendix -4-).

| | Required Tests/ الاختبارات المطلوبة | Conforming to Standard |
|---|---|----------------------------|
| 1 | Acid soluble chloride of sand & aggregates <i>حمض الكلوريدات الذائبة في الركام الناعم والخشن</i> | BS EN 1744-5 or Equivalent |
| 2 | Acid soluble Sulphate of sand & aggregates <i>حمض الكبريتات الذائبة في الركام الناعم والخشن</i> | BS EN 1744-1 or Equivalent |
| 3 | Sulphate content of aggregates <i>الكبريتات الذائبة في الركام الخشن</i> | BS EN 1744-1 or Equivalent |

| | Required Tests/ الاختبارات المطلوبة | Conforming to Standard |
|----|--|---|
| 4 | Acid soluble material in fine aggregates الاحماض الذائبة | BS EN 1744-1 or Equivalent |
| 5 | Organic impurities of fine aggregates الشوائب العضوية في الركام الناعم والخشن | ASTM C40 / C40M ASTM C87 / C87M BS EN 12620 or Equivalent |
| 6 | Los Angeles Abrasion of small Size and Large Size & Coarse Aggregate. (It is for one size fraction only) اختبار لوس أنجلوس | ASTM C131/C131M & ASTM C535 BS EN 1097-2 or Equivalent |
| 7 | Sand Equivalent Value القيمة المكافئة للرمل | ASTM D2419 or Equivalent |
| 8 | Material Finer than 75 Micron المواد الناعمة | ASTM C117, BS EN 933-1 or Equivalent |
| 9 | Clay Lumps & Friable Particles in Aggregate كتل الطين والجسيمات الغريبة | BS EN 12620/ASTM C142/ C142M or Equivalent |
| 10 | Shell content in coarse aggregate محتوي القواقع (القشريات) في الركام الخشن | BS EN 933-7 or Equivalent |
| 11 | Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates تحليل المناخل للركام الخشن والناعم | ASTM C136/C136M/ BS EN 933-1 or Equivalent |
| 12 | Specific Gravity of coarse and Fine aggregates الوزن النوعي للركام الخشن والناعم | ASTM C127 & ASTM C128 or Equivalent |
| 13 | Particle Density & Water Absorption الكثافة الجزيئية وامتصاص الماء | BS EN 1097-6 or Equivalent |
| 14 | dry and wet sieve analysis التحليل بالمنخل الرطب والجاف | ASTM C136/C136M/ BS EN 933-1 or Equivalent |
| 15 | Relative density/ Total density الكثافة النسبية / الكثافة الكلية | ASTM C128/ BS EN 1097-3 or Equivalent |
| 16 | Water absorption امتصاص المياه | ASTM C127, C128, BS EN 1097-6 or Equivalent |
| 17 | Organic impurities الشوائب العضوية | ASTM C40/C40M/BS EN 12620 or Equivalent |
| 18 | Chloride contents تحديد نسبة أملاح الكلوريدات | BS EN 1744-5 or Equivalent |
| 19 | Sulphate contents | BS EN 1744-1 or Equivalent |

| | Required Tests/ الاختبارات المطلوبة | Conforming to Standard |
|----|--|---|
| | الكمية الكلية لأكسيد الكبريت | |
| 20 | 10%Fines Value (10%TFV) فحص قيمة المواد الناعمة 10% | BS EN 1097-2 or Equivalent |
| 21 | Hardness test or soundness اختبار الصلادة / اختبارات الأصالة (سلامة الركام) | ASTM C88/C88M/ BS EN 1367-2 or Equivalent |

2.3 Water

Table 05: Schedule of Standard Specification for Water.

| | Title | Conforming to Standard | Frequency |
|---|------------------------------------|--------------------------|---|
| 1 | Mixing Water for Concrete | GSO ISO 12439 | Initially and periodic thereafter with specified frequency (At Least once every 6 months) Where a new non-FEWA source is used for the first time + In case of doubt |
| 2 | Chlorides Ion (Cl) | ASTM D512 or Equivalent | |
| 3 | Sulfates Ion (SO ₄) | ASTM D516 or Equivalent | |
| 4 | Total and Dissolved Carbon Dioxide | ASTM D513 or Equivalent | |
| 5 | PH value of Water | ASTM D1293 or Equivalent | |

Notes:

- It should be complying with the requirements of (ASTM C1602 / C1602M) & (BS EN 1008).
- Additional testing might have conducted at the request of the Engineer and/or Authority.
- Contract Specifications shall be implemented if more or other tests are required.
- Above tests shall be performed in an approved third-party laboratory and compliance to the schedule is under the responsibility of the end user i.e. contractor or read-mix concrete supplier where the water will be mixed.

Table 06: Schedule of Minimum Tests for Water.

| | Required Tests | Conforming to Standard | الاختبارات المطلوبة |
|---|------------------------|--------------------------|------------------------------|
| 1 | Chloride Content Test | ASTM D512 or Equivalent | نسبة الكلوريدات |
| 2 | Sulphate Content Test | ASTM D516 or Equivalent | نسبة الكبريتات |
| 3 | Total Dissolved Solids | ASTM D5907 or Equivalent | نسبة المواد الغريبة في الماء |

| | | | |
|---|--------------------------|--------------------------|-------------------|
| | Impurities Content Ratio | | |
| 4 | PH Value of Water | ASTM D1293 or Equivalent | نسبة الحموضة (PH) |

2.4 Reinforcing Steel

Table 07: Schedule of Standard Specification for Reinforcing Steel.

| | Title | Conforming to Standard | Frequency |
|----|------------------------------|---|--|
| 1 | All Grades | BS EN 10080 GSO 1808 or Equivalent | |
| 2 | Mechanical Properties | Steel reinforcement specified shall comply with the relevant standard specifications as referred to in the project's specifications. Standard Specifications covered are (BS 4449, ASTM A615/A615M, ASTM A 1035, ISO 6935-2) or Equivalent and shall be cut and bent in compliance with ACI315 or Equivalent. | 1- Initially, one set of tests for Mechanical and Chemical Properties for each range of bar diameters (Small $D < 16\text{mm}$, Medium $16 \geq D \geq 25$ or Large $D > 25$) 2- Every 100 tons of steel delivered to the site thereafter. Number of Samples: 3 samples for each bar size and length depends on the required length by testing laboratories. -Mill Test certificate shall be provided from the manufacturer for each delivery |
| 3 | Yield Strength | | |
| 4 | Ultimate Strength | | |
| 5 | Elongation at Maximum Force | | |
| 6 | Elongation to Fracture | | |
| 7 | Mass / meter | | |
| 8 | Nominal Cross-sectional Area | | |
| 9 | Bending | | |
| 10 | Re-bending | | |
| 11 | Surface Geometry | | |
| 12 | Chemical Properties | | |

Notes:

- Every consignment of Steel shall have (Mill Test Certificates) to be attached to the Material Inspection Request for the Engineer's review.
- Steel tags having heat number shall be provided with the steel.
- Tests shall be repeated whenever there is a change in the source of supply.
- Additional testing might have conducted at the request of the Engineer and/or Municipality.
- Contract Specifications shall be implemented if more or other tests are required.

- Reinforcing steel, supplied by a certified manufacturer approved by RAK Municipality shall be tested at the beginning of the project for at least one of the 3 ranges then and every 200 tons delivered to site thereafter.
- Couplers shall comply with the (ACI318 or ISO 15835-1) requirements whenever used.
- Cover blocks shall comply with (ACI318) requirements.
- For performance and testing requirement of spacers and chairs refer to (BS 7973-1).

Table 08: Schedule of Minimum Tests for Reinforcing Steel. For More details, refer to (Appendix -4-).

| | Required Tests | Standard | الاختبارات المطلوبة |
|---|--------------------------------|---|--------------------------|
| 1 | Tensile Test & Elongation Test | BS 4449, ASTM A615/A615M, ASTM A 1035, ISO 6935 GSO 1808 or Equivalent | شد الحديد |
| 2 | Yield Test & Re-bend Test | | إعادة الثني |
| 3 | Carbon ratio Test | ASTM A615 /A615M/BS4449, BS 6200-3 or Equivalent | الكشف عن نسبة الكربون |
| 4 | Phosphor ratio Test | | الكشف عن نسبة الفسفور |
| 5 | Sulphate ratio Test | | الكشف عن نسبة الكبريت |
| 6 | Nitrogen ratio Test | | الكشف عن نسبة النيتروجين |

2.5 Epoxy-Coated Steel

Table 09: Schedule of Standard Specification for Epoxy-Coated Steel.

| | Title | Conforming to Standard |
|---|---------------------|--|
| 1 | Coating Thickness | BS ISO 14654, BS ISO 14656/ ASTM A775 / A775M or Equivalent |
| 2 | Coating Continuity | |
| 3 | Coating Flexibility | |
| 4 | Coating Adhesion | |

Notes:

- Additional testing might have conducted at the request of the Engineer and/or Authority.
- Contract Specifications shall be implemented if more or other tests are required.
- Every consignment of Steel shall have Mill & Test Certificates to be attached to the Material Inspection Request for the Engineer's review.
- Steel tags having heat number shall be provided with the steel.

2.6 Cast In-Situ Concrete (Ready-Mixed Concrete)

2.6.1 Laboratory & Plant Trial Mixes

Table 10: Schedule of Standard Specification for Ready-Mixed Concrete (Laboratory & Plant Trial Mixes).

| | Title | Conforming to Standard | Periodic Inspection | Notes |
|----|---|--|---|------------------------------------|
| | Composition/Selection | Structural Reinforced Concrete | | |
| 1 | Standard Specification for Ready Mixed Concrete | ASTM C94 / C94M /GSO ASTM C94/C94M or Equivalent | General | |
| 2 | Concrete Temperature | ASTM C1064/C1064M | Each load | |
| 3 | Consistency | BS EN 12350-2 or Equivalent | Visually for each load and by testing whenever consistency is specified | |
| 4 | Flow Table ⁽¹⁾ | EN 12350-5 or Equivalent | Each load | |
| 5 | Slump Flow ⁽²⁾ | C1611 / C1611M or Equivalent | Each Load | |
| 6 | J-Ring | ASTM C1621/C1621M or Equivalent | As per project specifications | |
| 7 | Fresh Concrete Density & Yield | ASTM C138/C138M BS EN 12350-6 | Twice per week | |
| 8 | Air Content ⁽³⁾ | BS EN 12350-7 ASTM C138/C138M or Equivalent | Twice per week | |
| 9 | Compressive Strength (Hardened Concrete) | BS EN 12390-3 or Equivalent | 1. Critical Structures (columns, cantilevers...): One set every 50m ³ or fraction thereof | A set consists of at least 6 cubes |
| 10 | | | 2. Intermediate Structures: One set every 100 m ³ or fraction thereof | |
| 11 | | | 3. Mass Concrete (rafts...): One set every 150 m ³ for pours less than 2000 m ³ One set every 200 m ³ for pours | |

| | Title | Conforming to Standard | Periodic Inspection | Notes |
|----|--|--------------------------------|---|-------|
| | | | greater than 2000 m ³ | |
| 12 | Tensile/Flexural Strength | BS EN 12390-5 BS EN 12390-6 | At 7 & 28 days for grades where flexural strength is required | |
| 13 | Evaluation of Strength Test Results of Concrete | ACI 214, 363.2 or Equivalent | Biweekly for each grade of structural concrete: The overall variation class of operation for general construction testing shall be at least "Good". The within-test variation class of operation for field control testing shall be at least "Very Good". | |
| 14 | Visual Examination of Aggregates (by washing) | Project Specifications | As request of the Engineer | |
| 15 | Sulfate and Chloride Content | BS 1881-124 or Equivalent | Each grade Whenever the source of any ingredient changes. | |
| 16 | Resistance to Chloride Ion Penetration (RCP Test) | ASTM C1202 or Equivalent | At 28 days for each grade of structural concrete where durability testing is specified | |
| 17 | Water Absorption | BS 1881-122 or Equivalent | | |
| 18 | Water Permeability Depth of penetration of water under pressure | BS EN 12390-8 or Equivalent | | |

(1) Where flowable concrete is specified.

(2) Where Self Compacting Concrete is specified.

Notes:

- Designed concrete shall conform to the requirements specified in (BS EN 206, BS 8500-1, BS 8500-2).
- Additional testing might be conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Follow the recommendations of the following codes/standards:

- ACI 311.5: Guide for concrete plant inspection and testing of ready-mixed concrete.
- ACI 304: Guide for measuring, mixing, transporting, and placing concrete.
- ASTM C94 / C94M: Standard Specification for Ready Mixed Concrete.
- The European Guidelines for Self-Compacting Concrete.

2.6.2 Concrete Production & Site Deliveries (Ready-Mixed Concrete)

Table 11: Schedule of Standard Specification for Ready-Mixed Concrete (Concrete production & Site Deliveries).

| Title | Conforming to Standard | Periodic Inspection | Notes |
|---|---|---|------------------------------------|
| Composition/Selection | Structural Reinforced Concrete | | |
| Standard Specification for Ready Mixed Concrete | ASTM C94 / C94M /GSO ASTM C94/C94M or Equivalent | General | |
| Concrete Temperature | ASTM C1064/C1064M | Each load | |
| Consistency | BS EN 12350-2 or Equivalent | Visually for each load and by testing whenever consistency is specified | |
| Flow Table ⁽¹⁾ | EN 12350-5 or Equivalent | Each load | |
| Slump Flow ⁽²⁾ | C1611 / C1611M or Equivalent | Each Load | |
| J-Ring | ASTM C1621/C1621M or Equivalent | As per project specifications | |
| Fresh Concrete Density & Yield | ASTM C138/C138M BS EN 12350-6 | Twice per week | |
| Air Content ⁽³⁾ | BS EN 12350-7 ASTM C138/C138M or Equivalent | Twice per week | |
| Compressive Strength (Hardened Concrete) | BS EN 12390-3 or Equivalent | 1. Critical Structures (columns, cantilevers...): One set every 50m ³ or fraction thereof | A set consists of at least 6 cubes |
| | | 2. Intermediate Structures: One set every 100 m ³ or fraction thereof | |
| | | 3. Mass Concrete (rafts...): One set every 150 m ³ for pours less than 2000 m ³ | |

| Title | Conforming to Standard | Periodic Inspection | Notes |
|--|--------------------------------|---|-------|
| | | One set every 200 m ³ for pours greater than 2000 m ³ | |
| Tensile/Flexural Strength | BS EN 12390-5 BS EN 12390-6 | At 7 & 28 days for grades where flexural strength is required | |
| Evaluation of Strength Test Results of Concrete | ACI 214, 363.2 or Equivalent | Biweekly for each grade of structural concrete: The overall variation class of operation for general construction testing shall be at least "Good". The within-test variation class of operation for field control testing shall be at least "Very Good". | |
| Visual Examination of Aggregates (by washing) | Project Specifications | As request of the Engineer | |
| Sulfate and Chloride Content | BS 1881-124 or Equivalent | Each grade Whenever the source of any ingredient changes. | |
| Resistance to Chloride Ion Penetration (RCP Test) | ASTM C1202 or Equivalent | At 28 days for each grade of structural concrete where durability testing is specified | |
| Water Absorption | BS 1881-122 or Equivalent | | |
| Water Permeability Depth of penetration of water under pressure | BS EN 12390-8 or Equivalent | | |

(1) Where flowable concrete is specified.

(2) Where Self Compacting Concrete is specified.

Notes:

- A strength test is the average strength of concrete specimens sampled from the same batch or load.
- A load is the quantity of concrete transported in a vehicle comprising one or more batches from a central mixer.

- A batch is the quantity of fresh concrete produced in one cycle of operations of a mixer or the quantity discharged during one minute from a continuous mixer.
- Follow the recommendations of (ACI 305.1-06) during hot weather.
- When available, follow the requirements of Ras Al Khaimah Municipality for plants and transit agitators' inspections.
- Follow the recommendations of the following codes/standards:
 - ACI 311.5: Guide for concrete plant inspection and testing of ready-mixed concrete
 - ACI 304R: Guide for measuring, mixing, transporting, and placing concrete.
 - ASTM C94/C94M: Standard Specification for Ready Mixed Concrete.
- Each load shall be accompanied by a computer controlled non simulated printout listing all the information related to the mix. This includes the actual amounts of all added individual raw materials compared to their targets.
- Each truck mixer/agitator, when it arrives at site, shall have its water container full. If that container is not full or field test results are outside the specified limits, the load shall be rejected.
- Additional testing might have conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- It is recommended to take samples from concrete cubes rather than cylinders in order to avoid multiple correction factors and errors from capping.

Unsatisfactory failures can be caused by:

1. Insufficient attention to testing procedures:

- Sampling and making of specimen.
- Storing and transportation of specimen.
- Specimen condition (flatness, perpendicularity, straightness.)
- Specimen preparation.
- Specimen positioning in the testing machine (centering).
- Loading and loading rate.

2. A fault with the testing machine.

* For cylindrical specimens, failure of the capping before the concrete is unsatisfactory failure.

