Materials Testing

Introduction

Construction material science is the engineering object that involved with the use of construction materials in constructing buildings in a way that achieve the strength, economy, safety and durability. This science also search anew suitable materials to be used in building construction. Building materials have an important role to play in this modern age of technology. Although their most important use is in construction activities, no field of engineering is conceivable without their use. Also, the building materials industry is an important contributor in our national economy as its output governs both the rate and the quality of construction work.

There are certain general factors which affect the choice of materials for a particular scheme. Perhaps the most important of these is the climatic background, Obviously, different materials and forms of construction have developed in different parts of the world as a result of climatic differences. Another factor is the economic aspect of the choice of materials. The rapid advance of constructional methods, the increasing introduction of mechanical tools and plants, and changes in the organization of the building industry may appreciably influence the choice of materials.

Reference books:

1-Building Materials (Third Revised Edition), S. K. Duggal.

2- A Text Book of Building Materials, C.J, Kulkarrni,

3- Building Materials, P.C. Varghese, PHI, Pvt. Ltd.

4- Building Construction, P. C. Varghese, PHI, Pvt. Ltd.

Specification, Codes, Standards

Specification, Codes, Standards:

Standard: A Standard can be defining as a set of technical definitions and guidelines that function as instructions for designers, manufacturers, operators, or users of equipment, Ex ASME31.3 is a standard for process piping.

Code: A standard becomes a Code when it has been adopted by one or more governmental bodies and is enforceable by law, or when it has been incorporated into a business contract.

Specification: Specifications clearly and accurately describe the technical requirements of any given product or process and are used heavily by purchasing departments for controlling the quality of incoming materials, EX: ASTM C150, "Specification for Portland Cement"

Below some of some of the Specifications, Codes and Standards with their abbreviations.

IOS	Iraqi Standard
ACI	American Concrete Institute
ASTM	American Society for Testing and Materials
BS	British Standard
BS EN	British –Adopted European Standard
AASHTO	American Association of State Highway Transportation Officials
ISO	International Organization for Standardization

A specification often refers to a set of documented requirements to be satisfied by a material, design, product, or service. A specification is often a type of technical standard. There are different types of technical or engineering specifications (specs), and the term is used differently in different technical contexts. They often refer to particular documents, and/or particular information within them. The word specification is broadly defined as "to state explicitly or in detail" or "to be specific"

The specifications usually containing the following information:

1- Manufacturing Method.
2- The shape – Dimensions – Finishing.
3- Desired physical and chemical properties.
4- Limits of undesirable factors and components.
5- How to take Samples.
6- Method of examination and control.
7- Standard definition of the material.

One of the most important benefits of standard specifications:

Let's look at the main reasons why the specification is so important to the construction process:

1. It provides clear instructions on the intent, performance and construction of the project.
2. It can reference the quality and standards which should be applied.
3. Materials and manufacturers' products can be clearly defined.
4. The requirements for installation, testing and handover can be identified.
5. Classification in the specification can be used to support handover and running of the asset.

6.The drawing or model does not need to be overloaded with detailed information, which can sometimes be difficult to identify.
7. It can be used to support the costing of a project: not only the materials and products but also the performance and workmanship
8.The specification forms part of the contractual documents, along with the drawings, and therefore can help minimise project risk and provide support should there be any legal disputes.
9.It supports the interpretation of the client brief and gives the client assurance that the asset which they commissioned is being delivered.
10. It is not only essential for the construction phase but also used as part of the soft landing process, subsequent asset management and the lifecycle plan.
11. By being clear and concise and containing all the information, it saves the project team, the client and the contractor time and money by providing answers to many of the on-site construction questions.
12. There is the option for the design team to build a suite of office masters, which would improve efficiency, provide quality assurance and project consistency.
13. Office masters can save the team time and money by being developed over a period of time and then being adapted to suit the project specifics, therefore drawing on specialist knowledge when needed.
14. The specification should be used by all the project team throughout the construction phase; it should be a living document and not stop being used at the design phase.
15. The specification and any variations or value engineering can also be used for the project audit trail and should form part of the handover documents. It will then form the basis for the running of the asset by the asset management team.

Materials testing, measurement of the characteristics and behavior of such substances as metals, ceramics, or plastics under various conditions. The data thus obtained can be used in specifying the suitability of materials for various applications—e.g., building or aircraft construction, machinery, or packaging. A full- or small-scale model of a proposed machine or structure may be tested. Alternatively, investigators may construct mathematical models that utilize known material characteristics and behavior to predict capabilities of the structure.

Materials testing can be classified into the following major categories:

1-Subject of Testing

A-Commerciale Testing:

These are the tests that carry out for the materials in relation to their characteristics in order to accept them if they are conforms to commercial specifications or for the purposes of controlling production or manufacture, and this follows standard steps to know whether the material conforms to the specifications or not.

