

**AIU Exam – Civil Engineering and Materials**

**Subject of Courses**: ***Basic Civil and Mechanical Engineering***

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**Name of study material (video or book)**:

***Basic Civil and Mechanical Engineering* by Shanmugam G**, (**Chapter 3)**

**Link to access study material (video or book):**

[**http://aiustudev.aiu.edu/submissions/profiles/resources/onlineBook/S7i8v6\_Civil\_and\_Mechanical\_Engineering-2018.pdf**](http://aiustudev.aiu.edu/submissions/profiles/resources/onlineBook/S7i8v6_Civil_and_Mechanical_Engineering-2018.pdf)

**Exam Starts Here.**

**Introduction**: In the following space, write 4 to 8 paragraphs to introduce the topics covered in the exam.

 In this essay critical explanations will show and disregard and bias and any disadvantages of Civil engineering in relation to materials. Materials are very important "tool" to say in engineering system. Materials represent a key component of an Engineering system. Materials can come in different forms as well and certain industries complement each other having a huge external effect on the market.

 This course seeks to bring to the Civil Engineer the knowledge and use of materials in systems Infrastructure Engineering such as construction materials including Bricks, cement, concrete cement, stones and steel. The questions below provide an detailed insight in to what are construction material, their structure, the different types and a most importantly their uses. Thus, the Civil Engineer managing any type of Engineering system which uses any of these materials will have a firm grasp of the different material available especially if he must use cement, concrete, brick, cement concrete and steel.

 Critical functions and role of a Civil Engineer are also described in this course which is very important. The Civil Engineer has a critical role to play in the systems engineering process.

**Questions:**

Answer each question below with complete paragraphs. Also give examples to illustrate the ideas. As well, give examples on how you would apply the knowledge in your work or life.

**Chapter 3**

1. List the uses of the following construction materials: bricks, stones, cement, cement concrete and steel.

*Bricks*

 These are materials used in different engineering systems. For example, in Construction Engineering, Residential Buildings, Construction of a Residencial House. Bricks could be used to design a wall inside the Dining room or outside like the Garage. This is a common use of Bricks. Bricks are also cheaper and easy to handle. They also consume less mortar and less labor.

*Stones*

 Is a useful, versatile and common material used in all industries that are involved in Infrastructure. Stones properties and structure allows its use to be a necessary component of different Civil Engineering Systems. Stones are made from Rock. Stones are usually dressed. This procedure brings the stone to a form usable by the customer or buyer. A critical procedure concerning the material science is the testing of stones. Some examples include the Hardness Test and the Impact Test.

*Cement*

 Cement is a material usually made and supplied in powder form in cement protective bags. Another definition is Cement is obtained by burning at a very high temperature a mixture of calcareous and

argillaceous materials. Shanmugam,G. and Palanichamy,M,S. (2018)

Cement Concrete

 Cement Concrete is a mixture of cement of a suitable quality mixed with other components such as sand and water to form concrete. It is the hardened form of concrete and is used in all forms of construction where concrete cement is needed. Is a durable and hard material as well.

2. What are the qualities of a good brick?

These are the nine qualities of good bricks.

I. Bricks should have perfect edges, well-burnt in kilns, copper colored, free from cracks with proper rectangular shape and of standard size (19 × 9 × 9 cm).

 II. Bricks should give a clear ringing sound when struck with each other.

 III. Bricks must be homogeneous and free from voids.

 IV. The percentage absorption of water by weight should not be greater than 20 per cent for first-class bricks and 22 per cent for second-class bricks when soaked in cold water for 24 hours.

 V. Bricks should be sufficiently hard, i.e., no nail impression must be present when scratched. The average weight of bricks should be 3–3.5 kg.

 VI. Bricks should not break when dropped from a height of 1 m.

 VII. Bricks should have low thermal conductivity and should be soundproof.

 VIII. Bricks should not show deposits of salts when immersed in water and dried.

 XV. The minimum crushing strength of bricks must be 3.5 N/mm2

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3. What are the requirements for a stone which is to be used as a building material?

 Building material called stones are made or produced from rock.

Stones are a strong material and humans in the past used Stones in building Construction. Stones are used in the infrastructural components such as:

a} Foundations

b} Walls

c} Columns

d} Lintels

e} Arches

f} Roofs

g} Floors

h} damp proof courses

 Additionally, stones are used with brick masonry for various structures and designs. Civil Engineers in public roles or private roles use stones in Pavement Installation. Stones are also a key component for concrete, moorum of roads, calcareous cements, ballast in railways, flux in blast furnaces, in construction of bridges piers, abutments, retaining walls, light houses and dams. All these are what makes a stone valuable making it suitable for use as a building material.