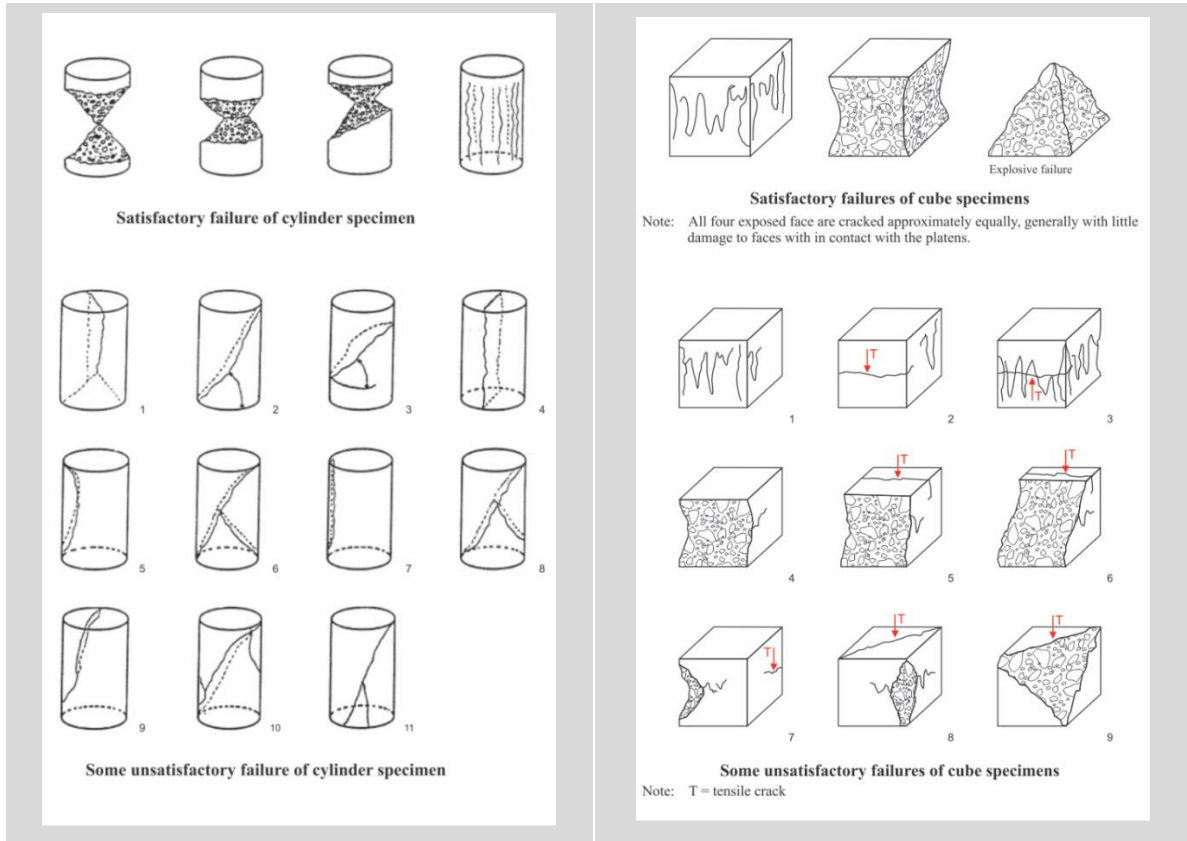


Figure 01: Shown Satisfactory/Unsatisfactory Failure.

Table 12: Schedule of Tests for Ready-Mixed Concrete. For More details, refer to (Appendix -4-).

| | Required Tests / الاختبارات المطلوبة | Conforming to Standard |
|---|---|---|
| 1 | Mix Design. تصميم الخلطة | (ACI 211, 211.1, BS EN 206 and its complementary standards BS 8500-1+ BS 8500-2, GSO ISO 15673 or Equivalent |
| 2 | Consistency (Slump) Test On Fresh Concrete. اختبار الهبوط | BS EN 12350-2 or Equivalent |
| 3 | Making Teste Cube from Fresh Concrete. عمل عينات مكعبة من الخرسانة الطازجة | BS EN 12390-2, BS EN 12390-1 or Equivalent |
| 4 | Density of Compacted Fresh Concrete. الكثافة للخرسانة الطازجة المدموكة | BS EN 12350-6, ASTM C138 / C138M or Equivalent |

| | Required Tests / الاختبارات المطلوبة | Conforming to Standard |
|----|---|--|
| 5 | Mixing and Sampling Fresh Concrete in Lab. <i>الخلط وعمل عينات من الخرسانة الطازجة بالمعمل</i> | ASTM C172 BS 1881-125 or Equivalent |
| 6 | Bleeding of Fresh Concrete. <i>اختبار النضح للخرسانة الطازجة</i> | ASTM C232 / C232M or Equivalent |
| 7 | Air Content of Fresh Concrete. <i>اختبار محتوى الهواء في الخرسانة الطازجة</i> | BS EN 12350-7, ASTM C231 / C231M or Equivalent |
| 8 | Compressive Strength of Concrete Cube. <i>مقاومة الضغط للمكعبات الخرسانية</i> | BS EN 12390-3, ASTM C39 / C39M or Equivalent |
| 9 | Water Absorption of Hardened Concrete. <i>امتصاص المياه للخرسانة المتصلدة</i> | BS 1881-122, ASTM D6489 or Equivalent |
| 10 | Initial Surface Absorption Test. <i>اختبار الامتصاص السطحي الابتدائي</i> | BS 1881-208 or Equivalent |
| 11 | Depth of Penetration of Hardened Concrete. <i>اختبار عمق الاختراق للخرسانة المتصلدة</i> | ASTM C803 / C803M or Equivalent |
| 12 | Density of Hardened Concrete. <i>الكثافة للخرسانة المتصلدة</i> | BS EN 12390-7 or Equivalent |
| 13 | Chloride Content. <i>تحديد أملاح الكلوريدات</i> | BS 1881-124 or Equivalent |
| 14 | Gross Value of Sulphate Oxide <i>الكمية الكلية لأكسيد الكبريت</i> | BS 1881-124 or Equivalent |
| 15 | pH <i>نسبة الحموضة</i> | ASTM D4262 or Equivalent |

2.6.3 Site Laboratories (Requirements for Concrete Testing Laboratories)

A. Human Resources

- The testing lab services shall be provided under the technical direction of a professional engineer with relevant experience in construction material testing, and a supervising lab technician with relevant experience in construction material testing.
- The testing field and/or lab technician shall have undergone a training program covering all the relevant tests performed by the technician.

B. Test Methods and Procedures

- The site-testing laboratory shall be capable of performing the required tests as per standard methods, guides, or practices.

- The laboratory shall use the latest version of each referenced method within one year of its publication unless the client requires an earlier version of the standard.
- Laboratory personnel shall have convenient access to applicable standards.

C. Facilities, Equipment and Supplemental Procedures

- The laboratory shall have facilities and equipment conforming to the requirements of the applicable test methods.
- All equipment and instruments shall be verified and calibrated before being placed in service and at the frequency set by the pertinent standards and local regulations.
- All balances and scales shall be calibrated annually or whenever accuracy is in doubt.

D. Preparations and Conditions

- Proper sampling of fresh concrete shall be conducted in accordance with the pertinent standards and project specifications.
- The required field tests shall be performed at the frequencies stated in the project specifications or as per the above recommendations whichever more stringent.
- The floor, where tests are performed and compressive strength specimens are stored, shall be levelled and free of any vibrations.
- Concrete test specimens shall be protected from evaporation and damage.
- Proper tagging of the specimens shall be done specifying the date, time, location, grade of concrete and name of technician molding the specimens.
- Initial curing temperatures for the concrete specimens shall be maintained between the limits set in the pertinent standards.
- De-molding of the concrete specimens shall be done within the time limitations stated in the relevant standards.
- Curing tanks shall be of sufficient size and controlled temperature. Temperature shall be verified with recording thermometers.

E. Laboratory Records and Reports

The laboratory shall maintain a system of records that permits verification of any issued report. The records shall include:

- Standard operating procedures.
- Calibration certificates of the equipment and instruments used.
- Records on laboratory personnel that document work experience, competency, and certification.
- Current standard test methods.

All testing reports shall include the information required and stated by the pertinent standards and test methods. All testing reports shall state the acceptance criteria of the test being carried out as well as a statement on whether the test results passed or failed.

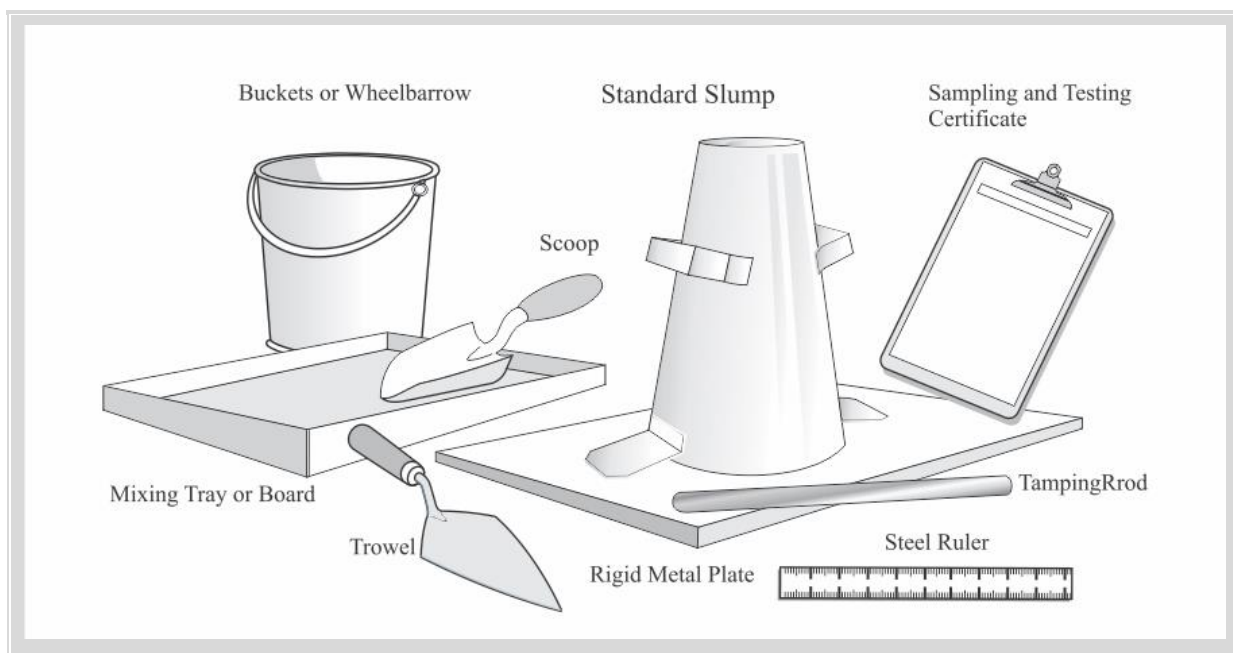


Figure 02: Shown Slump flow test equipment.

2.7 Post Tensioning

Table 13: Schedule of Standard Specification for Post Tensioning.

| | Title | Conforming to Standard |
|---|--|----------------------------------|
| 1 | Strands/Mechanical Properties | |
| | Yield Strength at 1% extension | ASTM A370/ BS 5896 or Equivalent |
| | Breaking Strength | ASTM A370/ BS 5896 or Equivalent |
| | Elongation | ASTM A370/ BS 5896 or Equivalent |
| | Relaxation | ASTM E328/ BS 5896 or Equivalent |
| 2 | Chemical Properties | |
| | Sulphur | BS 5896 or Equivalent |
| | Phosphorus | BS 5896 or Equivalent |
| 3 | Grout for Post Tension Duct | |
| | Grout for Prestressing tendons. Grouting procedures. | BS EN 446 or Equivalent |
| | Grout for Prestressing tendons. Test methods. | BS EN 445 or Equivalent |
| | Temperature, Compressive Strength, Fluidity, Bleeding, Volume Change | BS EN 445 or Equivalent |
| | Uncoated Stress-Relieved Steel Wire | ASTM A421 / A421M or Equivalent |
| | Test methods. Prestressing steel | BS EN ISO 15630-3 or Equivalent |

Notes:

- Design should be in accordance with (ACI318 as a minimum).
- Anchorage for post tensioning system shall comply with the minimum performance requirement of (BS EN 13391).
- Pre bagged non shrink material to be used for post tensioning grout.
- For grouting equipment and procedures (BS EN 446) shall be followed.
- For grout specification (BS EN 447) shall be followed.

2.8 Precast Concrete

Table 14: Schedule of Standard Specification for Precast Concrete.

| | Title | Conforming to Standard | Periodic Inspection |
|---|----------------------------------|--|--|
| 1 | Material Testing | Refer to the requirements of the Cast- in-place Concrete and Reinforcing Steel sections of this Guidelines | |
| 2 | Testing Finished Material | | |
| | Compressive Strength | BS EN 12390-3 | As directed by the Engineer (Cores from precast units) |
| | Durability Requirements | ASTM C1202 | As directed by the Engineer (Cores from precast units) |
| 3 | Joint Sealant and Fillers | | |
| | Cement Grout (Portland Cement) | BS EN 197-2 | As directed by the Engineer |
| | Natural Sand | Return to aggregates standard specifications | |
| | Non-shrink Grout | ASTM C1107 / C1107M | As directed by the Engineer |
| | Elastomeric Sealants | ACI 504 | |
| 4 | Inserts and Other Hardware | ASTM A307, ASTM F3125 / F3125M, ASTM A108, ASTM A1064 / A1064M | |
| 5 | Corrosion Protection | ASTM A276 / A276M | |

Notes:

- Additional testing might have conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Follow the recommendations of the manuals published by "(PCI) Precast/Pre-stressed Concrete Institute".

2.9 Reinforced Concrete

Table 15: Schedule of Minimum Tests for Reinforced Concrete.

| | Required Tests / الاختبارات المطلوبة | Conforming to Standard |
|----|---|---|
| 1 | Splitting Tensile Test of Cylindrical Concrete <i>(اختبار الشد الغير مباشر) اختبار الانشطار لعينة اسطوانية</i> | ASTM C496 / C496M or Equivalent |
| 2 | Compressive Strength of Concrete Cube <i>اختبار مقاومة الضغط للمكعبات</i> | BS EN 12390-2 or Equivalent |
| 3 | Compressive Strength of Concrete Core <i>اختبار مقاومة الضغط للقالب الخرساني</i> | BS EN 12504-1 or Equivalent |
| 4 | Water Absorption of Hardened Concrete <i>اختبار امتصاص المياه للخرسانة المتصلدة</i> | BS 1881-122/ ASTM D6489 or Equivalent |
| 5 | Flexural Strength of Concrete Prism <i>اختبار مقاومة الانحناء</i> | ASTM C78 / C78M, ASTM C293 / C293M or Equivalent |
| 6 | Depth of Penetration of Hardened Concrete <i>اختبار عمق الاختراق للخرسانة المتصلدة</i> | ASTM C803 / C803M or Equivalent |
| 7 | Sulphate content Ratio <i>اختبار تحديد نسبة الكبريتات</i> | BS 1881-124 or Equivalent |
| 8 | Chloride Content Ratio <i>اختبار تحديد نسبة الكلوريدات</i> | BS 1881-124 or Equivalent |
| 9 | Water Permeability Test <i>اختبار النفاذية الماء</i> | BS EN 12390-8 or Equivalent |
| 10 | Chloride Permeability Test <i>اختبار نفاذية الكلور</i> | ASTM C1202 or Equivalent |
| 11 | Cement Content Ratio <i>اختبار تعيين المحتوي الاسمنتي</i> | ASTM C1084 BS 1881-124 BS EN 206 or Equivalent |

2.10 Glass Reinforced Concrete (GRC) Elements

Table 16: Schedule of Standard Specification for GRC Elements.

| | Title | Conforming to Standard |
|---|--|------------------------|
| 1 | Composition of GRC Elements | |
| | Glass Content | Project Specifications |
| | Wet Bulk Density | |
| 2 | Testing Finished Material | |
| | Modulus of Rupture | Project Specifications |
| | Limit of Proportionality using J Lloyd T 5000/SS | |

Notes:

- Additional testing might have conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall comply with the following requirements:
 - PCI MNL 117 - Manual for Quality Control for Plants and Production of Architectural Precast Construction Products.
 - PCI MNL 128 - Recommended Practice for Glass Fiber Reinforced Concrete Panels.
 - PCI MNL 130 - Manual for Quality Control of Plants and Production of Glass Fiber Reinforced Concrete Products.

2.11 Bored In-Situ Piles and Drilled Shafts

Table 17: Schedule of Standard Specification for Bored In-Situ Piles and Drilled Shafts.

| | Title | Conforming to Standard |
|---|---|------------------------------------|
| | Composition/Selection | |
| 1 | Reinforcing Steel | BS EN 10080 GSO 1808 or Equivalent |
| 2 | Concrete | Concrete Specifications |
| 3 | Static Axial Compressive Load / Ultimate | ASTM D1143 / D1143M |
| 4 | High-Strain Dynamic | ASTM D4945 or Equivalent |
| 5 | Low Strain Impact Integrity | ASTM D5882 or Equivalent |
| 6 | Ultrasonic Cross Hole Testing | ASTM D6760 or Equivalent |
| 7 | Conducting Borehole Geophysical Logging: Mechanical Caliper | ASTM D6167 or Equivalent |

Notes:

- Additional testing might have conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- For Diaphragm Wall the following instruments shall be fixed for monitoring purpose: Inclinometer, Steel Strain gauges, concrete stress gauges, and pressure cells.

2.12 Blocks

2.12.1 Concrete Blocks

Table 18: Schedule of Standard Specification for Blocks.

| | Title | Conforming to Standard | Periodic Inspection |
|---|--------------------------------------|--|--|
| 1 | Masonry Blocks | | |
| | Dimensions | BS EN 772-16 or Equivalent | - One test per machine per production shift. - Every 25,000 blocks |
| | Compressive Strength | BS EN 772-1 or Equivalent | |
| | Density | BS EN 772-13 or Equivalent | |
| | Chloride and Sulfate Content | BS 1881-124 or Equivalent | |
| 2 | Paving Blocks | | |
| | Dimensions and Compressive Strength | BS EN 1338/DMS 1: Part 4 or Equivalent | - One test per machine per production shift. -10 Pieces every 2500 m ² |
| | Density | ASTM C140 / C140M or Equivalent | |
| | Chloride and Sulfate Content | BS 1881-124 or Equivalent | |
| | Water Absorption | BS EN 1338/ASTM C140 / C140M or Equivalent | |
| | Concrete paving flags. | BS EN 1339/ASTM C140 / C140M or Equivalent | |
| 3 | Filler Blocks (Normal Weight) | | |
| | Dimensions | BS EN 772-16 or Equivalent | - One test per machine per production shift. -Every 25,000 blocks |
| | Compressive Strength | BS EN 772-1 or Equivalent | |
| | Density | BS EN 772-13 or Equivalent | |
| | Chloride and Sulfate Content | BS 1881-124 or Equivalent | |
| 4 | Filler Blocks (Light Weight) | | |
| | Dimensions | BS EN 772-16 or Equivalent | - One test per machine per production shift. -Every 25,000 blocks |
| | Compressive Strength | BS EN 772-1 or Equivalent | |
| | Density | BS EN 772-13 or Equivalent | |
| | Chloride and Sulphate Content | BS 1881-124 or Equivalent | |

Notes:

- Additional testing might have conducted at the request of the Engineer and/or RAK Municipality.

- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall conform to Ras Al Khaimah Municipality and International Standards.

2.12.2 Autoclaved Aerated Concrete Blocks (AAC Blocks)

Table 19: Schedule of Standard Specification for Autoclaved Aerated Concrete Blocks.

| | Title | Conforming to Standard | Periodic Inspection |
|---|------------------------------|---|--|
| | Composition/Selection | | |
| | AAC Blocks | BS EN 771- 4or Equivalent | |
| 1 | Dimensions | BS EN 772-16 or Equivalent | - One test per machine per production shift. -Every 20,000 blocks |
| 2 | Compressive Strength | BS EN 772-1 or Equivalent | |
| 3 | Thermal Conductivity* | ASTM C518/ BS EN ISO 10456 | |
| 4 | Dry Density | BS EN 772-13 or Equivalent | |
| 5 | Chloride and Sulfate Content | BS 1881-124 or Equivalent | |
| 6 | Drying Shrinkage | BS EN 680 or Equivalent | |
| 7 | Fire Rating | BS EN 1364-1/ASTM E119/ BS EN 13501-1/ BS 476 or Equivalent | Fire rating has to be done as per civil defense requirements |
| 8 | Mortar | Project Specifications | |

Notes:

- Additional testing might have conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall conform to Ras Al Khaimah Municipality and International Standards.
- *The required Thermal Conductivity value for all types of block/brick must achieve thermal transmittance according to the requirements of Ras Al Khaimah Green Buildings Regulations (Barjeel).

2.12.3 Normal Weight Concrete Polystyrene Sandwich Blocks

Table 20: Schedule of Standard Specification for Normal Weight Concrete Polystyrene Sandwich Blocks.

| | Title | Conforming to Standard | Periodic Inspection |
|----|---------------------------------------|--|--|
| 1 | Composition/Selection | | |
| 2 | Dimensions | BS EN 772-16 or Equivalent | - One test per machine per production shift. -Every 20,000 blocks |
| 3 | Compressive Strength | BS EN 772-1 or Equivalent | |
| 4 | Thermal Conductivity* | BS EN 12667 or ASTM C518 or Equivalent | |
| 5 | Chloride and Sulfate Content | BS 1881-124 or Equivalent | |
| 6 | Apparent Density | BS EN 1602 or Equivalent | |
| 7 | Polystyrene Dimensions and Density | ASTM C578 / ASTM C303 or Equivalent | |
| 8 | Polystyrene Core Thermal Conductivity | BS EN 13163 / ASTM C578 / ASTM C1696 or Equivalent | |
| 9 | Fire Rating (Polystyrene) | Fire rating has to be done as per civil defense requirements | |
| 10 | Mortar | Project Specifications | |

Notes:

- Additional testing might be conducted at the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall conform to Ras Al Khaimah Municipality and International Standards.
- * The required Thermal Conductivity value for all types of block/brick must be achieve thermal transmittance according to the requirements of Ras Al Khaimah Green Buildings Regulations (Barjeel).

2.12.4 Light Weight Masonry Units

Table 21: Schedule of Standard Specification for Light Weight Masonry Units.

| | Title | Conforming to Standard | Periodic Inspection |
|------------------------------|------------------------------|---|--|
| Composition/Selection | | | |
| 1 | Dimensions | BS EN 772-16 or Equivalent | - One test per machine per production shift. -Every 20,000 blocks |
| 2 | Compressive Strength | BS EN 772-1 or ASTM C140 / C140M or Equivalent | |
| 3 | Thermal Conductivity* | BS EN 12667 or ASTM C518 or Equivalent | |
| 4 | Gross Density | BS EN 772-13 or Equivalent | |
| 5 | Chloride and Sulfate Content | BS 1881-124 or Equivalent | |
| 6 | Drying Shrinkage | BS EN 680 or Equivalent | |
| 7 | Fire Rating | BS EN 1364-1/ASTM E119/ BS EN 13501-1/ BS 476 or Equivalent | Fire rating has to be done as per civil defense requirements |
| 8 | Mortar | Project Specifications | |

Notes:

- Any Additional testing might have conducted as per the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall conform to Ras Al Khaimah Municipality and International Standards.
- *The required Thermal Conductivity value for all types of block/brick must be achieve thermal transmittance according to the requirements of Ras Al Khaimah Green Buildings Regulations (Barjeel).

2.12.5 Clay Masonry Blocks with Polystyrene Insert

Table 22: Schedule of Standard Specification for Clay Masonry Blocks with Polystyrene Insert.

| | Title | Conforming to Standard | Periodic Inspection |
|---|-------------------------------------|-------------------------------|---------------------|
| 1 | Composition/Selection | | |
| 2 | Dimensions and Compressive Strength | ASTM C67 / C67M or Equivalent | |

| | | | |
|----|--|--|---|
| 3 | *Thermal Conductivity of Block | BS EN 12667 or ASTM C518 or Equivalent | -One test per machine per production shift. -Every 20,000 blocks |
| 4 | Thermal Conductivity of Thermal Insulation | BS EN 12667 or ASTM C518 or Equivalent | |
| 5 | Density of Thermal Insulation | ASTM C302 or Equivalent | |
| 6 | Water Absorption | BS EN 772-21 or Equivalent | |
| 7 | Apparent Density | ASTM C67 / C67M/ BS 6073-2 or Equivalent | |
| 8 | Block Efflorescence | ASTM C1400 or Equivalent | |
| 9 | Fire Rating (Polystyrene) | Fire rating has to be done as per civil defense requirements | |
| 10 | Mortar | Project Specifications | |

Notes:

- Any Additional testing might have conducted as per the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall conform to Ras Al Khaimah Municipality and International Standards.
- * The required Thermal Conductivity value for all types of block/brick must be achieve thermal transmittance according to the requirements of Ras Al Khaimah Green Buildings Regulations (Barjeel).

Table 23: Schedule of Minimum Tests for Blocks. For More details, refer to (Appendix -4-).

| | | Required Tests | Reference | الاختبارات المطلوبة | |
|---|-----------------------------------|---|-------------------------|------------------------------|---------------------------------|
| 1 | ACC Block & Clay Block | Water Absorption | Refer to Blocks Testing | امتصاص الماء | الطابوق الخفيف والطابوق الطيني |
| 2 | | Dimension of Autoclaved Aerated Concrete | | الأبعاد | |
| 3 | | Drying Shrinkage of Autoclaved Aerated Concrete | | الانكماش الجاف | |
| 4 | | Gross Dry Density of Masonry Unit | | الكثافة الجافة الكلية للوحدة | |
| 5 | | Compressive Strength Of Masonry Units | | مقاومة الضغط | |
| 6 | Masonry & Thermo Block | Compressive Strength of Solid Masonry Blocks | Refer to Blocks Testing | مقاومة الضغط للطابوق المصمت | الطابوق العازل للحرارة والعمادي |
| 7 | | Compressive Strength of Hollow Masonry Blocks | | مقاومة الضغط للطابوق المفرغ | |
| 8 | | Compressive Strength of Filler Blocks | | مقاومة الضغط للطابوق المائل | |

| | | | | | |
|----|-----------------|------------------------------------|-------------------------|----------------------|-------------------------|
| 9 | Concrete Blocks | Dimension of Solid Masonry Blocks | Refer to Blocks Testing | أبعاد الطابوق المصمت | الطابوق الخرساني |
| 10 | | Dimension of Hollow Masonry Blocks | | أبعاد الطابوق المفرغ | |
| 11 | | Dimension of Filler Blocks | | أبعاد الطابوق المالى | |
| 12 | | Block Density Filler | | كثافة الطابوق | |
| 13 | Concrete Blocks | Compressive Strength | Refer to Blocks Testing | مقاومة الضغط | الطابوق الخرساني |
| 14 | | Chloride Content | | نسبة الكلوريدات | |
| 15 | | Sulfate Content | | نسبة الكبريتات | |
| 16 | | Water Absorption | | امتصاص المياه | |
| 17 | Paving | Bearing force | Refer to Blocks Testing | قوة التحمل | طوب الأرصفة والانتربولك |
| 18 | | Chloride Content Ratio | | نسبة الكلوريدات | |
| 19 | | Sulphate Content Ratio | | نسبة الكبريتات | |
| 20 | | Water Absorption | | امتصاص الماء | |

- * Any Additional testing might have conducted as per the request of the Engineer and/or RAK Municipality.

2.13 Plastering

Table 24: Schedule of Standard Specification for Plaster.

| | Title | Conforming to Standard |
|-----------------------|------------------------------|---|
| Cement Plaster | | |
| 1 | Portland Cement | BS EN 197-1, BS EN 413-1 or Equivalent |
| 2 | Lime | BS EN 459-1 or Equivalent |
| 3 | Sand | ASTM C144 or Equivalent |
| 4 | Aggregates | BS EN 12620 or Equivalent |
| 5 | Water | BS EN 1008 or Equivalent |
| 6 | Ready Mix Rendering Material | BS EN 998-1, BS EN 998-2 or Equivalent |
| 7 | Bagged Rendering Material | BS EN 13914-1 or Equivalent |
| 8 | Plaster Accessories | BS EN 13914-1 or Equivalent |
| 9 | Pull-Off Test | BS 1881-207 or Equivalent |

Notes:

- Any Additional testing might have conducted as per the request of the Engineer and/or RAK Municipality.
- Contract Specifications shall be implemented if more or other tests are required.
- Works and Material shall conform to the following codes: Code of practice for External Rendered Finishes ([BS EN 13914-1](#)) Code of practice for Internal Plastering ([BS 8481](#)).
- Code of practice for Plastering and Rendering ([BS 8000-10](#)).

2.14 Bituminous Materials Testing

Testing is an important process in determining whether the bitumen materials meet adequate performance levels.

Table 25: Schedule of Tests for Bituminous Materials.

| | Title | Conforming to Standard |
|----|---|---|
| 1 | Core log / photo | Regulatory standard ASTM D4 - 86 |
| 2 | Test Determination of bulk density - Procedure A: Dry | Regulatory standard BS EN 12697-6 |
| 3 | Test Determination of bulk density - Procedure B: SSD | Regulatory standard BS EN 12697-6 |
| 4 | Test Determination of bulk density Procedure C: Sealed specimen | Regulatory standard BS EN 12697-6 |
| 5 | Test Laboratory compaction by vibratory compactor | Regulatory standard BS EN 12697-32 |
| 6 | Test Maximum density - Volumetric | Regulatory standard BS EN 12697-5 |
| 7 | Test Percentage refusal density | Regulatory standard BS EN BS EN 12697-9 / BS EN 12697-32 |
| 8 | Test Soluble binder content and PSD - bottle and filter | Regulatory standard BS EN 12697-1 |
| 9 | Test Soluble binder content | Regulatory standard BS 598-102 |
| 10 | Test Washing and drying sieving | Regulatory standard BS EN 933-1 / BS EN 12697-2 or Equivalent |
| 11 | Core log / photo | Regulatory standard BS EN 12697-36 |
| 12 | Test Determination of bulk density - Procedure A: Dry | Regulatory standard BS EN 12697-6 |

Table 26: Schedule of Minimum Tests for Bituminous Materials. For More details, refer to: (Appendix -4-).

| | Required Tests | Conforming to Standard | الاختبارات المطلوبة |
|---|--------------------------------------|---|-------------------------|
| 1 | MC30 / MC70 /SS1h | (BS 598) or Equivalent | ----- |
| 2 | Cold Bitumen Emulsion | | مستحلب البيتومين البارد |
| 3 | Color AC PEN: 40/50 - 60/70 - 85/100 | | اللون |
| 4 | Duration of drying | | مدة التجفيف |
| 5 | Density | (BS EN 12697-6 & BS EN 12697 -5) & (BS 598-104) or Equivalent | الكثافة |
| 6 | Solids content | (BS 598) & (ASTM C836 / C836M) or Equivalent | نسبة المواد الصلبة |

Table 27: Schedule of Minimum Tests for Waterproofing membrane. For More details, refer to (Appendix -4-).

| | Minimum Required Tests | Conforming to Standard | الاختبارات المطلوبة |
|----|---|-----------------------------|---------------------------|
| 1 | Water Vapor Transmission | ASTM E96 / E96M | نقل بخار الماء |
| 2 | Tensile Properties of Water Proofing | ASTM D3105 | خصائص الشد للعازل |
| 3 | Tensile Properties of Flexible Sheet | BS EN 12311-2 or Equivalent | خصائص الشد للألواح المرنة |
| 4 | Coefficient of Friction (L-direction) | ASTM D1894 | معامل الاحتكاك تجاه L |
| 5 | Coefficient of Friction (T-direction) | ASTM D1894 | معامل الاحتكاك تجاه T |
| 6 | Thickness | BS EN 1849-2 | السماكة |
| 7 | Water absorption | ASTM D570 | امتصاص الماء |
| 8 | strength test | ASTM D412 | اختبار التقوية |
| 9 | Tension /Elongation test (L-direction). | | الشد والاستطالة تجاه (L) |
| 10 | Tension /Elongation test (T-direction). | | الشد والاستطالة تجاه (T) |

2.15 Painting

Table 28: Schedule of Standard Specification for Painting.

| | Title | Conforming to Standard |
|---|---|---------------------------|
| 1 | Specific Density <i>الكثافة النوعية</i> | ASTM D1475 or Equivalent |
| 2 | Solid Content | ASTM D 2139 or Equivalent |
| 3 | Drying Time | ASTM D 1650 or Equivalent |
| 4 | Adhesion Strength | ASTM D4541 or Equivalent |
| 5 | Abrasive Strength | ASTM D4060 or Equivalent |
| 6 | Impact | ASTM D2794 or Equivalent |
| 7 | Hardness | ASTM D2240 or Equivalent |
| 8 | Void Content | ASTM D2734 or Equivalent |
| 9 | Salt Spray Resistance | ASTM B117 or Equivalent |

Table 29: Schedule of Minimum Tests for Painting. For More details, refer to (Appendix -4-).

| | Minimum Required Tests الاختبارات المطلوبة | Conforming to Standard |
|---|--|------------------------------------|
| 1 | Evaluating Degree | ASTM D660 or Equivalent |
| 2 | Solar Reflectance Index -SRI- مؤشر الانعكاس الشمسي | ASTM E1980 or Equivalent |
| 3 | Adhesion Strength | ASTM D454/ASTM D2197 or Equivalent |
| 4 | Volatile Organic Compound -VOC- المواد المتطايرة (الثقيلة) | (ASTM D3960 or Equivalent |
| 5 | Water Resistance مقاومة المياه | ASTM D870 or Equivalent |
| 6 | Water Resistance in 100 % Relative Humidity | ASTM D2247 or Equivalent |
| 7 | Corrosion Resistance مقاومة التآكل | ASTM D2803 or Equivalent |
| 8 | Evolved Formaldehyde عدم احتواءه على الفورمالدهيد | ASTM D6191 or Equivalent |
| 9 | The Weight Percent Individual Volatile Organic Compounds وزن المركبات العضوية | ASTM D6886 or Equivalent |

- For SRI & VOC tests requirements, painting shall comply with RAK Municipality Green Building Regulations (Barjeel)

2.16 Earthwork

Table 30: Schedule of Standard Specification for Earthwork.

| | Title | Conforming to Standard | Periodic Inspection |
|---|--|----------------------------------|---|
| 1 | Particle Size Analysis & Determination of Soil (Dry & Wet) | BS EN ISO 17892-12 or Equivalent | All tests shall be carried out at a minimum rate of 3 tests for 1000m ³ for every different soil resource. |
| 2 | Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils | BS EN ISO 17892-12 or Equivalent | |
| 3 | Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate. | ASTM D4318 or Equivalent | |

| | Title | Conforming to Standard | Periodic Inspection |
|----|--|--|--|
| 4 | Soil Classification (for road embankment construction) | ASTM D 2487 or AASHTO M 145 or Equivalent | One sample for classification representing not more than 3,000 m ³ of the material in use and if the soil source will be changed |
| 5 | Chlorides & Sulfates in Soil | BS 1377-3 or Equivalent | |
| 6 | In-Situ Density of Soil - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method. | BS EN 1377 or Equivalent ASTM D1556 / D1556M | Make at selected locations at least one field density test for every 500 m ² / layer, but in no case less than three (3) tests per day operation. |
| 7 | a. Trenches | | |
| 8 | b. Walkways | | |
| 9 | c. Pavement Layer (Subgrade, Subbase and Base) | | |
| 9 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³)) | BS 1377-4 or ASTM D1557 or AASHTO T 180 (Method D) or Equivalent | All required tests shall be carried out for every 400 m ³ of material. |
| 10 | Bearing Ratio Test | BS EN 1377 / AASHTO T 193 or Equivalent | |

Notes:

- Additional testing may be conducted at the request of the Engineer and/or Authority.
- In case the Contractor finds it necessary to provide the design with the requirements of the administrative controlling Authorities, and if the Authorities' Specifications and regulations are more stringent than the provisions stipulated in this guidelines, the Authorities' Specifications shall prevail.