B-Research Testing:

The usual purposes of research Testing are:

1. To obtain new information for familiar materials.
2. To discover the properties of new materials.
3. To develop standard methods for testing materials.
4. To study the behavior of certain materials and indicate their suitability for special uses.

C-Scientific Testing:

The purpose of these tests is to obtain basic, useful and reliable information for the materials when it requires knowledge of their exact properties and behaviors in any design.

2- Location of Testing

According to the location of test there is two types:

1- Field Tests of Building Materials.

2- Laboratory Tests of Building Materials.

1- Field Tests of Building Materials.

Field test of brick, cement, sand and stone chips are very much essential as they are the most common construction materials which are used in almost all of the civil engineering construction from brickwork to floor finishing everywhere. As a civil engineer, working in a site is the challenging one, as on the site engineer all the responsibility and liabilities depends upon for good quality construction. But alone a good supervision is not enough for a good construction having required properties and durability. A proper quality control is essential at all the stages, specially at the very start, where we have to select right materials for a type of construction, as the materials are the cell of each structure. A Civil Engineer may not always have the facility of laboratory at the site for the testing of materials so as to ascertain the quality of a material weather it is bad or good, suitable or not. So a civil engineer should be able to judge the quality of the basic construction materials such as Brick, Cement, Sand

and Stone Chips by means of Visual Inspection of those materials, which can be done by doing the Field Test on those materials. Here I've listed the different field tests for basic construction materials which becomes necessary in day to day work.

How To Check If A Brick Is Good?

The following field tests are to be performed in order to determine if a Brick is good: -

1. A good brick should be of proper shape and standard specified size, the edges of it should be sharp, there should not be any cracks and fissures on the brick.
2. The colour of a good brick should be copper red colour. A yellowish tint on brick indicates that it is under burnt and hence possessing of lower strength, and if a brick is of dark blackish blue colour then it indicates the brick is over burnt and is brittle in nature.
3. When a brick is struck by a hammer or against another brick, it should emit a clear metallic ringing sound, it should not be dull.

4. A freshly fractured brick should show a homogeneous compact structure without any lumps.
5. If a brick is dropped from about a height of 1m on a hard ground or on another brick, it should not break.
6. When a brick is scratched with finger nail it should not leave any impression on the brick.
7. A good brick (1st Class) should not absorb water by not more than 20% of its own Dry weight when immersed in water for a period of 24 Hours.

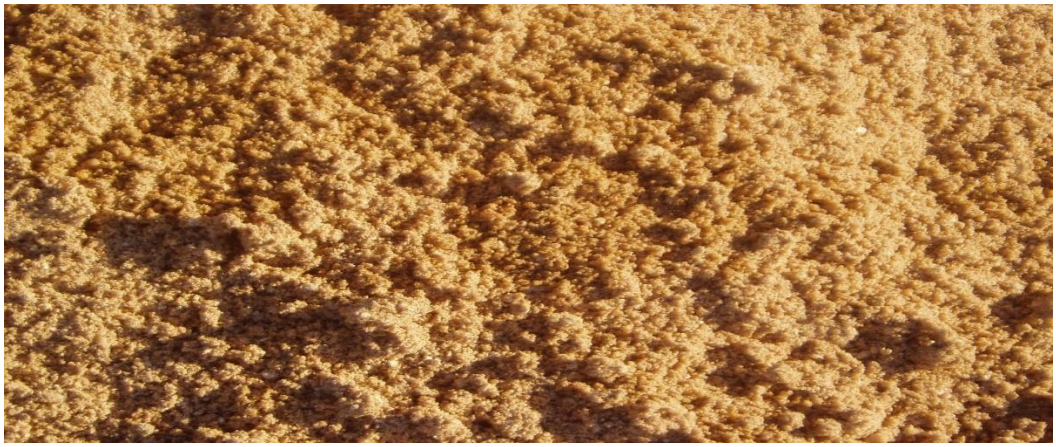
How To Check If Cement Is Good?

The following field tests should be performed to determine if the cement is of good quality: -

1. The cement should be of Greenish Gray colour for Ordinary Portland Cement, and Blackish Gray colour for Portland Pozzulana Cement and Whitish Gray colour for Portland Slag Cement.
2. There should not be any hard lumps on cement, the cement should be finely powdered. If cement contains hard lumps, then it must be rejected.

3. The cement when rubbed between fingers should feel smooth, it should not feel granular. If it is granular then it means adulteration with sand.
4. A cement paste should feel sticky in between fingers.
5. When hand is dipped into a heap or into a bag of cement, it should feel cool, not warm.
6. If a hand full of cement is thrown into a bucket of water, the cement should sink, not float as the Specific Gravity of Cement is greater than that of Water.
7. If a thick cement paste made on a glass and immersed in water should set, not crack.