 Types of Building Stones

a) Granite

b) Basalt and Trap

c) Chalk

d) Limestone

e) Sandstone

f) Laterite

g) Gneiss

h) Marble

i) Gravel

j) Slate

k) Quartz

4. Explain the properties of cement.

 *What are the properties of cement?*

Cement has many properties including:

a) The cement is uniform e.g. grey.

b) Cement should sink in a bucket of water and when touched should be cool and uniform.

c) Cement should be free of lumps.

d) . Cement mortar at the age of three days should have a compressive strength of 11.5 N/mm2 and tensile strength of 2 N/mm2. Also, at the age of seven days, compressive strength should not be less than 17.5 N/mm2 and tensile strength should not be less than 2.5 N/mm2.

e) The alumina iron oxide ratio should be greater than 0.66.

f) If ignited Cement should not lose more than 4% of its weight.

g) Total Sulphur content should be greater than 2.27%.

h) Insoluble residue weight(cement)<(less than) 5%(shouldn't be greater)

i) Magnesia weight should not exceed 5%.

j) The specific surface of cement as found from the fineness test should not be less than 2250 mm2/gm.

k) Setting time= 30 minutes/Final setting time=10 hours

l) Cement expansion after soundness test= 10mm

These are the 12 properties that make up a good cement. Shanmugam,G. and Palanichamy,M,S. (2018)

5. Which are the normal steel sections available in the market? Give neat sketches.

6. Explain in detail, the functions of a civil engineer.

These are the functions of a Civil Engineer:

 *Functions of a Civil engineer*

Civil engineering incorporates activities such as construction of structures like buildings,

dams, bridges, roads, railways, hydraulic structures, water supply and sanitary

engineering.

 Various functions of a civil engineer are listed below.

1. Investigation:

 The first function of a civil engineer is to collect the necessary data that is required before planning a project.

2. Surveying: The objective of surveying is to prepare maps and plans to locate the various structures of a project on the surface of earth.

3. Planning: Depending on the results obtained from investigation and surveying, a civil engineer should prepare the necessary drawing for the project with respect to capacity, size and location of its various components. Based on this drawing, a preliminary estimate should be worked out.

4. Design: After planning, the safe dimension of the components required are worked out. With this dimension a detailed drawing is prepared for various components and for the whole structure and a detailed estimate are also calculated.

5. Execution This function deals with the preparation of schedules for construction

activities, floating of tenders, finalization of contracts, supervision of construction work, preparation of bills and maintenance.

7. Explain the constituents of brick.

The constituents of "Bricks" are provided below and are:

1.Alumina

2. Silica

3. Lime,

4. Oxide of Iron

5. Magnesia

 1. Alumina: It is the chief constituent of clay. A good brick should have 20–30 per cent of alumina. This imparts plasticity to the earth.

2. Silica: It exists in clay in a free or combined form. A good brick earth should contain about 50–60 per cent of silica. The presence of silica prevents cracking, shrinking and warping of raw bricks. It imparts uniform shape to bricks. The durability depends on proper proportion of silica.

3. Lime: Up to 5 per cent of lime is desirable in good brick earth. It prevents shrinkage in raw bricks. Sand alone is infusible, but it fuses at kiln temperature due to the presence of lime. Bricks may melt and lose their shape due to excess of lime content. Civil Engineering and Materials 3.7

4. Oxide of iron: This gives the red color to bricks. A small quantity of iron oxide up to 5 or 6 per cent is desirable.

5. Magnesia: This imparts yellow tints to bricks, and it reduces shrinkage.

8. Describe the various types of cement, specifying the applications for each.

What are the various types of cement?

 There are different types of cement which will be described below and since they are different, they have different uses; Note cements may be Portland or non-Portland cement:

(1) Rapid-hardening Cement:

 This cement hardens rapidly and is used where high-quality strength is needed. This cement is used where infrastructure needs a high, high strength. For e.g., repair works and early removal of formwork.

(2) Sulphate-resisting Cement:

 This type of cement is used in cement lacking cement like ordinary Portland cement and used in infrastructure where sulphate content is high to fight the effects of sulphates. Used in construction of sewage treatment works, marine structures and foundations in soils having a high sulphate content.

(3) Low-heat Cement:

 - hardens slowly

 - produces less heat than other cements when reacting with water.

 - used in “Mass Concreting works” e.g., Construction of Dams.

(4) Quick-setting Cement:

 - sets quickly. E.g., used in drainage systems.

 - reduced content of “Gypsum” = causes cement to set quickly due lack of Gypsum.

 - used for “Underwater Construction” and “Grouting Operation”

(5) Portland Pozzolana Cement:

- siliceous material.

-produces less heat of hydration.

- Greater resistance to the attack of aggressive water.