2.17 Soil Test

Table 31: Schedule of Minimum Tests for Soil. For More details, refer to (Appendix -4-).

| | Minimum Required Tests | الاختبارات المطلوبة | Conforming to Standard |
|---|------------------------|-----------------------|--------------------------------------|
| 1 | Bearing Capacity | تعيين قوة تحمل التربة | BS EN ISO 22476-2, BS EN ISO 22476-3 |

| | Minimum Required Tests الاختبارات المطلوبة | Conforming to Standard |
|----|--|---|
| | | BS EN ISO 22476-1, BS EN 1997-2 or Equivalent |
| 2 | Density of Soil at Site تعيين كثافة التربة بالموقع Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method | BS EN ISO 22476-2, BS EN ISO 22476-3 BS EN ISO 22476-1, BS EN 1997-2 or Equivalent |
| 3 | Compaction Test اختبارات الدمك | ASTM D698, ASTM D7380, BS 1377-4 or Equivalent |
| 4 | Organic matter content of soil تعيين المواد العضوية بالتربة | ASTM D1557 or Equivalent |
| 5 | Total Sulfate of Soil كمية الكبريتات الكلية بالتربة | BS 1377-3 or Equivalent |
| 6 | Acid Soluble Sulphate of Soil أحماض الكبريتات الذائبة في التربة | |
| 7 | Water Soluble Sulphate of Soil الكبريتات الذائبة في المياه في التربة | |
| 8 | Carbon Content of Soil محتوي الكربون بالتربة | |
| 9 | Water Soluble Chloride of Soil الكبريتات الذائبة في الماء بالتربة | |
| 10 | pH of Soil حامضية التربة | |

2.18 (Filling + Road base) Test

Table 32: Schedule of Minimum Tests for Filling + Road base. For More details, refer to (Appendix -4-).

| | Minimum Required Tests الاختبارات المطلوبة | Conforming to Standard |
|---|---|---|
| 1 | Wet & dray Sieve Analysis التحليل بالمناخل (الرطب والجاف) | ASTM C92 or Equivalent |
| 2 | Liquidity Limit حد السيولة Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils | BS EN ISO 17892-12 / ASTM D4318 or Equivalent |
| 3 | Maximum Dray Density & Optimum moisture content إيجاد الكثافة الجافة القصوى ونسبة الرطوبة المثلى | BS 1377-4 or Equivalent ASTM D1557 or |

| | | |
|---|--|---|
| | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³)) | AASHTO T 180 (Method D) AASHTO T 193 |
| 4 | CBR (California Bearing Ratio)- submerged in water <i>تجربة الـ CBR المغمورة في الماء</i> | |
| 5 | Heaving ratio after 96 hours <i>إضافة قياس نسبة الانتفاش بعد 96 ساعة</i> | BS 1377-4 or Equivalent |
| 6 | Organic Impurities <i>الشوائب العضوية</i> | ASTM D2974 or Equivalent |
| 7 | Chloride Content ratio <i>تحديد نسبة أملاح الكلوريدات</i> | BS 1377-3 or Equivalent |
| 8 | Gross amount of soluble sulfur oxide <i>الكمية الكلية لأكسيد الكبريت الذائب</i> | |

2.19 Glazing Elements (Glass)

Table 33: Schedule of Minimum Tests for Glazing Elements (Glass). For More details, refer to (Appendix -4-).

| | Minimum Required Tests <i>الاختبارات المطلوبة</i> | Conforming to Standard |
|---|---|---------------------------------------|
| 1 | Thermal Transmittance (U-Value) | EN 673, ASHRAE or equivalent |
| 2 | Shading Coefficient (SC) | EN 410 Clause 4.4 or equivalent |
| 3 | Light Transmittance (LT) | EN 410 Clause 4.2 & 4.3 or equivalent |
| 4 | Solar Heat Gain Coefficient (SHGC) | NFRC 201 or equivalent |
| 5 | Blast Resistance by Shock tube (Strength Measurement Class) | EN 13123-1 or equivalent |
| 6 | Impact Test | BS EN 12600 or equivalent |

- Additional testing may be conducted at the request of the Engineer and/or Authority.
- For U-Value, LT, SC or SHGC test requirements, glazed glass shall comply with RAK Municipality Green Building Regulations (Barjeel).

2.20 Solar Water Heating Collectors

Table 34: Schedule of Minimum Tests for Solar Water Heating Collectors. For More details, refer to (Appendix -4-).

| | Minimum Required Tests الاختبارات المطلوبة | Conforming to Standard |
|---|---|------------------------|
| 1 | Internal pressure for absorber | ISO 9806 or equivalent |
| 2 | High temperature resistance | ISO 9806 or equivalent |
| 3 | Exposure | ISO 9806 or equivalent |
| 4 | External / Internal thermal shock | ISO 9806 or equivalent |
| 5 | Rain penetration (for glazed collectors only) | ISO 9806 or equivalent |
| 6 | Mechanical load | ISO 9806 or equivalent |
| 7 | Thermal performance | ISO 9806 or equivalent |
| 8 | Stagnation temperature | ISO 9806 or equivalent |

- Additional testing may be conducted at the request of the Engineer and/or Authority.
- Recommendations and guidelines reflected in RAK Municipality Green Building Regulations (Barjeel) shall be taken into consideration.
- Manufacturers shall have a Certificate of Conformity from Solar Key Mark or any other accredited certification body.
- Whenever used, the solar collectors' labeling shall be as specified in BS EN 12975-1.
- The manufacturer of Solar Collectors for solar heating system shall provide an installer instruction manual in ARABIC/ENGLISH language as required in BS EN 12975-1 whenever supplied in RAK.

Chapter 3: Appendices

3. Appendix -1-

(Recommended Practices Before and During Concreting)

This appendix provides a guidance and recommendations for some Concreting practices.

3.1 Formwork

- All forms should be perfectly cleaned.

- Non-reactive mold release agent applied correctly.
- Correct position.
- Line and level.
- Accuracy within tolerances.
- Verticality (plumb).
- Correct angles for batters.
- Finishing heights (mark off).
- Joints flush and tight.
- Joints sealed as required.
- No nails protruding into the concrete.
- Bracing.

3.2 Concrete Consolidation

- Make sure you can see the concrete surface.
- When inserting the poker, its head should be put in quickly and allowed to penetrate to the bottom of the layer as quickly as possible under its own weight. If done slowly, the top layer might have compacted first, making it more difficult for the entrapped air in the lower part of the layer to escape to the surface.
- The head should be inserted vertically. This minimizes the voids created by inserting the head and allows air bubbles to rise up unimpeded by a sloping vibrator.
- The poker should be left in the concrete for about 10 seconds and withdrawn slowly.
- The poker should not touch the form face.
- The poker should extend 100mm into any previous layer.
- The maximum depth of the new layer equals the vibrator head length minus 100mm. If the depth of concrete is greater, then the new part will not be fully compacted.
- It should be noted that where finish is important, extra vibration can reduce the number of blowholes.

3.3 Concreting

- Experienced professional in the construction of formwork should always be present at site when the concrete is being placed.
- Grout/paste loss is an indication that joints were not tight, or some movements have occurred during placing.
- In walls and columns, no layer should be more than about 450mm thick. With layers thicker than 450mm, the weight of concrete on top makes it impossible even with vibration to get the air out from the bottom of the layer.

- Make sure that each layer of concrete has been fully compacted before placing the next one.
- Fully compacted concrete will be dense, strong, durable, and impermeable. Badly compacted concrete might be weak, non-durable, honeycombed, and porous. The air must be removed.
- For maximum compaction, preference should be given to the use of self-compacting concrete (Refer to Section 3.6).

3.4 Hot Weather Concreting

The American Concrete Institute "Hot Weather Concreting", "ACI 305", defines hot weather as any combination of high ambient temperature, high concrete temperature, low relative humidity, high wind speed, and excessive solar radiation that can impair the quality of fresh or hardened concrete. These factors individually or combined, can accelerate moisture loss and cement dehydration.

Concrete mixed and placed during hot weather is subject to conditions that can adversely affect the properties and serviceability of the hardened concrete. Some of these conditions are:

- Increased water demand.
- Increased rate of slump loss.
- Increased rate of setting.
- Increased tendency of plastic shrinkage cracking and drying shrinkage cracking.
- Low ultimate strength.
- Decreased durability.
- Increased permeability.
- Increased potential for reinforcing steel corrosion.

Successful hot weather concreting requires careful planning and close coordination among all members of the construction team. Best results might have achieved if the following important procedures are followed.

A. Production at Batching Plants

- Shading the aggregates.
- Cooling the mixing water before use.
- Using crushed Ice.
- Painting plants and transit agitators with light colors.
- Approved water cementitious material ratio should be respected.

- Set retarding admixtures can be added to slow setting of concrete and reduce water demand.
- Use of Supplementary Cementitious Materials (SCM's) such as Fly Ash and GGBS for the control of initial setting time.

B. Transport

- Steady flow of concrete.
- Drum rotation should be at the lowest agitating speed.
- Major placement of concrete should be scheduled during evening or night times and periods of lower traffic.
- The dispatching of transit agitators should be coordinated with the rate of placement to avoid delays in arrival or long waiting periods.
- Traffic arrangement at site should ensure easy access of transit agitators to the unloading points.
- Site traffic should be coordinated for a quick turnaround of concrete transit agitator.

C. Placement of Concrete

- Have adequate manpower and equipment (plus stand-by units) available to handle the concrete at the desired rate of placement and to unload the concrete trucks promptly.
- Water should be available in sufficient quantities. The temperature of water used for curing must be as close as possible to that of the concrete to avoid thermal shock (not more than 11 ° C than that of concrete).
- Erect temporarily windbreaks and shades to protect fresh concrete from hot sun and drying winds.
- Arrangement should be made for the ready availability of backup equipment for placing, vibrating and material for curing.
- Dampen the sub grade, forms and reinforcing steel the night before, do this again thoroughly before placing concrete.
- Cover concrete as soon as it is placed, until final finishing can be started.
- Water curing should start immediately after finishing and it should be continuous as per specified period of curing.
- Temperature of concrete should be as per specified limit.
- For mass concrete a method statement should be given addressing the logistical and technical issues (Refer to section 3.5).

D. Testing

- An approved trained technician should perform all tests.
- Leaving the samples of fresh concrete exposed to sun, wind or dry air is not acceptable.
- Samples of fresh concrete shall be provided with an impervious cover, cured, and stored in a shaded environment (temperature of shaded environment

should be as per relevant standards). Record temperature using maximum minimum thermometer.

- Prevent moisture loss of samples during transportation by wrapping them in plastic wet burlap. Be sure to avoid excessive rough handling during transportation to the laboratory.

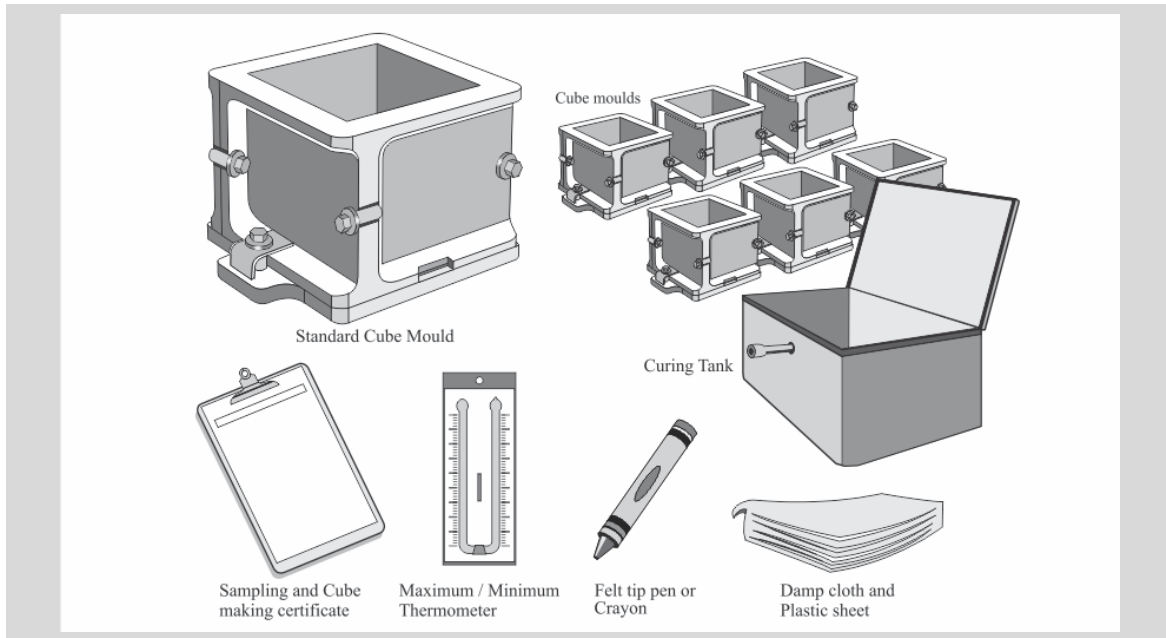


Figure 03: Shown Cube Test Apparatus.

3.5 Mass Concrete

A. Definition

According to the American Concrete Institute, mass concrete is defined as “any volume of concrete with dimensions large enough to require that measures be taken to cope with generation of heat from hydration of the cement and attendant volume change to minimize cracking”. Concrete Society Digest No. 2 defines mass concrete as “a pour of sufficient size to demand special attention to be given to logistical and technical considerations such as: concrete supply; casting sequence; cold joints; plastic settlement; and heat of hydration”. While the definition is somewhat vague, it is intentionally vague because the concrete mix design, the dimensions, the type of the placement, and the curing methods all affect whether or not cracking will occur.

References:

- ACI 207.1, “Mass Concrete”, American Concrete Institute.
- Concrete Society Digest No. 2, “Mass Concrete”, Concrete Society.

- PCA, "Design and Control of Concrete Mixtures", Portland Cement Association.
- CIRIA Report 135, "Concreting Deep Lifts and Large Volume Pours", Construction Industry Research and Information Association.
- BS 8110-2, "Structural Use of Concrete – Code of Practice for Special Circumstances"
- Professional Development Series, "Engineering Mass Concrete Structures".

B. Temperature Control

All concrete generates heat as it cures. The heat is caused by the hydration of the cementitious materials. The majority of the heat generation occurs in the first few days after placement. For thin items such as pavements, heat dissipates almost as quickly as it is generated. For thicker concrete sections (mass concrete), heat dissipates more slowly than it is generated.

Management of these temperatures is necessary to prevent damage, minimize delays and meet project specifications.

Maximum allowable concrete temperatures and temperature differences are often specified to ensure that proper planning occurs prior to concrete placement.

Other reasons include reducing cooling time and associated delays and minimizing the potential for cracking due to thermal expansion and contraction.

A maximum allowable concrete temperature difference should be specified always to minimize the potential for thermal cracking. This temperature difference is the difference between the temperature at the hottest portion of the concrete and that at the surface. Thermal cracking will occur when contraction due to cooling at the surface causes tensile stresses that exceed the tensile strength of the concrete.

C. Predicting Concrete Temperatures

Specifications for mass concrete often require particular cement types, minimum cement contents, and maximum supplementary cementitious material contents. Once this information is available, the process of predicting maximum concrete temperatures and temperature differences can begin.

Several options are available to predict maximum concrete temperatures.

D. Methods of Temperature Control

Methods of controlling mass concrete temperatures range from relatively simple to complex and from inexpensive to costly. Depending on a particular situation, it may be advantageous to use one or more methods over another. Thermal controls used

currently include optimal concrete mix design, insulation, concrete cooling before placement, concrete cooling after placement, and the use of smaller placements.

3.6 Self-Compacting Concrete

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. When hardened it is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete.

Self-compacting concrete offers a rapid rate of concrete placement, with faster construction times and ease of flow around congested reinforcement. The fluidity and segregation resistance of (SCC) ensures a high level of homogeneity, minimal concrete voids, and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier demolding and faster use of elements and structures.

The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction.

A. Relevant standards:

The specification, performance and conformity requirements for structural concrete are given in "BS EN 206". However, in the case of SCC some properties in the fresh state exceed the limits and classes provided in this standard. None of the test methods in the current "BS EN 12350" series 'Testing fresh concrete' are suitable for assessment of the key properties of fresh SCC. Appropriate test methods for SCC are given in Annex B of The European Guidelines for Self-Compacting Concrete and it is envisaged that the "BS EN 12350" series might extended to cover these test methods.

B. Properties of Self Compacting Concrete:

The filling ability and stability of (SCC) self-compacting concrete in the fresh state can be defined by four key characteristics. Each characteristic can be addressed by one or more test methods:

Table 35: Schedule of Test methods for assessing the workability properties of SCC.

| | Characteristic | Preferred test method(s) |
|---|--------------------------------------|---------------------------------------|
| 1 | Flowability | Slump-flow test |
| 2 | Viscosity (assessed by rate of flow) | T500 Slump-flow test or V-funnel test |
| 3 | Passing ability | L-box test |
| 4 | Segregation | J Ring |

A brief description of the above tests is given below.

Slump – flow and T500 Test:

The slump-flow and T500 time is a test to assess the flow ability and the flow rate of self-compacting concrete in the absence of obstructions.

It is based on the slump test described in "BS EN 12350-2". The result is an indication of the filling ability of self- compacting concrete. The T500 time is also a measure of the speed of flow and hence the viscosity of the self-compacting concrete.

Table 36: Schedule of Slump Test method.

| Test Method | Test Procedure | Class | Specification Limit |
|-------------|--|-------|---------------------|
| Slump Flow | European Guidelines for Self-Compacting Concrete | SF1 | 550-650 mm |
| | | SF2 | 660-750 mm |
| | | SF3 | 760-850 mm |
| T 500cm | European Guidelines for Self-Compacting Concrete | VS1 | ≤2 sec |
| | | VS2 | >2 sec |

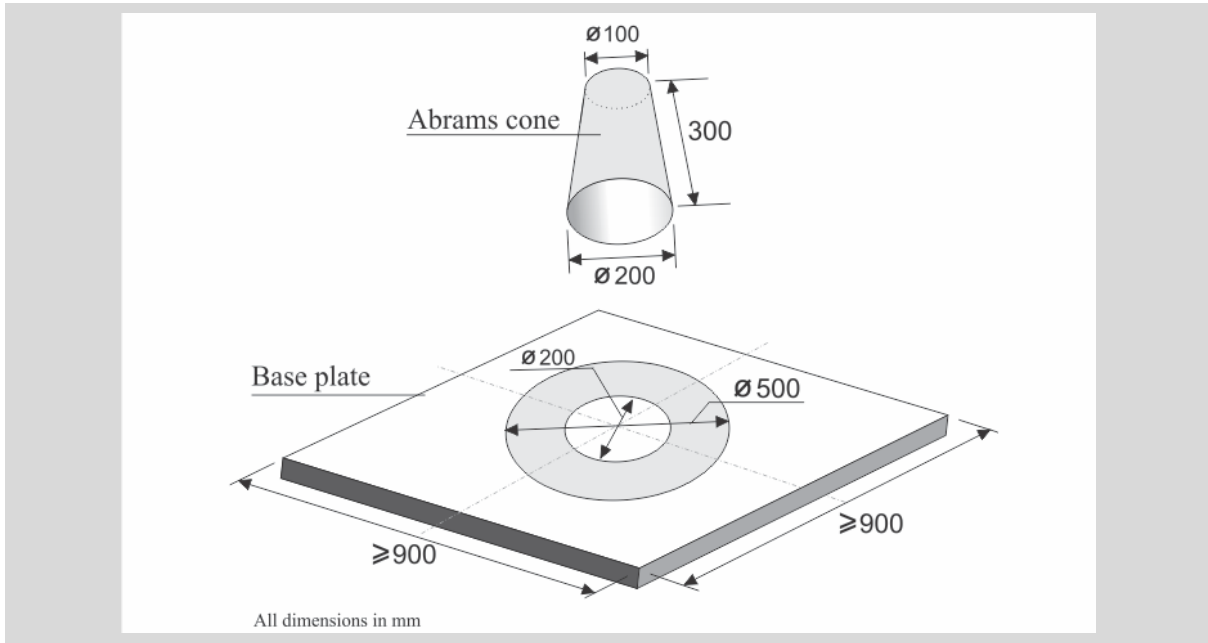


Figure 04: Shown Slump flow -test-apparatus.

