Subject Name: ConcreteTechnology

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Year and Sem, Department: III yr-I sem, Civil

UNIT I
CEMENT AND ADMIXTURES
PART-A

1.What are Bouge's compounds?

Bogues Compounds: when water is added to cement it react with the ingredients of the cement chemically & results in the formation of complex chemical compounds terms as BOGUES compounds:

1. Tri-Calcium Aluminate (3CaO.Al2O3 or C3A) ----------8-12%

2. Tetra Calcium Alumino Ferrate (4CaO.Al2O3.Fe2O3 or C4AF)----6-10%

3. Tri-Calcium Silicate (3CaO.SiO2 or C3S)----------30-50%

4. Di-Calcium Silicate (2CaO.SiO2 or C2S)----------20-45%

2. Explain in detail how each one of these compounds influences the strength and setting properties of cement?

1. **Tri-Calcium Aluminate (3CaO.Al2O3 or C3A)**
   Formed in 24 hrs of addition of water
   Max. evolution of heat of hydration
   check setting time of cement
2. **Tetra Calcium Alumino Ferrate (4CaO.Al2O3.Fe2O3 or C4AF)**
   Formed within 24 hrs of addition of water
   High heat of hydration in initial periods
3. **Tri-Calcium Silicate (3CaO.SiO2 or C3S)**
   Formed within week
   Responsible for initial strength of cement
   Contribute about 50-60% of strength
   Content increase for the pre fabricated concrete construction, Cold weathering construction.
4. **Di-Calcium Silicate (2CaO.SiO2 or C2S)**
   Last compound formed during hydration of cement
   responsible for progressive later stage strength
   Structure requires later stages strength proportion of this component increase
   E.g. hydraulic structures, bridges.

3. Explain heat of hydration and hydration process of cement in detail.

- The heat of hydration of cement is usually determined in accordance with ASTM C 186, Standard Test Method for Heat of Hydration of Hydraulic Cement (see box). Table 1 has heat of hydration values for a variety of portland cements from 1992 to 1996. Although this data is very limited, it confirms the general trends expected: Type III cement has higher heat of hydration than other cement types (average = 88.5 cal/g at 7 days) and Type IV has the lowest (average = 55.7 cal/g at 7 days). Portland cement evolves heat for a long time. (4) Reference 4 and Fig. 2 present heat of hydration data out to 13 years. shows that the rate of heat generation is greatest at early ages. Usually, the greatest rate of heat liberation occurs within the first 24 hours and a large amount of heat evolves within the first 3 days. For most concrete elements, such as pavements, long-term heat generation is not a concern as this heat is dissipated into the environment.

4. Explain setting time of cement and factors effecting setting time of cement.

Materials can be selected to minimize or maximize the heat of hydration, depending on the need. Cements with higher contents of tricalcium silicate and tricalcium aluminate, as well as a higher fineness, such as Type III cements, have higher rates of heat generation than other cements. Tricalcium silicate and tricalcium aluminate chemically generate more heat, and at a faster rate, than dicalcium silicate or other cement compounds. Sulfate content, in its relation to controlling the hydration of calcium aluminate, participates in the rate of heat liberation.

5. Explain about the dry process of manufacturing of Portland cement?

1- Moisture content of the pellets is 12%
2- Size of the kiln needed to manufacture the cement is smaller
3- The amount of heat required is lower, so the required fuel amount is lower
4- More economically
5- Difficult to control the mixing of raw materials process, so it is difficult to obtain homogeneous material
6- The machinery and equipments need more maintenance

6. Explain about the wet process of manufacturing of Portland cement?

1- Moisture content of the slurry is 35-50%
2- Size of the kiln needed to manufacture the cement is bigger
3- The amount of heat required is higher, so the required fuel amount is higher
4- Less economically

5- The raw materials can be mix easily, so a better homogeneous material can be obtained
6- The machinery and equipments do not need much maintenance

7. Discuss the difference between the wet and dry process of manufacturing of Portland cement?

Wet process	Dry process
1- Moisture content of the slurry is 35-50%	1- Moisture content of the pellets is 12%
2- Size of the kiln needed to manufacture the cement is bigger	2- Size of the kiln needed to manufacture the cement is smaller
3- The amount of heat required is higher, so the required fuel amount is higher	3- The amount of heat required is lower, so the required fuel amount is lower
4- Less economically	4- More economically
5- The raw materials can be mix easily, so a better homogeneous material can be obtained	5- Difficult to control the mixing of raw materials process, so it is difficult to obtain homogeneous material
6- The machinery and equipments do not need much maintenance	6- The machinery and equipments need more maintenance

8. Briefly explain different types of cement?

Different types of cement and their uses in construction work as follows:-

1. Rapid hardening cement

- When formwork is to be removed early for reuse.
- when sufficient strength for further construction is wanted .
- emergency repair work.
- in cold regions (Resistant to frost damage).