-Produced by grinding cement clinker, pozzolana with gypsum.

(6) High-alumina Cement:

-produces high heat when mixed water.

-causes high early strength development.

-USE=good for infrastructure in cold climates.

(7) Air-entraining Cement:

- mixture of a small amount of an air-entraining agent with ordinary Portland cement.

-Frost resistance of hardened concrete increased.

-properties of concrete can be changed due to the different components.

(8) Masonry Cement:

-Great plasticity; more than Portland Cement

-great workability; more than Portland Cement

-great water retentivity. more than Portland Cement

-Masonry Construction, e.g., mortars and plasters

(9) Expansive Cement:

- Produces an expansion in concrete during curing/ cracks are avoided due to expansion.

- used to overcome cracks in reinforced cement concrete structures.

(10) Hydrophobic Cement:

- water -repellent cement.

-Improves workability of concrete.

-Can be stored for long duration in wet-climatic conditions.

(11) Colored Cement:

- consists of ordinary Portland cement with 5% to 10% pigment for coloring.

- Used for aesthetic purposes.

(12) White Cement:

- Cement which is white.

-same functions as ordinary Portland Cement.

- used for architectural purposes.

-used for manufacturing colored concrete, flooring tiles. etc.

(13) High- Strength Cement

- High strength concrete.

-components; higher content of C3S & higher fineness.

-used in railway sleepers, prestressed concrete, precast concrete, and air-filed works.

9. Briefly explain the different types of light weight concrete and list out its advantages.

Light-Weight Concrete characteristics:

* low -density concrete.
* low- thermal conductivity.
* lowers handling costs and haulage

 Types of Light-weight Concrete:

1. Light-weight aggregate concrete:

 This concrete is produced by replacing the minerals aggregate with cellular porous or light weight aggregate. Two categories of this concrete;

Natural light-weight aggregates and Artificial light-weight aggregates.

Natural light-weight aggregates are:

 (i)Pumice

 (ii) Diatomite

 (iii) Scoria

 (iv) Volcanic cinders

 (v) Saw dust

 (vi) Rice husk

 Artificial light-weight aggregates are:

 (i) Artificial cinders

(ii) Foamed slag

(iii) Bloated clay

 (iv) Sintered fly ash

1. ) Aerated concrete:

 This is concrete that is a mixture of water, cement, finely crushed sand with air or gas introducing agents.

For example: aluminum power (powered metal) may be used to create air bubbles.

(c)No-fine concrete:

Method of Production.

Sand is not used in the manufacturing ingredients of the aggregate. This concrete is made up of only single-sized aggregate of size passing of 20 mm and retained on 10 mm coarse aggregate, cement and water. The single sized aggregate makes a good no-fine concrete, which in addition gives large voids and hence is light in weight. It also offers an architecturally attractive look.

10. Write short notes on the following types of concrete.

(i) High-density concrete:

 This type of concrete is denser than normal concrete thus the name high-density concrete. Mainly used in the construction of radioactive shields. The unit weight ranges from about 3360-3840 kg/m3. This Concrete is made by using heavy aggregates such BARITE, MAGNETITE, LEMONITE. In this type of manufacturing process, it is necessary to control the water cement ratio, correct admixture and vibrators for good compaction.

 (ii) Polymer concrete:

 When normal concrete is lacking in quality due to water voids and air voids due to high water-cement ratio and other factors “Polymer concrete” is used. Polymerization is used to reduce the porosity of the concrete.

(iii) Fiber reinforced concrete:

 This is where concrete tensile strength is low and certain methods are used to increase the inherent tensile strength. Methods used may include using conventional reinforced steel bars or using fibers in the concrete.

11. Describe briefly the factors affecting workability.

 There are many factors which affect workability such as:

1.Qualified or unskilled workers.

2.Transporting equipment

3.Distance

4.Quality of concrete

12. Explain, how you will measure the workability of the concrete mixture.

 A Civil Engineer for example will use tests to test the workability of the concrete. Tests for example are Flow test, compaction test, slump test.

 Tests such as Flow test and Compaction Test are mainly used in a Laboratory setting.

 Slump Test are used mostly in the field. The slump procedure is as follows:

 The standard slump cone is placed on the ground. The operator holds the cone firmly by standing on the foot pieces. The cone is filled with about onefourth portion and then rammed with a rod which is provided with bullet nose at the lower end. The diameter of the rod is 16 mm, and its length is 60 mm. The strokes to be given for ramming vary from 20 to 30. The remaining portion of the cone is filled in with similar layers and then the top of concrete surface is struck off such that the cone is full of concrete. The cone is then gradually raised vertically and removed. The concrete is allowed to subside and then the height of concrete is measured. The slump of concrete is obtained by deducting the height of concrete after subsidence from 30 cm.