V-Funnel Test

The V-funnel test is used to assess the viscosity and filling ability of self-compacting concrete.

Table 37: Schedule of V-funnel Test method.

| Test Method | Test Procedure | Class | Specification Limit |
|------------------------|--|-------|---------------------|
| V-Funnel | European Guidelines for Self-Compacting Concrete | VF1 | ≤8 sec |
| | | VF2 | 9-25 sec |
| V-Funnel at T5 minutes | European Guidelines for Self-Compacting Concrete | – | +3 sec. |

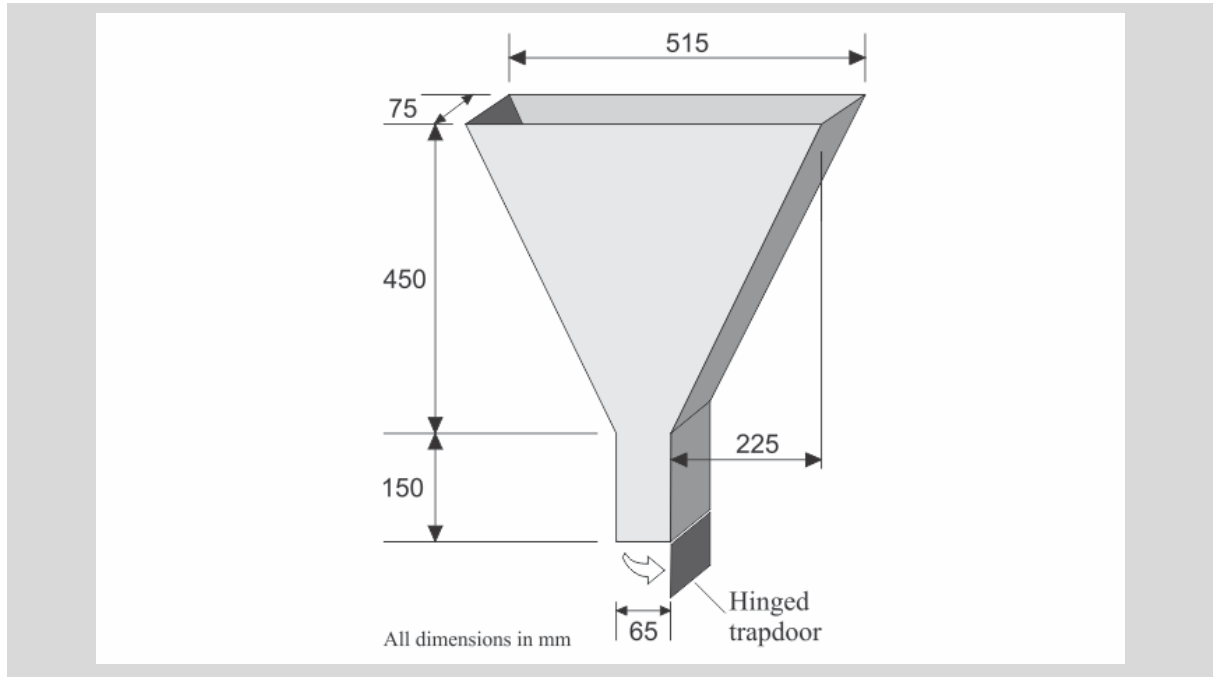


Figure 05: Shown V-funnel-test-apparatus.

L-Box Test

L-Box test is used to assess the passing ability of self- compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking. There are two variations; the two bar test and the three bar test. The three bar test simulates more congested reinforcement.

Table 38: Schedule of L – Box Test method.

| Test Method | Test Procedure | Class | Specification Limit |
|----------------------|--|-------|----------------------|
| L-Box (h2/h1) rebars | European Guidelines for Self-Compacting Concrete | PA1 | ≥ 0,80 with 2 rebars |
| | | PA2 | ≥0,80 with 3 rebars |

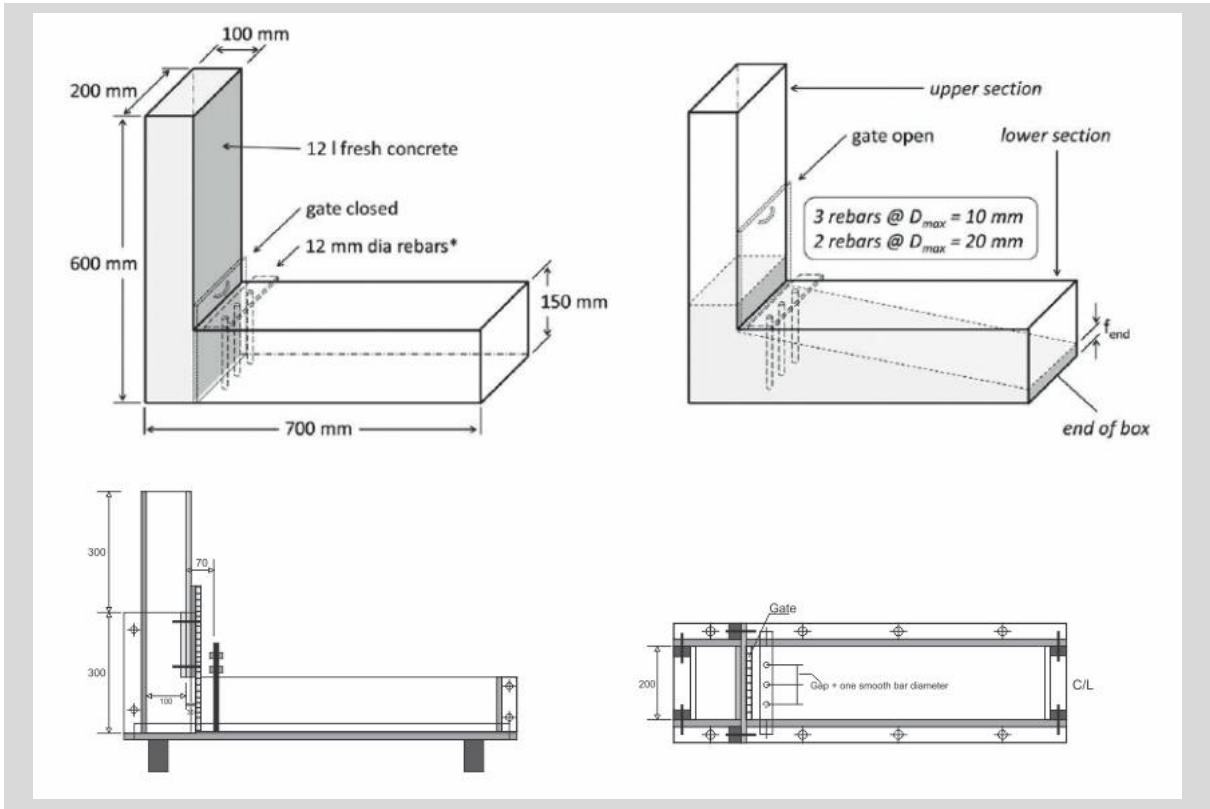


Figure 06: Shown L-Box test-apparatus.

J-Ring Test

The J-Ring test aims at investigating both the filling ability and the passing ability of SCC. It can also be used to investigate the resistance of SCC to segregation by comparing test results from two different portions of sample.

Table 39: Schedule of J – Ring Test method.

| Test Method | Test Procedure | Class | Specification Limit |
|-------------|--|-------|---------------------|
| J-Ring | European Guidelines for Self-Compacting Concrete | SR1 | ≥ 20% |
| | | SR2 | ≥ 15% |

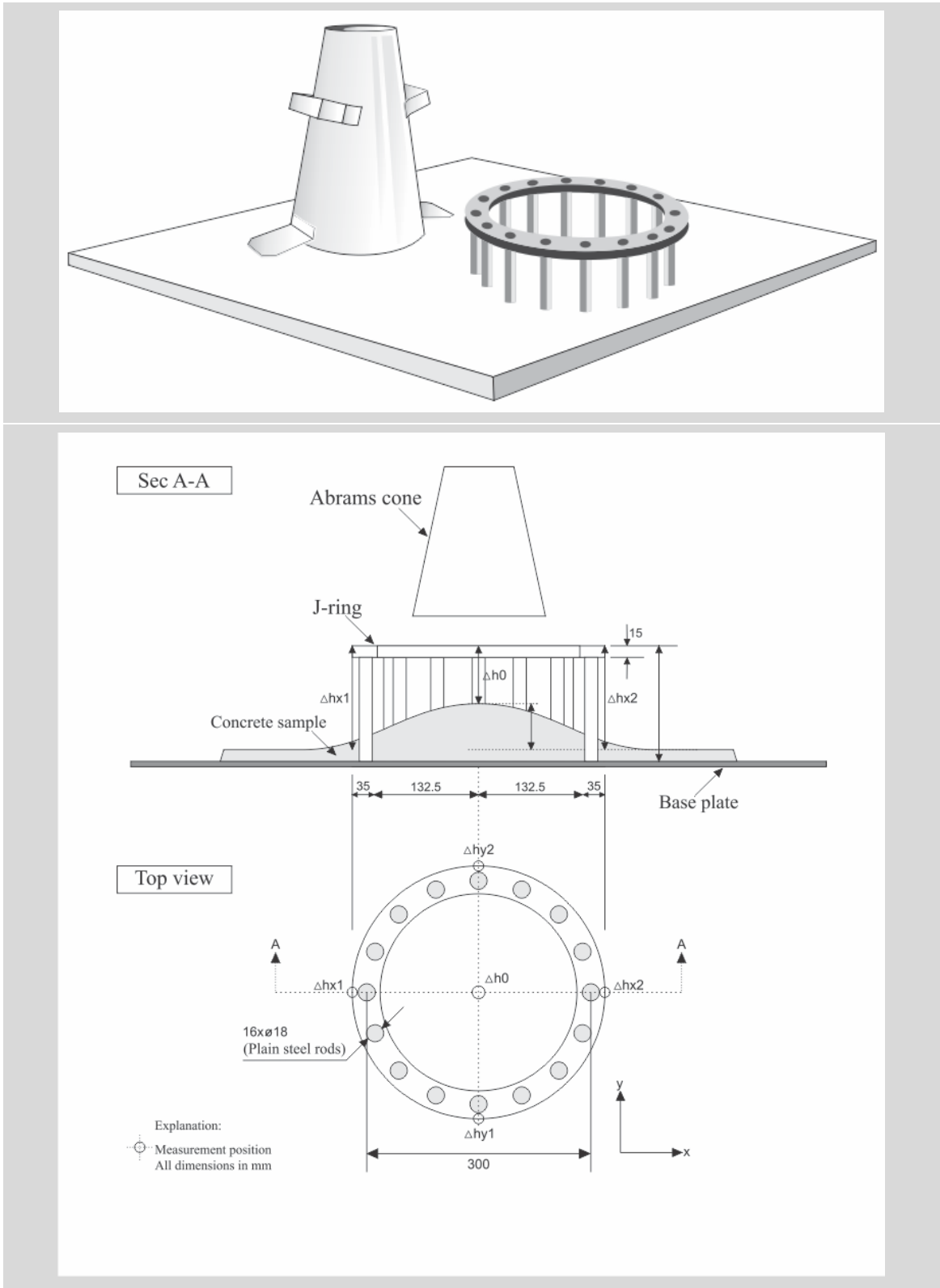


Figure 07: Shown j-Ring test-apparatus.

The procedure and apparatus for the above tests should refer to The European Guidelines for Self- Compacting Concrete, Specification, Production and Use, May 2005.

4. Appendix -2-

(Masonry specification) Brickwork and Blockwork

4.1 General

■ Codes of Practice

All brickwork and blockwork is to be carried out in accordance with the latest amendments of "BS EN 1052-1, BS EN 1996-1-1, BS EN 1996-1-2, BS EN 1996-2, BS EN 1996-3, PD 6697" 'Eurocode 6. Design of masonry structures.

■ Mortar Testing

All test cubes shall be made and tested in accordance with the requirements of "BS EN 1015-11 / BS 4551". The following table shows the required (7) and (28) days strength for preliminary and work tests:

Mean compressive strength of 100mm mortar cubes in N/mm²

Table 40: Schedule of Mortar Testing

| Grade Mix | | 7 days | 28 days | 7 days | 28 days |
|-----------|--------------|--------|---------|--------|---------|
| I | 1:0 to ¼:3 | 10.7 | 16.0 | 7.3 | 11.0 |
| II | 1: ½:4 to 4½ | 4.3 | 6.5 | 3.0 | 4.5 |
| III | 1:1:5 to 6 | 2.4 | 3.6 | 1.7 | 2.5 |
| IV | 1:2:8 to 9 | 1.0 | 1.5 | 0.7 | 1.0 |

■ Preliminary Test

Preliminary tests shall be carried out in ample time for the results to be approved before brick laying is due to commence, and before any change is made in the mortar mix, materials of source or materials.

The mortar shall be made in the laboratory from the materials and in the proportions proposed for use on site. Where coloring pigments shall be used, they must be incorporated in the mix.

Mixing, molding and curing shall be in accordance with "BS 4551". Three no. cubes shall be tested (7) days after casting and (3) No. after (28) days. If the cubes do not attain the strength specified, the Contractor shall obtain materials

from other sources, or with different grading, and repeat at his own expense the preliminary tests.

■ **Site Control Tests**

Mortar shall be taken from the spot boards and made into four (100) mm mortar cubes for each 100m² of wall, or for every story whichever is more frequent, for each designation of mortar used. (2) no. cubes shall be crushed at (7) days and (2) no. at (28) days and shall attain the strengths specified in the Table above for site tests.

Compressive strengths: final acceptance of the work will depend on the 28-day cube strength and the 7-day tests should be regarded as a guide to strength development and an early indication of defective mortar. The Contractor shall keep a record of the positions from which test cubes have been taken.

In the event of 7-day strengths falling below those specified, the Contractor may elect to continue work at his own risk while awaiting the 28-day result, or immediately take down the work represented by the defective cubes.

Where either the 7-day or the 28-day strength falls below that specified, the Contractor shall immediately investigate cause of the drop in strength, and take steps to prevent further low results including, where necessary, a change in the source of materials.

Work built with mortar represented by the defective cubes shall be liable to rejection by the Architect. The Architect's decision as to whether the work shall be retained or rejected shall be final and the Contractor shall take down and rebuild at his own expense the rejected work, together with any work which has to be removed to gain access.

4.2 Materials

■ **Bricks**

Generally, all bricks shall be the best of their respective kinds; hard, square cornered, sound and well burnt in accordance with the following:

- a) Fired - clay bricks to "BS EN 771-1, BS EN 772-7, BS EN 772-3".
- b) Concrete bricks to "BS EN 771-1, BS EN 772-2, BS EN 771-3, BS EN 771-16".
- c) Special bricks to "BS 4729".

- **Common Bricks**

All common bricks shall have a minimum average crushing strength of not less than 20N/mm². All special bricks, i.e. squints, 'pistols', radials, etc shall be manufactured and not cut from rectangular bricks.

- **External Facing Bricks**

Facing bricks to be specified by the Architect.

- **Blocks**

Generally, all blocks shall be the best of their respective kinds; hard, square cornered and sound, in accordance with a Specification as per shown in Table No. (18, 19, 20, 21, 22, 23).

- **Compressive Strength**

All bricks and blocks shall have the required minimum compressive strengths as specified by these standard specifications' guidelines. The Contractor shall satisfy himself throughout the period of delivery, that batches of bricks and blocks used have the required minimum compressive strength in accordance with these standard specifications' guidelines. The Contractor shall obtain certificates of such test carried out by the brick or block suppliers/manufacturer.

- **Delivery and Storage of Bricks and Blocks**

All bricks and blocks shall be carefully unloaded and stacked. They shall be unloaded by hand or machine onto a reasonably dry and level site and not tipped from vehicles. In addition to this, common bricks shall be delivered to site in metal bands using the 'strapack' system of delivery (Polyester strapping is the most commonly used polymer strapping material. Its strength and durability have made it the most commonly used material to replace steel strapping, furthermore metal bands are heaving a much higher risk of injuries in case of bursting straps) and shall be off-loaded and placed in position of working before breaking the bands. Also, particular attention must be paid to facing bricks and fair faced bricks and blocks, to preserve the arises and avoid face damage. All bricks and blocks must be protected from rain, snow and rising moisture. All bricks and blockwork shall be kept dry at all times.

- **Cement**

The specification is Referred to in these Guidelines {page No. (17)}. Masonry cement is to be to "BS EN 413-1" but shall not be used in load-bearing walls.

■ **Sand**

In general, the sand used in mortar shall comply with "BS EN 1200" and be free from any deleterious substances. The use of sand which has been in contact with sea water shall not be permitted unless it has been washed adequately, so that the total quantity of soluble salts does not exceed 0.3%. The sand shall be stored away from other materials, where it will not become contaminated by deleterious matter, and extreme variations of moisture content shall be avoided.

■ **Lime**

The lime is to be hydrated and shall be hydraulic (calcium) lime or semi hydraulic lime to conform to "BS EN 459-1" Class B, and a type deemed suitable by the Contractor. Lime shall be stored as cement.

■ **Water**

The water used for mixing shall be obtained from a statutory water undertaking or shall satisfy the recommendations given in appendix of "BS EN 1008". No sea water or water from excavations shall be used.

■ **Admixtures**

No admixtures might have permitted, however, a plasticizer conforming to "BS EN 934-3" may be used at the Contractors discretion. The use of calcium chloride will not be permitted.