How To Check If Sand Is Good?



The following tests should be performed to determine the quality of Sand: -

1. The Sand should be free from organic impurities and mineral salts, The maximum permissible quantity of organic impurities should be restricted to 5%.
2. The Sand should be of Golden Yellow colour.
3. The Sand particles should be sharp and angular to increase the interlocking property between the sand particles.

4. The sand should coarse for Concreting and medium sand may be allowed in brickwork and is preferable for plastering works.

How To Check If Stone Chips Are Good?

The visual tests or field tests for Coarse aggregate, that is stone chips are very limited though there are many laboratory tests are available. Mainly the following things are observed as for Field Test: -

1. The Stone Chips are to be well graded to increase the mechanical interlocking between them.
2. Stone Chips should be Angular as far as possible and be porous.
3. The Stone Chips should not be flaky and elongated.
4. The Stone Chips should not contain organic and other impurities, as only 5% clay content in concrete can reduce the strength of the concrete as much as 20%.

2- Laboratory Tests of Building Materials.

This includes all materials used in construction work, whether they are products or raw materials. For example: -

- Adhesives & sealants
- Bricks
- Blocks
- Building hardware
- Cement
- Ceramic
- Concrete, grout & mortar
- Construction materials & geological samples
- Floors
- Insulating products
- Lintels
- Masonry - slate & stone
- Pavers
- Pipes
- Rock & natural stone
- Slates
- Soils & stabilized soils
- Tiles.

3- Way of Testing

According to the general method used:

1-Testing on full size model.

2-Testing on a small model.

3- Testing on a model cut from the original model.

4- Testing on a sample of materials made or raw.

4- With regard to the use of the substance after the examination:

1- Destructive Testing:

An examination is carried out on a sample so that after this examination is performed the sample is not valid for the use for which it was intended. Such as a tensile test of the reinforcing bars or the compression of the clay bricks. For example, the following tests:

- Extracting, End preparation and Testing of 50 mm-150 mm diameter core samples
- (concrete roads, slabs, concrete culverts, beams, columns, decks, walls, wing walls etc.,)
- Windsor probe test: Penetration resistance of concrete existing Structure
- Extracting and determining the density of bituminous mixture
- Pullout Test

2- Non-Destructive Testing:

An examination is carried out on a sample or structure without affecting in the properties of the model negatively, the model remains valid for the use for which it was designed. Like an ultrasound scan. For example:

1. **Ultra-Sonic pulse velocity (UPV) Test**

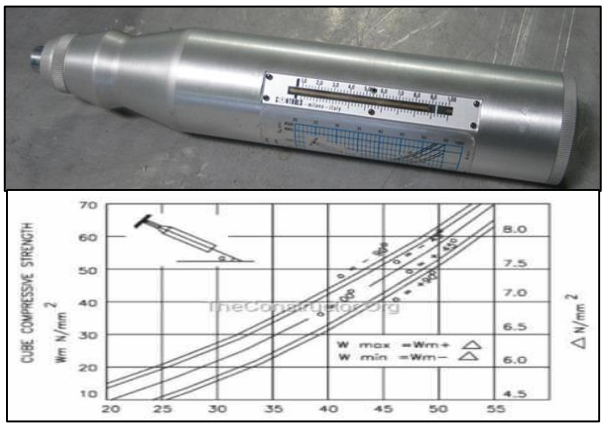
An ultrasonic pulse velocity (UPV) test is an in-situ, nondestructive test to check the quality of concrete and

natural rocks. In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic pulse passing through a concrete structure or natural rock formation. It is used in :

- Measure the quality of concrete (Direct method)
- Measure the quality of concrete (Indirect method)
- Measure the crack depth (Indirect method).

2. Re-bound hammer test

Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring controlled mass that slides on a plunger within a tubular housing.



Objective of Rebound Hammer Test

As per the Indian code IS: 13311(2)-1992, the rebound hammer test has the following objectives:

1. To determine the compressive strength of the concrete by relating the rebound index and the compressive strength.
2. To assess the uniformity of the concrete
3. To assess the quality of the concrete based on the standard specifications.
4. To relate one concrete element with other in terms of quality.
5. Measure the surface hardened of concrete.

3-Cover meter test:

A cover meter is an instrument to locate rebars and measure the exact concrete cover. Rebar detectors are less sophisticated devices that can only locate metallic objects below the surface. Due to the cost-effective design, the pulse-induction method is one of the most commonly used solutions

- Measure the Re-bar location/Diameter.
- Measure the Re-bar location for core cutting.

- **4-Other tests:**
- Measure the crack width.
- Carbonation test (without drilling).
- Load test.
- Half-cell potential test.
- Pull-Out Test.

QUSTIONS OF LECTURE One