13. Briefly explain about the testing of hardened concrete.

 The testing of hardened concrete is very important in can be used by Civil Engineers to test the concrete. Tests that can be done by a Civil Engineer for any Design system during the preparation phases and maintenance phases of an Infrastructure system include the following:

1. Tensile strength
2. Compressive strength
3. Non-destructive tests for concrete

14. Explain the various factors affecting the compressive strength of concrete.

 There are many factors affecting the compressive strength of concrete and this is a very important aspect of any Infrastructure system that uses concrete. Concrete in modern times is a key component of Infrastructure systems. Factors include and are very important as well:

1. Types of cement:

 The composition, quality and the age of the cement used in the concrete mixture has a direct influence on its STRENGTH. If the cement has been stored for a long timeframe it will make the concrete weaker or the strength will be weaker. If the cement has a content of TRI-CALCIUM SILICATES and /or the very fine particles in terms of cement size the concrete will have a HIGHER STRENGTH.

1. Nature of Aggregates:

The two essential components of concrete are:

1.Sand.

2. Coarse aggregates.

 The nature/structure of the Coarse aggregates influence the bonding between the cement and the aggregates and thus the quality of concrete.

The aggregates should also have a reasonable/good compressive strength.

Some examples:

1.component=chalk/soft limestone….weak compressive strength.

2.Component= massive limestone…weak compressive strength.

These two examples above relate to the strength of the aggregates, soft limestone has a weak strength and massive limestone has a strong strength thus resulting in the concrete weak or strong.

Structure of aggregates:

1.Aggregates with sharp edges, clean surfaces and rough texture= good bonds.

2.Aggregtes with smooth and rounded bonds=poor bonds.

1. Water-cement ratio:

 Important: In the cement mixture with other things being the same when the cement-water ratio increases the compressive strength decreases. Thus, it is very critical that the Civil Engineer in charge maintains minimum water or a low level of water in the concrete mixture to obtain maximum compressive strength on proper compaction.

1. Curing Conditions:

 The Civil Engineer in his role whether Design Engineer or Project Manager must supervise or detail proper curing instructions to cure the concrete. The concrete should be allowed to cure properly after its laying resulting in obtaining maximum compressive strength.

 Effects of Improper Curing

The Civil Engineer will face curing problems as during the curing period if:

>Incomplete curing of concrete.

>Incomplete Intermittent drying of concrete.

These problems will cause a loss of the compressive strength of the concrete to an extent of 40% or more.

1. Weather Conditions:

 Another important factor that the Civil Engineer must consider is the weather conditions. The weather conditions can cause the complete or incomplete hydration of the cement in the concrete which results in the concrete having variable strengths. Weather conditions include:

* Extremely cold
* Dry and hot
1. Admixtures:

 Another critical technique that can be implemented by the Civil Engineer is to add admixtures to the concrete to increase or reduce the strength of the concrete.

For e.g., calcium chloride increases compressive strength.

Some other admixtures such as air entraining agents affect the compressive strength of the concrete especially if the water-cement ratio is not controlled.

1. Methods of Preparation

 Improper mixing of the concrete and careless transport and storing may result in poor strength despite best cement and aggregates used in it. It is the workmanship that determines the quality of the concrete work in ultimate analysis. A skilled worker can produce best concrete works despite some other deficiencies. An incompetent worker, however, may spoil the entire work despite being given the best designed concrete mix. The voids left in the concrete on compaction and curing have a profound influence on the strength of the concrete.

It is the duty of the Civil Engineer to obtain quality workmanship to ensure quality production throughout the system Engineering process.

15. Explain the methods of testing the tensile strength of concrete with a neat sketch.

. Cement mortar at the age of three days should have a compressive strength of

11.5 N/mm2

 and tensile strength of 2 N/mm2

. Also, at the age of seven days,

compressive strength should not be less than 17.5 N/mm2 and tensile strength

should not be less than 2.5 N/mm2

**Conclusion**:

 In the Construction Industry, materials are very important and so the technical aspects of all types of material need to be studied and the use and functions be understood.

 Material such as stones, brick, cement, concrete cement, wood is used in all types of Engineering systems. For example, cement usage depends on the type of work done and the perspective quality of cement should be chosen. If the work is going to be done in watery areas the type and quality of cement should be different in both systems.

 I intend to improve my life and work by using my engineering skills to build and repair systems and earn a reasonable or exceptional amount of money. Knowledge of materials hence is very important.

**Bibliography:**

1. ***Basic Civil and Mechanical Engineering* by Shanmugam G**, (**Chapter 3)**
2. Building Material <https://en.wikepedia.org>> Building Material