■ **Pigments**

Any pigment used in mortar must conform to the requirements of "BS EN 12878". Pigments containing 'carbon black' will not be permitted.

■ **Mortar**

Mortar shall consist of one of the following types of mix. The mixes to be used might show on the relevant drawings.

Table 41: Schedule of Mortar Mix Types.

| | Cement: Lime: Sand Plasticizer | Masonry : Cement | Cement: Sand |
|-----|--------------------------------|------------------|--------------|
| I | 1:0 to ¼:3 | - | - |
| II | 1: ½:4 to 4½ | 1:2½ to 3½ | 1:3 to 4 |
| III | 1:1:5 to 6 | 1:4 to 5 | 1:5 to 6 |
| IV | 1:2:8 to 9 | 1:5½ to 6½ | 1:7 to 8 |

Where Sulphate resisting cements are used, the mortar designations shall be prefixed 'S'.

Ready mixed lime: sand for mortar is to be 1: 1: 5/6 range and shall be comply with the requirements of “BS EN 998-1, BS EN 998-2”.

Class i) Mortar to be used below dpc.

Class iii) Mortar to be used above dpc.

■ Damp Proof Course

Damp Proof Course (dpc) shall be specified by the Architect and shall be stored in accordance with the manufacturer's instructions.

■ Reinforcement

Reinforcement where required in brickwork shall be Brick force SBF60BSC.

■ Wall Ties & Anchors

All wall ties for cavity walls shall be in accordance with “BS EN 845-1”. Metal ties for cavity wall construction shall be grade 18/8 austenitic stainless steel double triangle type or similar approved. The double triangle type of tie with the appropriate retaining washer shall be used for the support of cavity wall insulation, or similar approved.

Ties and anchors between brickwork and concrete shall be stainless steel butterfly type cast into concrete as work proceeds, at specified spacing to suit brick / Block coursing.

Ties and anchors between blockwork and concrete shall be 40mm x 5mm galvanized hoop iron, fixed into concrete as work proceeds at specified spacing to suit block coursing.

■ Joist Hangers, Holding Down Straps & Metal Fittings

Galvanized hot rolled strip used to provide stability between sections of walls, or between blockwork and the frame of a building, shall be in accordance with the requirements of EN2 (H.S.4B.) of "BS 1449-1.1".

Joist hangers, wall and roof anchors, etc, shall be constructed from mild steel grade 43A, or its equivalent, i.e. EN2 (H.S.4B.) of "BS 1449-1.1" for hot rolled strip. Joist hangers, and similar fabrication shall be galvanized after manufacture, with a minimum coating weight of 610 gm/m² to "BS EN ISO 1461". All other fittings shall be galvanized to the above standard (minimum local thickness 15 microns). All such angles shall be formed from grade 18/8 austenitic stainless-steel plate or sheet.

All bolts, sockets and shims used to fix such angles to the structure shall also be grade 18/8 austenitic stainless steel.

- **Externally Exposed Supporting Angles**

Sealants used in brickwork joints shall be poly-Sulphate stored in accordance with the manufacturer's instructions.

- **Metal in Walls**

All metal embedded in external solid walls, or the outside skin of external cavity walls shall be grade 18/8 austenitic stainless steel.

4.3 Workmanship

- **Setting out Brickwork & Blockwork**

Refer to the Architects drawings.

- **External Facing Bricks**

The Contractor is to allow in his prices for sorting and selecting facing bricks to match the approved sample panel and carefully selecting for size for building pier, projections and other sections of the work designed to brick modules or with tight tolerances.

The color and texture of bricks delivered shall be approved by the Architect.

In order to ensure a uniform appearance of facing brickwork, the Contractor shall agree with the Architect on the provision of a stockpile of facing bricks of sufficient quantity and access for selection, so that throughout the face brickwork program thorough mixing and selecting from pallets is possible.

The Contractor's attention is drawn to the fact that a high standard of workmanship might be required for facing work generally and particular care must be taken to keep such work free from mortar droppings and other staining.

- **Cavity Walls**

All bricks used in cavity walls shall be whole bricks and no snapped headers shall be used except to maintain bond. Every care is to be taken to prevent mortar droppings from falling down the cavity, for example, by the use of laths that should be drawn up the cavity as work proceeds. Any mortar which may unavoidably fall on the wall ties should be removed daily and temporary openings (coring holes or clean-outs) should be provided to permit the daily clearance of mortar droppings from the bottom of the cavity. Where coring holes are used, extreme care is to be taken to avoid any damage to the d.p.c.

In cavity walls the skins shall be tied together by wall ties embedded in the mortar, at the time the course is laid, with a minimum embedment into each leaf of 50mm. The ties shall not be placed at more than 450mm vertically (2 courses of blockwork maximum) or more than 900mm horizontally, staggered. Additional ties shall be provided near the sides of all openings, and at sides of all columns so that there is one for each 300mm of height, the ties being within 150mm of the openings or side column. At the edges of all panels, beams, etc., the first row of ties must be within 300mm of the edge. Wall ties shall be bedded with a slight fall to the outer skin.

- **Mortar**

Mortar made on site must be mixed by machine, which must be cleaned before use to avoid contamination and must be cleaned out before changing mixes, and at the end of every working period.

All materials must be measured accurately by volume or weight, and not shovels. Powdered plasticizer must be dissolved in part of the mixing water before use.

Mortar should be used within 2 hours of the mixing of the cement and water, and any mortar not then used must be discarded and not re-tempered. This period of time may require reducing due to temperature and weather conditions.

- **Stability During Construction**

During construction all walls shall be adequately restrained and laterally supported by Temporary supports able to resist forces as may be imposed by the wind and other loadings, until such time that the wall has been completed, achieved its full strength and is permanently restrained.

- **Bricklaying & Block laying**

Unless otherwise specified by the Architect, the bonding of the brickwork shall be as follows:

- Walls of one brick thickness and over - English Bond
- Walls of half brick thickness - Stretcher Bond

Brickwork is to be constructed so that four courses equal a vertical dimension of 300mm, and the bond is to be carried up regularly. No half bricks or bats shall be used except where required for the proper closures.

The rate of laying bricks must be such that it will prevent the squeezing of mortar joints. Blockwork is to be constructed such that the coursing coincides with the brickwork coursing where applicable.

Units should be laid in true and regular courses with adequate bond. All perpendents shall be truly kept, and all joints properly flushed up or pointed as shown on the drawings.

Pointing should be carried out from the top of the wall downwards, unless specified, as work proceeds. The work is to be carried up to even heights all round so far as is practicable and no part is to rise more than scaffold height (i.e. maximum 2m) above any adjoining brickwork. One skin of a cavity wall should never be more than 450mm higher than the other. The construction of any portion of the works shall not rise by more than 1.5 meters in any one day.

All brickwork and blockwork shall be laid on a full bed of mortar, and vertical joints shall be filled up. The cavity faces of blockwork and brickwork shall be 'flushed up' as work proceeds. The average thickness of the vertical and horizontal joints shall be 10mm, exclusive of any key in the jointing surfaces of the units.

Where bricks have 'frogs' they shall be laid with the 'frogs' facing upwards. Clay bricks having a suction rate greater than 1.5 kg/m²/minute shall be wetted so as not to exceed this figure at the time they are laid.

Before orders for the clay bricks are placed, the Contractor shall satisfy himself that either that the suction rate of the brick does not exceed 1.5 kg/m²/minute or that he is able to adjust it consistently so as not to exceed this value. The method of testing might as have outlined in "The British Ceramic Research Association's Special Publication No. 56".

Blockwork shall be laid strictly in accordance with the manufacturer's recommendations, which may vary with weather conditions, temperature, exposure, etc. Movement joints shall be formed where shown on the drawings in accordance with the details given and care is to be taken to ensure that the gap is free from debris. Brickwork and blockwork joints to be provided at not greater than 12.0m and 6.0m respectively – joint location to be specified by Architect to suit elevation treatments.

All internal walls to be fully bonded/ toothed-in to external walls u.n.o. All internal and external masonry to be restrained the head at not less than 600mm centers to the underside of the roof and/or floor construction, steelwork, or suitably designed masonry restraints.

No finishes or fixings shall be tied across movement joints. In addition, particular attention shall be paid to the manufacturer's recommendations for spacing and formation of contraction and expansion joints and in the reinforcement to prevent cracking around openings, joints in return walls and movement joints. Where the manufacturer's recommendations are not in accordance with the details, such variations shall be drawn to the Architect's attention.

All vertical loadbearing walls shall be built prior to the construction of the floor over. Nonloadbearing walls shall not be completed until at least two weeks after any structural propping to the floor over is removed. Load bearing walls shall not be block bonded to non-loadbearing walls. Internal nonloadbearing walls shall not be block bonded to external cavity walls but must be tied to provide the necessary restraint as specified. This also applies to any walls on separate foundations.

Where in situ finishes shall be applied to work other than faced work, the faces of all brick walls shall be prepared with an adequate key to receive plastering, rendering, etc.

- **Installation and laying information Paving stones and Blocks.**

- **Joint Formation**

The joint width must be 2 - 5 mm (BS 7533-3).

- **Bedding**

- a. Bedding shall comprise of clean, well-graded sand complying with (BS 7533-3).
- b. The sand shall comply with grading limits when tested in accordance with the (BS EN 933-1).
- c. Grading for Bedding Sand (BS EN 12620) fine aggregate).

- **Laying**

Because of the addition of natural raw materials, concrete paving blocks/bricks are subject to natural, slight color variations. For this reason, always lay blocks from at least three packages and from different layers within the packages simultaneously. This is especially the case for shaded paving blocks. In this way you avoid large scale color concentrations and will achieve a harmonious overall appearance. The laying takes place from the laid surface onwards so that the recently laid bedding is not trodden on in the process. The blocks must be laid flush, level and aligned using a cord or lath. Never crush paving blocks/bricks too close to each other, as in this way the edges will flake off and production tolerances cannot be compensated for. On paths, the rows of paving should run perpendicular to the direction of travel.

- **Jointing**

Concrete paving blocks and slabs shall be laid with joint widths of at least 2 mm (BS 7533-3).

- **Joint Material**

The jointing sand shall comply with (BS 7533-3).

- **Faced Brickwork and Blockwork**

In addition to the requirements for bricklaying and block laying, the following apply to Faced brickwork and blockwork. Facing bricks, bricks for fair faced brickwork and fair faced blocks shall be handled carefully on site to preserve the arises and to avoid damage. Units shall be carefully laid, and faces kept free of

mortar splashes and smears. The responsibility for protection of completed work is with the Contractor and polythene sheeting or similar covering must be arranged, and the walls clearly labelled as finished work.

The Contractor is to provide a "Clipper" saw or similar machine for cutting all blocks for face work. Cut ends must be built in. In the construction of faced work:

-

- All bed joints shall be true and level.
- All perpends to be kept true.
- Units shall be laid to the bond as required by the Architect.
- Gauge rods must be used for both horizontal and vertical coursing from datum.

Water content of mortar must be adjusted to avoid smearing on the face of any faced work and excess mortar is to be lifted away with the edge of the trowel.

"Making good" of faced work is impossible; therefore, the greatest accuracy must be exercised in cutting and boring holes for services. Intersections in fair faced work shall be butt jointed and tied together. Heads of walls shall be finished true and level. Faced work in course of erection must be adequately protected against rain and weather, and adjacent scaffold boards turned back at night.

■ Pointing

Fair faced brickwork internally is to be pointed with a neat flush joint as the work proceeds. The joints of all external facings shall be pointed with a bucket handle joint as the work proceeds. Fair faced blockwork internally is to be pointed with a bucket handle joint as the work proceeds.

■ Sample Panels

Sample panels for all faced work shall be built on site in a protected position before commencement of the works, to provide an agreed standard for the work and treatment of joints. Such panels shall be maintained throughout the contract and removed on completion.

■ Services Holes and Chases

The position of chases and holes shall be agreed between the Contractor and Architect/Engineer before work commences. Unless otherwise agreed with the Architect, the following conditions shall apply.

- Depth of horizontal chases shall not exceed one-sixth of the thickness of the single leaf at any point in non-loadbearing walls.
- Horizontal chases will not be allowed in loadbearing walls.
- Depth of vertical and diagonal chases (up to 30° from vertical) should not exceed one quarter of the thickness of the single leaf at any one point.
- Where chases are necessary back-to-back, the total depths of the two chases must not exceed the depths shown above.
- All chases shall be cut with a saw, and cut out cleanly without damage to the wall, and without over cutting. Reciprocating hammers of any type shall not be used.
- Cutting of isolated holes may be permitted up to a maximum of 300mm square to the Architect's/Engineers approval.
- No holes or chases shall be cut through walls within a line spreading at 45° from the bearing of a beam or other concentrated load, for a depth of 1.0m below the load.
- In the event that the rules are not complied with, the remedial works shall be at the Contractor's expense.

■ Bearing of Lintels

Details of bearings for lintels and beams might be shown on the drawings. In the absence of specific information, the following rules shall be adopted: -

- The minimum bearing for lintels onto brickwork shall be 150mm.
- The minimum bearing for lintels onto blockwork shall be 300mm.
- Lintels shall bear on whole blocks not cut blocks.
- Lintels shall be bedded in mortar similar to that used for laying the units.

■ Fixing of Brick Support Angles

After slabs and edge beams have been cast and formwork props removed, the Contractor is to accurately survey the positions of the cast in sockets. He is then to make templates from the results of his survey to enable holes to be accurately drilled in the stainless-steel angles. The enlargement of holes in the angles will not be permitted.

The Contractor is to allow in his tender for providing stainless steel shims to fill gaps between the angles and edge beam caused by tolerances in the position of the

edge beam or the cast in sockets protruding from face of the beams. The depth of the shim is to be the full depth of the angle.

- **Damp Proof Course**

The damp proof course shall be laid in accordance with the requirements of SP56 – Model Specification for Clay and Calcium Silicate Structural Brickwork (BCRA).

- **Fixing Cavity Wall Insulation**

Cavity wall insulation shall be fixed in accordance with the manufacturer's instructions. Damaged boards shall not be used, and the cavity shall not be bridged by the insulation.

The Contractor shall provide facilities free of charge for the Architect or Clerk of Works periodically to satisfy themselves that all precautions are being taken to ensure that the cavity is not bridged. Notwithstanding the foregoing item no claim by the Contractor might admitted by the Architect should it be necessary to carry out remedial works as a result of bridging the cavity.

Table 42: Spacing of Wall Ties.

| Cavity Width | Horizontally | Vertically |
|--------------|----------------------------|------------|
| 50 - 75 mm | 900 mm | 450 mm |
| 75 - 100 mm | 750 mm | 450 mm |
| 100 - 150 mm | 450 mm | 450 mm |
| Openings | Maximum 150 mm from reveal | 225 mm |

Note: Wall ties shall be evenly spaced and staggered.

Table 43: Mortar Mixes (Location).

| Mortar Group | | | | |
|--------------------------|------------------|--------------------------|--------------------------------------|-------------------------------------|
| Type of Construction | Weather Exposure | Type of Bricks or Blocks | No risk of frost during construction | Frost may occur during construction |
| Loadbearing, engineering | Any | Clay (DPC class A or B) | 1 | |
| Retaining walls | Any | Clay (Class A or B) | 1 or 2 | |

| Mortar Group | | | | |
|--|--------------------------------|----------------------------------|--------------------------------------|-------------------------------------|
| Type of Construction | Weather Exposure | Type of Bricks or Blocks | No risk of frost during construction | Frost may occur during construction |
| Sills & Copings | Any | Clay (with low Sulphate content) | 3 | 5 |
| Parapets (not rendered) external freestanding walls, work below dpc. | Any | Clay (with low Sulphate content) | 1, 2 or 3 | |
| External walls between eaves and DPC | Severe exposure | Clay | 3 | |
| External walls between eaves and DPC | Sheltered or moderate exposure | Clay | 3 4 | 5 |
| Backing to external solid walls | ----- | Clay | 3 4 | 5 |
| Inner leaf of cavity walls | ----- | Clay or concrete block | 3 | 3 |
| Inner walls | ----- | Clay or concrete block | 4 or 6 Block | 3 |

Table 44: Mortar Mixes (Composition of Ingredients).

| Mortar Group | Hydraulic Lime: Sand | Cement Lime: Sand | Cement Sand with Plasticizer |
|--------------|----------------------|---|------------------------------|
| 1 | ----- | 1:0 – 3:3 | ----- |
| 2 | ----- | 1:2:4 - 42 | ----- |
| 3 | ----- | 1:1:5 - 6 | 1: 5 - 6 |
| 4 | 1:2 – 3 | 1:2:8 -9 | 1:7 - 8 |
| 5 | ----- | 1:2:8-9 with plasticizer to entrain 8 to 12% air | 1:7 - 8 |
| 6 | 1:3 | 1:3:10 - 12 | 1:8 |

5. Appendix -3-

(Steel Work Specification)

5.1 Steel Structure Specification

The following is a list of the steel standards and specifications to be followed Unless approved otherwise:

Table 45: List of the Steel Standards and Specifications.

| No. | Components | | Conforming to Standard | Strength |
|-----|---|----------|---|-------------------------------|
| 1 | Hot Rolled | Tubes | JIS -G 3466 –STKR 490 | Fy = 32.5 KN /cm ² |
| | | Channels | EN -10025 S355JR, Grade 50B | Fy = 34.5 KN /cm ² |
| 2 | Cold formed: Black steel for purlins, girts, columns, rafters and door frame | | ASTM A1008 / A1008M + ASTM A1011 / A1011M Grade 50, class 1, type 1 | Fy = 34.5 KN /cm ² |
| 3 | Cold formed: Galvanized steel for purlins, girts, columns, rafters and door frame | | JIS –G 3302, SGH490 | Fy = 36.5 KN /cm ² |
| 4 | Anchor Bolts –Galvanized | | JIS G3101 –SS 400 | Fy = 23.5 KN /cm ² |
| 5 | High strength bolts for primary bolted connections | | ASTM A325M Type 1. Hot Dip Galvanized to ASTM A153M Class C | Fy = 30.3 KN /cm ² |
| 6 | Machine bolts for secondary bolted connections | | DIN 933 Class 5.8 | Fy = 13.8 KN /cm ² |
| 7 | Nuts for primary bolted connections (assembly for rafters, columns, etc.) | | ASTM A563M Class 10S or ASTM A194M Grade 2H. Hot Dip Galvanized to ASTM A153M Class C | |
| 8 | Nuts for secondary bolted connections (purlins, girts, eave trusts, wind flange) | | DIN 934 Class 8. Washers to ASTM F436. Electro galvanized to ASTM B633 Type 2 | |

bracing base angles,
clips)