2. Portland pozzolana cement

- It can be used in mass construction work.
- It can be used for low cost housing project.
- For construction of water tanks & water retaining structures.
- It can be used in hot weather regions.

3. Portland blast furnace slag cement

- It can be used in mass construction work.

- It is used for construction of marine structures.
- It is used for areas with high sulphate content in ground water.
- For manufacturing of sewage pipes.

4. Sulphate resisting cement

- It is used for construction work near seashore or where sulphate content is higher in ground water

For construction of marine structures.

5. Low heat cement

- It is used in hot weather regions.
- For mass concreting works such as gravity dam and thick retaining wall.

6. White cement

- For joining marbles and ceramic tiles .
- For preparing joints of sanitary wares .
- It is also used for architectural works.
- It is used in manufacturing of mosaic tiles.

7. Expansive cement

- It can be used for repairing grouting cracks.
- Grouting of anchor bolts and machine foundations.
- It is used for sealing of water tight or airtight joints.

8. Masonry cement

- It can be used in mortar for brickwork (joining of bricks).
- It is also used in Rubble masonry.

9. Ordinary Portland Cement

- It is used for all general purposes and widely used for all ordinary concrete work, mortar, plaster etc.

10. Antibacterial cement

- It is used in places like Floors of food processing plants, swimming pool, pharmaceutical industries, hospitals, bakeries, public baths and similar places where bacteria and fungi develope.

11. Hydrophobic cement

It is used where prolonged storage is required for cement such as

1. At dam site.
2. Near military establishments.
3. At major airports and sea ports

9. Explain setting time of cement and factors effecting setting time of cement?

The mineral composition of cement and their ratios are the main factors affecting the setting and hardening of cement. As mentioned above, various mineral components will reveal different characteristics when reacting with water. For example, the **increase of**

C3A can **speed up the setting and hardening rate of cement**, and the **heat of hydration is high** at the same time.

Generally speaking, if mixed materials are added into the cement clinker, the anti-erosion will increase, and the heat of hydration and the early strength will decrease.

10. Explain the purpose of gypsum

Gypsum is called the retarding agent of cement which is mainly used for regulating the setting time of cement and is an indispensable component. Without gypsum, cement clinker can condense immediately by mixing with water and release heat. The major reason is that C3A in the clinker can dissolve in water quickly to generate a kind of calcium aluminate hydrate, a clotting agent, which will destroy the normal use of cement. The retardation mechanism of gypsum is: when cement is hydrated, gypsum reacts with C3A quickly to generate calcium sulfoaluminate hydrate which deposits and forms a protection film on the cement particles to hinder the hydration of C3A and delay the setting time of cement.

11. What is the Impact of Cement's Fineness?

The size of cement particles directly affects the hydration, setting and hardening, strength and heat of hydration.

However, if the cement particles are too small, it is easy for them to react with the water and the calcium dioxide in the air to destroy the storage of cement. If the cement is too fine, its shrinkage is large in the hardening process. Thus, the finer the cement is ground, the more energy will lose and the higher the cost will be. Usually, the grain size of the cement particles is within 7-200pm (0.007-0.2mm).

12. What is the Impact of Curing Conditions

The curing environment has sufficient temperature and moisture which is conducive to the hydration and setting and hardening process of cement and benefits the development of the early strength. If the moisture of the environment is very dry, the water in the cement will evaporate, leading to insufficient hydration and ceasing of the hardening. Serious cracks will happen sometimes.

Usually, the temperature rises at the time of curing, and the hydration of cement and the development of early strength become fast. If the hardening process occurs at a low temperature, the final strength won't be affected though the development of the strength is slow. But if the temperature is under 0^0C, the hydration of cement will stop and the strength will not only stop growing but also destroy the structure of cement paste due to the condensation of water.

13. What is the Impact of the Mixing Water Content?

If the cement consumption is unchanged, **the increase of the mixing water content will enhance the amount of capillary porosities, lower the strength of cement paste, and extend the setting time**. Therefore, in practical projects, the amount of water and cement will be changed without modifying the water-cement ratio (the minimum amount of cement is regulated to ensure the durability of concrete) when the liquidity of cement concrete is adjusted.

14. What is The Impact of Admixture?

Hydration, setting, and hardening of Portland cement are constrained by C3S, C3A. And all the admixtures that affect the hydration of C3S, C3A can change the performance of the hydration, the setting and hardening of Portland cement. For example, the accelerator agents (such as CaC12, Na2S04) can accelerate the hydration and the hardening of cement and improve its strength. On the contrary, the retarding agents (such as calcium lignosulphonate) can delay hydration and hardening of cement and affect the development of the early strength.