5.2 Relevant Standards

The following reference standards included in this Section shall apply:

| A- The American Society for Testing and Materials (ASTM): | |
|--|---|
| ASTM A36 / A36M | Specification for Carbon Structural Steel. |
| ASTM A123 / A123M | Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. |
| ASTM A780 / A780M | Practice for Repair of Damaged and uncoated areas of Hot-Dip Galvanized Coatings. |
| AASHTO M 111M/M 111 | Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips. |
| AASHTO M 133 | Preservatives and Pressure Treatment Process for Timber. |
| AASHTO M 164 | High-Strength Bolts for Structural Steel Joints. |
| B -British Standard Specifications (BS): | |
| BS EN 10365 | Structural steel sections. Specification for hot-rolled sections. |
| BS EN 1993-1-10, BS EN 1993-5, BS EN 1993-6, BS EN 1993-1-8, BS EN 1993-1-1 | Specification for use of structural steel in buildings |
| BS 499-1 | Glossary for welding, bronzing and Thermal cutting. |
| BS EN ISO 1461 | Specification for hot dip galvanized coatings on iron and steel articles. |
| BS 1133-6.1 BS 1133-6.2 | Packing Code Section 6: Protection of metal surfaces against corrosion during transport and storage. |
| BS 1449-1.1 | Steel plate, sheet and strip. Specification for carbon and carbon manganese plate, sheet and strip. |
| BS EN ISO 18286 BS EN ISO 9445-1 BS EN ISO 9445-2 BS EN 10048 BS EN 10095 BS EN 10051 | Specification for stainless and heat-resisting steel plate, sheet and strip. |

| | |
|---|--|
| BS EN 515, BS EN 485-3, BS EN 573-3, BS EN 573-2, BS EN 485-2 | Specification for wrought aluminum and aluminum alloys for general engineering purposes -plate, sheet and strip. |
| BS 1473, AMD 4477 | Specification for wrought aluminum and aluminum alloys for general engineering purposes-rivet, bolt and screw stock. |
| BS EN 573-3, BS EN 755-2, BS EN 755-3, BS EN 755-4, BS EN 755-6, BS EN 755-7, BS EN 755-8, BS EN 755-9, BS EN 12020-2 | Specification for wrought Aluminum and aluminum alloys for general engineering purposes -bars, extruded round tube and sections. |
| BS EN ISO 7438 | Methods for bend testing of metals. |
| BS EN 10162 | Specifications for cold rolled steel sections |
| BS 3416, BS 6949 | Specification for black bitumen coating solutions for cold application. |
| BS EN 1993-1-8 | The use of high strength friction grip bolts in structural steelwork |
| Part 1: General grade | |
| BS EN 10210-2 | Specification for hot-rolled structural steel sections. Hollow Sections. |
| BS EN 10056-1 | Hot-rolled structural steel sections. Equal and unequal angles |
| BS 5950-1 | Structural use of steel work in buildings: Code of practice for design in simple and continuous construction: Hot rolled |
| Part 2: Sections | Specification for materials, fabrication and erection: Hot rolled sections |
| BS 6037-1 | Permanently installed suspended access equipment. |
| BS EN 10219-2 | Welded cold formed steel structural hollow sections |
| BS EN 1991-1-1, BS EN 1991-1-7 | Loading for buildings -Part 1: 1984 Code of practice for dead and imposed loads. |
| BS 7079 | Preparation of steel substrates before application of paints and related products |
| BS 7613 BS EN 10025-1, BS EN 10025-6 | Hot rolled quenched and tempered welded structural steel plates |
| BS 7668 | welded structural steels. Hot finished structural hollow sections in weather resistant steels |

| C - European Standard Specifications (EN): | |
|---|--|
| BS EN 10002 | Tensile testing of metallic materials. (part 1 : 5) |
| BS EN 10020 | Definition and classification of grades of steel. |
| BS EN 10021 | General Technical delivery requirements for steel and iron products |
| BS EN 10024 | Hot rolled taper flange I sections: Tolerances on shape and dimensions. |
| BS EN 10025 | Hot rolled products of non-alloy structural steels. Technical delivery conditions |
| BS EN 10029 | Tolerances on dimensions' shape and mass for hot rolled steel plates 3mm thick or above |
| BS EN 10034 | Structural steel I and H sections –Tolerances on shape and dimensions |
| BS EN10048 | Hot rolled narrow steel strip. Tolerances on dimensions and shapes. |
| BS EN 10051 | Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels –tolerances on dimensions and shape. |
| BS EN 10056 | Structural steel equal and unequal leg angles |
| BS EN 10025-1, BS EN 10025-3, BS EN 10025-4 | Hot-rolled products in welded fine grain structural steels |
| BS EN 10204 | Metallic products. Types of inspection documents |
| BS EN 10210 | Hot finished structural hollow sections of non-alloy and fine grain structural steels -Part 1: Technical delivery requirements, Part 2: Dimensions, tolerances & sectional properties. |
| BS EN 10219 | Cold formed structural hollow sections of non-alloy and fine grain structural steels |
| Metals: | |
| 1. Steel, Structural Shapes: To meet specified requirements of “BS EN ISO 18286, BS 7668, BS EN 10025-1, BS EN 10025-3, BS EN 10025-4, BS EN 10210-1, ASTM A36 / A36M”. | |
| 2. Steel, Angles and Hollow Sections: To meet specified requirements of “BS EN 10210-2, BS EN 10056-1” and BS 4360, or ASTM A36 / A36M”. | |
| 3. Steel Sheet: To meet specified requirements of “BS 1449-1.1” or “ASTM A1008 / A1008M”. | |
| 4. Aluminum, Extrusions: To meet specified requirements of “BS EN 573-3, BS EN 755-2, BS EN 755-3, BS EN 755-4, BS EN 755-6, BS EN 755-7, BS EN 755-8, BS EN 755-9, BS EN 12020-2” or AA6063-T5 for alloy and temper. | |

5. Aluminum, Sheet, and Exposed: To meet specified requirements of "BS EN 515, BS EN 485-3, BS EN 573-3, BS EN 573-2, BS EN 485-2" or AA1100-H14 for alloy and temper.

6. Stainless Steel Tube: Seamless, AISI Type 304.

7. Stainless Steel Sheet: To meet specified requirements of "BS EN ISO 18286, BS EN ISO 9445-1, BS EN ISO 9445-2, BS EN 10048, BS EN 10095, BS EN 10051" or AISI grade 316.

6. Appendix -4-

Various Codes for Construction Material Testing

Standards and Codes, which are widely used in the world or are references for other codes include:

1. ASTM International.
2. Canadian Standard Association.
3. European Standard.
4. British Standards.

6.1 ASTM International

It is the largest source of standards in the world for materials, goods, services, and systems. ASTM international also publishes documents on sampling and testing methods for health, safety and performance aspects of materials, effects of physical and biological agents and chemicals, and safety guidelines. Table 35 provides list of standards for testing various construction materials.

Table 46: ASTM international standards for testing different construction materials.

| Construction material | ASTM international standards |
|-----------------------|---|
| Soil | ASTM D2216, ASTM D4318, ASTM C136 / C136M, ASTM D5268, ASTM D6913 / D6913M, ASTM D2974, ASTM D422, ASTM D2434, ASTM D1140, ASTM D7263, ASTM D5918, ASTM D698, ASTM D854, and ASTM D1557. |
| Aggregate and Rock | ASTM C88 / C88M, ASTM C295 / C295M, ASTM C127, ASTM D5312 / D5312M, ASTM C128, ASTM D5313 / D5313M, ASTM C29 / C29M, ASTM D4992, ASTM D5821, ASTM D4791, ASTM D3967, ASTM C131 / C131M, ASTM D7012, and ASTM C535 |

| | |
|----------------------|--|
| Cement | EN 197, ASTM C150 / C150M, BS EN 15167-1, BS EN 15167-2, ASTM C989 / C989M, BS EN 450 S, ASTM C1240, ASTM C494 / C494M, ASTM C260 / C260M, ASTM C1017 / C1017M |
| Concrete and Masonry | ASTM C617 / C617M, ASTM C1231 / C1231M, ASTM C39 / C39M, ASTM C78 / C78M |

6.2 Canadian Standard Association (CSA)

The CSA is a standard organization which develops standards in Canada. It publishes standards in print and electronic form and provides training and advisory services.

All materials used in construction of buildings and other structures in Canada is manufactured to meet the requirements of the CSA standards. Table 36 provides selected standards used for testing different construction materials.

Table 47: Selected CSA Standards for testing construction materials.

| Construction materials | CSA standards |
|------------------------|--|
| Cement | CSA A3001, CSA A3002, CSA A3003, CSA A3004, and CSA A3005 |
| Concrete | CSA A23.1, CSA A23.2, CSA A23.4, and CSA S806 |
| Masonry | CSA A165.1, CSA A165.2, CSA A165.3, CSA A179, CSA A370, and CSA A371 |

6.3 European Standard (EN Euro codes)

Test standards are part of the comprehensive system of European standards relating to construction. They are intended to be used for the determination of material and product properties required for the design of buildings and other civil engineering structures with the EN Euro codes.

In particular, test standards related to the EN Euro codes comprise testing for materials, e.g. concrete, masonry, timber and metallic materials, non-destructive test methods as well as fire tests. BS EN is abbreviation for official English version of European standards.

Table 48: European Standards for testing different construction materials.

| Construction materials | European Standards (EN) |
|------------------------|---|
| Concrete | BS EN 12390-4, BS EN 12390-5, BS EN 12390-6, BS EN 1170-4 |
| Masonry | BS EN 1052-1, BS EN 846-5, BS EN 846-6 |
| Timber | BS EN 594, BS EN 1075, BS EN 1380 |
| Metallic Materials | BS EN ISO 6892-1 |
| Plywood | BS EN 636 |
| Stone | BS EN 12372, BS EN 14617-15, BS EN ISO 14580, BS EN 14617-2 |
| Aggregate | BS EN 1097-3 |

6.4 British Standards (BS)

British Standard publications, which are produced by the British Standard Institute, are technical specifications that give recommendations on a wide range of building and construction matters including materials, testing, health and safety, access, and regulations and many more.

They are essential reference for architects, developers, building owners, site managers, building contractors, structural engineers, and materials specifiers. Table 48 provide a selected list of British Standards for testing construction materials.

Table 49: Selected British Standards for testing construction materials.

| Construction materials | British Standards |
|--|---|
| Concrete | BS 1881-119, BS EN 12390-13 |
| Resin and Polymer /Cement compositions | BS 6319-10, BS 6319-11, BS 6319-2, BS 6319-3, BS 6319-6, BS 6319-7 |
| Mortar | BS EN 998-2, BS EN 998-1: Specification for ready-mixed building mortars BS EN 998-1, BS EN 998-2: Specification for dry packaged cementitious mixes - Pre-packed mortar mixes BS 4551: Methods of testing mortars screeds and plasters which is currently published in two parts is being republished as a single part Standard with the same Standard number. A multi part Standard on mortar testing has been published as BS EN 1015 BS EN 998-1 Specification for mortar for masonry - Part 1: Rendering and plastering mortar. |

BS EN 998-2 Specification for mortar for masonry - Part 2: Masonry mortar

7. Appendix -5-

(References)

7.1 Relevant ASTM Standards

The two digits after the dash denote the year of publication; 'a' denotes a revision in the year of publication; a date in brackets indicates the year in which the standards were last reapproved without change.

| Relevant ASTM Standards | |
|-------------------------|---|
| A- Cement | |
| ASTM C91 / C91M | Spec. for Masonry Cement |
| ASTM C109 / C109M | Test for compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens). |
| ASTM C115/C115M | Test for Fineness of Portland Cement by the turbid meter C150-0 Spec. for Portland cement. |
| ASTM C151 / C151M | Test for Autoclave Expansion of Portland cement C186-98 Test for Heat of Hydration of Hydraulic Cement. |
| ASTM C191 | Test for Time of Setting of Hydraulic Cement by Vicat Needle. |
| ASTM C204 | Test for Fineness of Hydraulic Cement by Air Permeability Apparatus. |
| ASTM C230 / C230M | Spec. for Flow Table for Use in Tests of Hydraulic Cement. |
| ASTM C266 | Test for Time of Setting of Hydraulic Cement Paste by Gillmore Needles. |
| ASTM C430 | Test for Fineness of Hydraulic Cement by the 45 μ (No. 325) Sieve |
| ASTM C452 | Test for Potential Expansion of Portland Cement Mortars Exposed to Sulfate. |
| ASTM C595 / C595M | Spec. for Blended Hydraulic Cements C845-96 Spec. for Expansive Hydraulic Cement. |
| ASTM C917 / C917M | Test for Evaluation of Cement Strength Uniformity from a Single Source. |
| ASTM C989 / C989M | Spec. for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars. |
| ASTM C1012 / C1012M | Test for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution. |

| | |
|----------------------|---|
| ASTM C1157 / C1157M | Performance Specification for Hydraulic Cement. |
| ASTM C1240 | Spec. for Silica Fume for Use as a Mineral Admixture in Hydraulic- Cement Concrete, Mortar, and Grout. |
| ASTM C979 / C979M | Spec. for Pigments for Integrally Colored Concrete |
| ASTM C1017 / C1017M | Spec. for Chemical Admixtures for Use in Producing Flowing Concrete. |
| B- Admixtures | |
| ASTM C260 / C260M | Spec. for Air-Entraining Admixtures for Concrete. |
| ASTM C311 / C311M | Tests for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete |
| ASTM C494 / C494M | Spec. for Chemical Admixtures for Concrete. |
| ASTM C618 | Spec. for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete. |
| C- Aggregate | |
| ASTM C29 / C29M | Test for Bulk Density (Unit Weight) and Voids in Aggregate. |
| ASTM C33 / C33M | Spec. for Concrete Aggregate. |
| ASTM C40 / C40M | Test for Organic Impurities in Fine Aggregate for Concrete C 70-94 (2001) Test for Surface Moisture in Fine Aggregate. |
| ASTM C87 / C87M | Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar. |
| ASTM C88 / C88M | Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate. |
| ASTM C117 | Test for Materials Finer than 75-micron (No.200) Sieve in Mineral Aggregate by Washing. |
| ASTM C117 | Test for Lightweight Particles in Aggregate. |
| ASTM C131 / C131M | Test for Resistance to Degradation of Small- Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine. |
| ASTM C227 | Test for Potential Alkali Reactivity of Cement – Aggregate Combinations (Mortar-Bar Method). |
| ASTM C289 | Test for Potential Alkali- Silica Reactivity of Aggregate (Chemical Method). |
| ASTM C294 | Descriptive Nomenclature for Constituents of Natural Mineral Aggregate. |
| ASTM C295 / C295M | Guide for Petrographic Examination of Aggregate for Concrete. |
| ASTM C330 / C330M | Spec. for Lightweight Aggregate for Structural Concrete. |

| | |
|--------------------|---|
| ASTM C331 / C331M | Spec. for Lightweight Aggregate for Concrete Masonry Units. |
| ASTM C332 | Spec. for Lightweight Aggregate for Insulating Concrete. |
| ASTM C441 / C441M | Test for Effectiveness of Mineral Admixtures of Grounds Blast- Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali –Silica Reaction. |
| ASTM C566 | Test for Total Evaporable Moisture Content of Aggregate by Drying. |
| ASTM C586 | Test for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregate (Rock Cylinder Method). |
| ASTM C1105 | Test for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction. |
| ASTM C1137 | Test for Degradation of fine Aggregate Due to Attrition E11-87Spec. for Wire-Cloth Sieves for Testing Purposes. |
| D- Concrete | |
| ASTM C31 / C31M | Marking and Curing Concrete Test Specimens in the Field. |
| ASTM C39 / C39M | Test for Compressive Strength of Cylindrical Concrete Specimens. |
| ASTM C42 / C42M | Test for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. |
| ASTM C78 / C78M | Test for Flexural Strength of Concrete (Using Simple Beam with third-Point Loading). |
| ASTM C94 / C94M | Spec. for Ready-Mixed Concrete. |
| ASTM C125 | Terminology Relating to Concrete and Concrete Aggregates. |
| ASTM C138 / C138M | Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete. |
| ASTM C143 / C143M | Test for Slump of Hydraulic Cement Concrete. |
| ASTM C156 | Test for Water Retention by Concrete Curing Materials. |
| ASTM C157 / C157M | Test for Length Change of Hardened Hydraulic-Cement Mortar and Concrete. |
| ASTM C171 | Spec. for Sheet Materials for Curing Concrete. |
| ASTM C173 / C173M | Test for Air Content of Freshly Mixed Concrete by the Volumetric Method. |
| ASTM C192 / C192M | Making and Curing Concrete Test Specimens in the Laboratory. |

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| ASTM C215 | Test for Fundamental Transverse, Longitudinal and Torsional Frequencies of Concrete Specimens. |
| ASTM C231 / C231M | Test for Air Content of Freshly Mixed Concrete by the Pressure Method. |
| ASTM C232 / C232M | Test for Bleeding of Concrete. |
| ASTM C293 / C293M | Test for Flexural Strength of concrete (Using Simple Beams with Center-Point Loading). |
| ASTM C309 | Spec. for Liquid Membrane-Forming Compounds for Curing Concrete. |
| ASTM C403 / C403M | Test Time of Setting of Concrete Mixtures by Penetration Resistance. |
| ASTM C418 | Test for Abrasion Resistance of Concrete by Sandblasting. |
| ASTM C457 / C457M | Test for Microscopical Determination of Parameters of the Air- Void System in Hardened Concrete. |
| ASTM C469 / C469M | Test for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression. |
| ASTM C 170/C170M | Test Method for Compressive Strength of Dimension Stone |
| ASTM C196 | Test for Splitting Tensile Strength of Cylindrical Concrete Specimens. |
| ASTM C512 / C512M | Test for Creep of Concrete in Compression. |
| ASTM C53 | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing. |
| ASTM C567 / C567M | Test for Determining Density of Structural Lightweight Concrete. |
| ASTM C597 | Test for Pulse Velocity through Concrete. |
| ASTM C617 / C617M | Standard Practice for Capping Cylindrical Concrete Specimens. |
| ASTM C642 | Test for Specific Gravity, Absorption, and Voids in Hardened Concrete. |
| ASTM C666 / C666M | Test for Resistance of Concrete to Rapid Freezing and Thawing. |
| ASTM C672 / C672M | Test for Scaling Resistance of concrete Surfaces Exposed to Deicing Chemicals. |
| ASTM C685 / C685M | Spec. for Concrete Made by Volumetric Batching and Continuous Mixing. |
| ASTM C779 / C779M | Test for Abrasion Resistance of Horizontal concrete Surfaces. |
| ASTM C803 / C803M | Test for Penetration Resistance of Hardened Concrete. |

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| ASTM C805 / C805M | Test for Rebound Number of Hardened Concrete. |
| ASTM C856 | Petrographic Examination of Hardened Concrete. |
| ASTM C873 / C873M | Test for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds. |
| ASTM C878 / C878M | Test for Restrained Expansion of Shrinkage-Compensating Concrete. |
| ASTM C900 | Test for Pullout Strength of Hardened Concrete. |
| ASTM C918 / C918M | Test Method for Measuring Early-Age Compression Test Values and Projecting Later-Age Strength. |
| ASTM C944 / C944M | Test for Abrasion Resistance of Concrete or Mortar Surfaces by the Rotating-Cutter Method. |
| ASTM C1038 / C1038M | Test for Expansion of Portland Cement Bars Stored in Water. |
| ASTM C1074 | Estimating Concrete Strength by the Maturity Method. |
| ASTM C1084 | Test for Portland-Cement Content of Hardened Hydraulic- Cement Concrete. |
| ASTM C1138M | Test for Abrasion Resistance of Concrete (Underwater Method). |
| ASTM C1152 / C1152M | Test for Acid-Soluble Chloride in Mortar and Concrete. |
| ASTM C1152 / C1152M | Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration. |

7.2 Relevant European and British standards (BS EN)

BS EN denotes a European Standard adopted as a British Standard.

The date in brackets indicates the year in which the standard was confirmed.

| Relevant European and British standards (BS EN) | |
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| A- Cement | |
| BS EN 196-1 | Methods of testing cement: Determination of strength. |
| BS EN 196-2 | Methods of testing cement: Chemical analysis of cement. |
| BS EN 196-3 | Methods of testing cement: Determination of setting time and soundness. |
| BS EN 196-5 | Methods of testing cement: Pozzolanicity test for Pozzolanic cement. |
| BS EN 196-6 | Methods of testing cement: Determination of fineness. Methods of testing cement: physical testes. |

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| BS EN 196-7 | Methods of testing cement: Taking and preparing sample. |
| BS EN 196-2 | Determination of the chloride, carbon dioxide and alkali content of cement. |
| BS EN 197-1 | Cement-composition, specifications, and conformity criteria: Common cements. Spec. for Portland cement. Spec. for Portland-blast furnace cement. Spec. for low heat Portland cement. Spec. for Portland pulverized-fuel ash cement. Specification for high slag blast furnace cement |
| BS EN 197-2 | Cement - conformity evaluation. |
| BS EN 450-2, BS EN 450-1 | Fly ash for concrete - Definitions, requirements, and quality control |
| BS EN 12878 | Pigments for the coloring of building materials based on cement and/or lime. Specifications and methods of test. |
| BS EN 14647 | Calcium aluminate cement. Composition, specifications, and conformity criteria. |
| BS EN 450-1 | Fly ash for concrete. Definition, specifications, and conformity criteria. |
| BS EN 15743 | Spec. for super Sulphate cement. |
| BS EN 196-1 BS 1881-131 | Strength tests. (Testing concrete) |
| BS 4550:3.8 | Test for heat of hydration. |
| BS EN 14216 | Spec. for pozzolanic pulverized-fuel ash cement (very low heat special cements). |
| BS EN 15167-1, BS EN 15167-2 | Spec. for ground granulated blast furnace slag for use with Portland cement, concrete, mortar and grout. |
| B- Admixtures | |
| BS EN 480-1, BS EN 480-2, BS EN 480-4, BS EN 480-5, BS EN 480-6, BS EN 480-8, BS EN 480-10, BS EN 480-11, BS EN 480-12, BS EN 934-6, BS EN 934-2 | - Admixtures for concrete, mortar and grout. Test methods. - Specification for super plasticizing admixtures. - Spec. for air-entraining admixtures. - Spec. for accelerating admixtures, retarding admixtures and water reducing admixtures. |
| BS EN 934-2 | Admixtures for concrete, mortar and grout. Concrete admixtures. Definitions, requirements, conformity, marking and labelling. |

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| BS EN 934-4 | Admixtures for concrete, mortar and grout. Admixtures for pre stressing tendons. Definitions, requirements, conformity, marking and labelling. |
| BS EN 934-6 | Admixtures for concrete, mortar and grout. Sampling, assessment and verification of the constancy of performance. |
| C- Aggregate | |
| BS EN 932-1 | Tests for general properties of aggregates. Methods for sampling. |
| BS EN 932-2 | Tests for general properties of aggregates. Methods for reducing laboratory samples. |
| BS EN 932-3 | Tests for general properties of aggregates. Procedure and terminology for simplified petrographic description. |
| BS EN 932-5 | Tests for general properties of aggregates. Common equipment and calibration. |
| BS EN 932-6 | Tests for general properties of aggregates. Definitions of repeatability and reproducibility. |
| BS EN 933-1 | Tests for geometrical properties of aggregates. Determination of particle size distribution. Sieving method. |
| BS EN 933-2 | Tests for geometrical properties of aggregates. Test sieves, nominal size of apertures. |
| BS EN 933-3 | Tests for geometrical properties of aggregates. Determination of particle shape. Flakiness index. |
| BS EN 933-4 | Tests for geometrical properties of aggregates. Determination of particle shape. Shape index. |
| BS EN 933-5 | Tests for geometrical properties of aggregates. Determination of percentage of crushed and broken surfaces in coarse aggregate particles. |
| BS EN 933-6 | Tests for geometrical properties of aggregates. Assessment of surface characteristics. Flow coefficient of aggregates. |
| BS EN 933-7 | Tests for geometrical properties of aggregates. Determination of shell content. Percentage of shells in coarse aggregates. |
| BS EN 933-8 | Tests for geometrical properties of aggregates. Assessment of fines. Sand equivalent test. |
| BS EN 933-9 | Tests for geometrical properties of aggregates. Assessment of fines. Methylene blue test. |
| BS EN 933-10 | Tests for geometrical properties of aggregates. Assessment of fines. Grading of fillers (air-jet sieving). |

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| BS EN 1097-1 | Test for mechanical and physical properties of aggregates. Determination of the resistance to wear (micro-Deval). |
| BS EN 1097-2 | Test for mechanical and physical properties of aggregates. Methods for the determination of resistance to fragmentation. |
| BS EN 1097-3 | Test for mechanical and physical properties of aggregates. Determination of loose bulk density and voids. |
| BS EN 1097-4 | Test for mechanical and physical properties of aggregates. Determination of the voids of dry compacted filler. |
| BS EN 1097-5 | Test for mechanical and physical properties of aggregates. Determination of the water content by drying in a ventilated oven. |
| BS EN 1097-6 | Test for mechanical and physical properties of aggregates. Determination of particle density and water absorption. |
| BS EN 1097-7 | Test for mechanical and physical properties of aggregates. Determination of particle density of filler. Pycnometer method. |
| BS EN 1097-8 | Test for mechanical and physical properties of aggregates. Determination of the polished stone value. |
| BS EN 1097-9 | Test for mechanical and physical properties of aggregates. Determination of the resistance to wear by abrasion from studded tyres. Nordic test. |
| BS EN 1367-1 | Test for thermal and weathering properties of aggregates. Determination of resistance to freezing and thawing. |
| BS EN 1367-2 | Test for thermal and weathering properties of aggregates. Magnesium Sulphate test. |
| BS EN 1367-3 | Test for thermal and weathering properties of aggregates. Boiling test for Sonnenboard basalt. |
| BS EN 1367-4 | Test for thermal and weathering properties of aggregates. Determination of drying shrinkage. |
| ISO 565 | Test sieves - woven metal wire cloth, perforated plate and electroformed sheet - nominal sizes of openings. |
| ISO 6274 | Concrete: sieve analysis of aggregates. |
| BS ISO 3310-1 | Test sieves. Technical requirements and testing. Test sieves of metal wire cloth. |
| BS ISO 3310-2 | Test sieves. Technical requirements and testing. Test sieves of perforated metal plate. |

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| BS EN 1097-3 | Tests for mechanical and physical properties of aggregates. Determination of loose bulk density and voids. |
| BS EN 932-1 | Tests for general properties of aggregates. Methods for sampling. |
| BS EN 933-1 | Tests for geometrical properties of aggregates. Determination of particle size distribution. Sieving method. |
| BS 812-103.2 | Testing aggregates. Method for determination of particle size distribution. Sedimentation test. |
| BS 812-104 | Testing aggregates. Method for qualitative and quantitative petrographic examination of aggregates. |
| BS EN 933-3 | Tests for geometrical properties of aggregates. Determination of particle shape. Flakiness index |
| BS EN 933-7 | Method for determination of shell content in coarse Aggregates. |
| BS 812-109 | Method for determination of moisture content. |
| BS EN 1097-2 | Tests for mechanical and physical properties of aggregates. Methods for the determination of resistance to fragmentation |
| | Method for determination of aggregates crushing value (ACV). |
| | Method for determination of 10% fines value (TFV). |
| | Method for determination of aggregates impact value (AIV). |
| BS EN 1097-8 | Method for determination of aggregates abrasion value (AAV). |
| | Determination of the polished stone value. |
| BS EN 1744-1 | Tests for chemical properties of aggregates. Chemical analysis |
| | Method for determination of water-soluble chloride salts. |
| | Method for determination of Sulphate content. |
| BS 812:121 | Method for determination of soundness. |
| BS 812-123 | Method for determination of alkali-silica reactivity. Concrete prism method. |
| BS 812-124 | Method for determination of frost heave. |
| BS EN 12620 | Spec. for aggregates from natural sources for concrete. |
| BS EN 13055 | Spec. for lightweight aggregates for masonry units and structural concrete. |
| D- Concrete | |

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| BS EN 206 | Concrete. Specification, performance, production and Conformity. |
| BS EN 678 | Determination of the dry density of autoclaved aerated Concrete. |
| BS EN 679 | Determination of the compressive strength of autoclaved aerated concrete. |
| BS EN 680 | Determination of the drying shrinkage of autoclaved aerated concrete. |
| BS EN 12350-1 | Testing fresh concrete. Sampling and common apparatus. |
| BS EN 12350-2 | Testing fresh concrete. Slump test |
| BS EN 12350-3 | Testing fresh concrete. Vebe test |
| BS EN 12350-4 | Testing fresh concrete. Degree of compactability |
| BS EN 12350-5 | Testing fresh concrete. Flow table test |
| BS EN 12350-6 | Testing fresh concrete. Density |
| BS EN 12350-7 | Testing fresh concrete. Air contents. Pressure Methods |
| BS EN 12504-1 | Testing concrete in structures. Cored specimens. Taking, examining and testing in compression. |
| BS EN 12504-2 | Testing concrete in structures. Non-destructive testing. Determination of rebound number. |
| BS EN 12390-7, BS 1881-122, BS 1881-209, BS 1881-208 | Methods of testing hardened concrete for other than strength. Density of hardened concrete, Method for determination of water absorption, the measurement of dynamic modulus of elasticity, the determination of the initial surface absorption of concrete. |
| BS EN 12390-2 | Method for making test cubes from fresh concrete, making, and curing specimens for strength tests. Method of normal curing of test specimens (200C method). |
| BS EN 12390-2, BS EN 12390-1 | Method for making test cylinders from fresh concrete. Testing hardened concrete. Shape, dimensions and other requirements for specimens and moulds. |
| BS EN 12390-3 | Testing hardened concrete. Compressive strength of test specimens (concrete cubes). |
| BS EN 12390-4 | Testing hardened concrete. Compressive strength. Specification for testing machines for concrete. |
| BS EN 12390-5 | Testing hardened concrete. Flexural strength of test specimens. |
| BS EN 12390-6 | Testing hardened concrete. Tensile splitting strength of test specimens. |
| BS EN 12390-13 | Method for determination of static modulus of elasticity in compression. |

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| BS 1881-113 | Method for marking and curing no-fines test cubes. |
| BS 1881-119 | Method for determination of compressive strength using portions of beams broken in flexure (equivalent cube method). |
| BS 1881-122 | Method for determination of water absorption. |
| BS 1881-124 | Method for analysis of hardened concrete. |
| BS 1881-131 | Method of using cement in a reference concrete. |
| BS EN 12504-4 | Testing concrete. Determination of ultrasonic pulse velocity. |
| BS 1881-207 | Recommendations for the assessment of concrete strength by near-to-surface tests. |
| BS 1881-208 | Recommendations for the determination of the initial surface absorption of concrete. |
| BS 1881-209 | Recommendations for measurement of dynamic modulus of elasticity. |
| BS EN 1008 | Test for water for making concrete (Mixing water for concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete). |
| BS EN 13791 | Guide to Assessment of in-situ compressive strength in structures and precast concrete components. |
| BS 7542 | Test for curing compounds for concrete. |
| BS EN 1992-3 | Code of practice for design of concrete structures for retaining aqueous liquids. (Design of concrete structures. Liquid retaining and containing structures). |
| BS EN 1992-1-1 | Structural use of concrete: code of practice for design and construction. (Design of concrete structures. General rules and rules for buildings). |
| BS 8500-1 | Concrete. Complementary British Standard to BS EN206-1. Method of specifying and guidance for the specifier. |
| BS ISO 5667-24 | Water quality. Sampling. Guidance on the auditing of water quality sampling |

8. Appendix -6-

(Abbreviations)

| Abbreviations | Meanings |
|---------------|--|
| ASTM | American Standard for Testing Material |
| BS | British Standard |
| GSO | GCC (Gulf Cooperation Council) Standardization Organization |
| EN | European Standard (EN Euro codes) |
| BS EN | European and British standards |
| CSA | Canadian Standard Association |
| DIN | (Deutsches Institute für Normung) German institute for standardization |
| JIS | Japanese Industrial Standards |
| IBC | International Building Code |
| ISO | International Standards Organization |
| PCI | Precast/Pre-stressed Concrete Institute |
| ACI | American Concrete Institute |
| AISI | American Iron and Steel Institute |
| AASHTO | American Association of State Highway and Transportation Officials |
| Q.C | Quality Control |
| OPC | Ordinary Portland Cement |
| W/C | Water-cement ratio |
| SCC | Self-compacting concrete |
| Barjeel | Ras Al-Khaimah Green Building Regulations |

Note: -

- There are a various standard codes for testing of construction materials are specified by **ASTM** international, **Euro** codes, **ACI** Codes, **BS** Codes, etc. These codes specify testing procedure and methods for concrete, masonry, aggregates, steel, soil, and other building materials.
- Codes and standards are living documents, continually revised, and refreshed to address changing requirements and emerging technologies. Commonly, they are reviewed after certain years as part of a process of continual improvement.

9. Appendix -7-

Duties and Responsibilities

9.1 Consultancy Company

The consultancy company must strictly adhere to the following:

- Following all the specifications, standard of construction material quality control guidelines.
- Preparing the drawings, specifications, and contracts in according to these specifications.
- If no standard is specified, then the relevant British Standard (BS) might deemed to apply, but the Engineer may at his discretion accept materials in accordance with other standards specifications (ASTM) if the quality is equivalent or superior to the (BS).

9.2 The Contractor

The Contractor shall adhere strictly to the following:

- Following the construction material quality control guidelines (Rak Municipality issued), or equivalent which are referred to in the Contract Documents.
- If no standard is specified, then the relevant to this guidelines Standard (BS) might deemed to apply, but the Engineer may at his discretion accept materials in accordance with other standards specifications (ASTM) if the quality is equivalent or superior to the (BS).
- The Contractor shall fully demonstrate in detailed documentation that he is complying with the construction material quality control guidelines and that he has investigated all local and imported manufactures of all products and materials listed in this specification. Preference must be given to UAE produced materials and products. In the event that the correct quality or cost margins are not met these shall be brought to the attention of the Consultancy/owner prior to rejection. The Consultancy/owner reserves the right to direct Contractors to purchase locally produced materials rather than overseas materials where all other factors are equal.
- Approval of materials, products or systems shall not, relieve the Contractor of full responsibility under the contract.

9.3 The Manufacture

- All Construction material manufactures shall comply with RAK Municipality requirements for material approvals.
- Certificates of Conformity for the specific material will be required for certain building materials as part of the product certifications to be decided by RAK Municipality and to be presented for the engineer's approval.
- All materials used must be manufactured by a factory possessing an established and approved quality control scheme complying with the requirements of RAK Municipality Guidelines/Regulations.
- Local manufacturers must periodically perform testing for compliance with the relevant standard at an approved independent laboratory by RAK Municipality. The local manufacturer shall have satisfactory, functioning and fully documented quality assurance procedures.

9.4 The Material Supplier

The suppliers shall adhere strictly to the following:

- All construction material quality control Guidelines, standard specifications, Codes of Practice, or similar which are referred to in the Contract Documents. If no standard is specified, then the relevant British Standard (BS) might deem to apply, but the Engineer may at his discretion accept materials in accordance with other standards specifications (ASTM) if the quality is equivalent or superior to the (BS).
- Certificate of Conformity will be required for certain building materials to be decided by RAK Municipality and to be presented for the engineer's approval as part of the requirements for the suppliers' registration.
- Materials shall be handled, stored as per manufacturer's recommendations, handed carefully, and kept clean.

Finally, all business partners must work as a team to fulfill the construction material quality control guidelines, specification and conform the minimum requirements in accordance with it, to ensure the quality of construction and elevate the welfare level in the emirate.

End of the Guideline