PART B (Short Questions)

1. Why does hydration of cement occur?
2. At what temperature is slurry burnt in a rotary kiln?
3. Explain different types of admixtures?
4. Write briefly about Accelerators.
5. Describe Wet process of cement manufacturing.
6. Write short notes on Air entraining agents
7. Describe Dry process of cement manufacturing.
8. Write short notes on Damp proofing agents
9. Write briefly about Retarders.
10. Explain the different types of cement in detail.

PART C (Long Questions)

1. What are Bouge's compounds? Explain in detail how each one of these compounds influences the strength and setting properties of cement?
2. Explain heat of hydration and hydration process of cement in detail.
3. Explain setting time of cement and factors effecting setting time of cement.
4. Discuss the difference between the wet and dry process of manufacturing of Portland cement?
5. Briefly explain different types of cement?
6. Explain setting time of cement and factors effecting setting time of cement?
7. Discuss the structure of hydrate cement.
8. Explain the following types of cement and their use in details.
   a) Rapid hardening cement
   b) Low heat cement
   c) Ordinary Portland cement
   d) Super sulphate cement.
9. Distinguish between plasticizers and super plasticizers.
10. Distinguish between natural and chemical admixtures
11. Describe the setting time and soundness test of cement.
12. Explain the different types of cement?
13. Describe the test done to determine aggregate abrasion value.
14. Explain different types of admixtures?
15. Explain the different types of Bouges compounds ?
16. Explain the different laboratory test on cement?
17. Define Admixture and explain the different admixture ?
18. Explain the different types of cement in detail.

19. Describe the setting time and soundness test of cement.
20. Write briefly about Accelerators.

OBJECTIVES

1. For quality control of Portland cement, the test essentially done is

A. setting time

B. soundness

C. tensile strength

D. consistency

E. **all the above.**

2.If 1500 g of water is required to have a cement paste 1875 g of normal consistency, the percentage of water is,

A. 20%

B. **25%**

C. 30%

D. 35%

E. 40%

3.Under normal conditions using an ordinary cement, the period of removal of the form work, is :

A. 7 days for beam soffits

B. 14 days for bottom slabs of spans 4.6 m and more

C. 21 days for bottom beams over 6 m spans

D. 2 days for vertical sides of columns

E. **all the above.**

4. Wp and Wf are the weights of a cylinder containing partially compacted and fully compacted concrete. If the compaction factor $\left(\frac{W_P}{W_F}\right)$ is 0.95, the workability of concrete is

A. extremely low

B. very low

C. low

D. high

E. **none of these**

5.For given water content, workability decreases if the concrete aggregates contain an excess of

A. thin particles

B. flat particles

C. elongated particles

D. flaky particles

E. **All the above.**

6.M10 grade of concrete approximates

A. 1 : 3 : 6 mix

B. 1 : 1 : 2 mix

C. 1 : 2 : 4 mix

D. 1 : 1.5 : 3 mix

E. none of these

7. For ensuring quality of concrete, use

A. single sized aggegates

B. two sized aggregate

C. graded aggregates

D. coarse aggregates.

8. What do you mean by workability?

a) ASTM C 125 defines workability as the property determining the effort required to manipulate a freshly mixed quantity of concrete with maximum loss of homogeneity
b) ASTM C 125 defines workability as the property determining the effort required to manipulate a freshly mixed quantity of concrete with minimum loss of heterogeneity
c) The strict definition of workability is the amount of useful external work, against the external friction between the individual particles in the concrete, necessary to produce full compaction
d) The workability is also defined as the ease with which a freshly mixed concrete can be properly compacted and also that it can be transported, placed, and finished

9. Workability of concrete can be improved by addition
a) Iron
b) Sodium

c) Zinc
d) Sulphur

10. Workability of concrete can be improved by?
a) More sand
b) More cement
c) More fine aggregates
d) Fineness of coarse aggregate

UNIT II
AGGREGATES

PART A

1. What is alkali-aggregate reaction? And how will it affect the concrete properties?

Alkali-aggregate reaction is a chemical reaction between certain types of aggregates and hydroxyl ions (OH-) associated with alkalis (Sodium Oxide and Potassium Oxide) in the cement. Usually, the alkalis come from the portland cement but they may also come from other ingredients in the concrete or from the environment. Under some conditions, the reaction may result in damaging expansion and cracking of the concrete. Concrete deterioration caused by alkali-aggregate reaction is generally slow, but progressive. Cracking due to alkali aggregate reaction generally becomes visible when concrete is 5 to 10 years old. The cracks facilitate the entry of de-icing salt solutions that may cause corrosion of the reinforcing steel, thereby accelerating deterioration and weakening a structure.

2. Requirements of aggregate?

- They must be crushed aggregate.
- They shall be clean, hard, durable and cubical in shape.
- They must be free from the dust, organic matter and other deleterious matter.
- They not be flakey or elongated.
- They must not consist of injurious or harmful materials such that they reduce the strength of structure.
- They should resist wear due to abrasive action of traffic on the surface course.

3. Properties of aggregates:

The aggregate have three properties
1. Physical properties.
2. Mechanical properties.
3. Chemical properties.

4. Bring out the detailed classification of aggregates and explain each one of them briefly?

The aggregates are specified based on their grain size, shape, texture and its gradation and it is specified by various agencies like ASTM, BSI, ISI and IRC.
Based on strength property, the coarse aggregates are divided into hard aggregates and Soft aggregates. Identifying a remote user or other agent correctly (authentication)
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Main desirable properties of aggregate are

1) Strength

1. The aggregates to be used in road construction should be sufficiently strong to withstand the stresses due to traffic wheel loads.
2. The aggregates which are to be used in top layer of the pavements, particularly in the wearing course have to be capable of withstanding high stresses in addition to wear and tear; hence they should possess sufficient strength and resistance to crushing.

2) Hardness

1. The aggregates used in the surface course are subjected to constant rubbing or abrasion due to moving traffic.
2. They should be hard enough to resist the wear due to abrasive action of traffic.
3. Abrasive action may be increased due to the presence of abrasive material like sand between the tyres of moving vehicles and the aggregates exposed at the top surface.
4. This action may be severe in the case of steel tyred vehicles.
5. Heavy wheel loads can also cause deformations on some types of pavement resulting in relative movement of aggregates and rubbing of aggregates with each other within the pavement layer.
6. The mutual rubbing of stones is called attrition, which also may cause a little wear in the aggregates; however attrition will be negligible or absent in most of the pavement layers.

3) Toughness

1. Aggregates in the pavements are also subjected to impact due to moving wheel loads.
2. Severe impact like hammering is quite common when heavily loaded steel tyred vehicles move on water bound macadam roads where stones protrude out especially after the monsoons.
3. Jumping of the steel tyred wheels from one stone to another at different levels causes severe impact on the stones.
4. The magnitude of impact would increase with the roughness of the road surface, the speed of the vehicle and other vehicular characteristics.
5. The resistance to impact or toughness is hence another desirable property of aggregates.

4) Durability

1. The stone used in the pavement construction should be durable and should resist disintegration due to the action of weather.
2. The property of the stones to withstand the adverse action of weather may be called soundness.

3. The aggregates are subjected to the physical and chemical action of rain and ground water, the impurities there-in and that of atmosphere.
4. Hence it is desirable that the road stones used in the construction should be sound enough to withstand the weathering action.

5) Shape of aggregates

1) The size of the aggregates is first qualified by the size of square sieve opening through which an aggregate may pass, and not by shape.
2) Aggregates which happen to fall in a particular size range may have rounded, cubical, angular flaky or elongated shape of particles.
3) It is evident that the flaky and elongated particles will have less strength and durability when compared with cubical, angular or rounded particles of the same stone.
4) Hence too flaky and too much elongated aggregates should be avoided as far as possible.
5) The voids present in a compacted mix of coarse aggregates depend on the shape factors.
6) Highly angular, flaky and elongated aggregates have more voids in comparison with rounded aggregates.
7) Based on the shape of the aggregate particle, stones may be classified as rounded, angular, flaky and elongated.
8) Angular particles possess well-defined edges formed at the intersection of roughly plane faces and are commonly found in aggregates prepared by crushing of rocks.
9) Flaky aggregates have lesser thickness when compared to the length and width.
10) Elongated aggregates have one of the dimensions or the length higher than the width and thickness.

6) Adhesion with Bitumen

The aggregates used in bituminous pavements should have less affinity with water when compared with bituminous material; otherwise the bituminous coating on the aggregates will be stripped off in presence of water.

5. What is aggregates and explain classifications of aggregates?

Aggregates:

Aggregates are the important constituents of the concrete which give body to the concrete and also reduce shrinkage. Aggregates occupy 70 to 80 % of total volume of concrete. So , we can say that one should know definitely about the aggregates in depth to study more about concrete

Classifications of aggregates: It is classified on based of shape and size

1. Based on shape:
    a. Rounded aggregate
    b. Irregular or partly rounded aggregates
    c. Angular aggregates
    d. Flaky aggregates
    e. Elongated aggregates
    f. Flaky and elongated aggregates
2. Based on size:
    a. Fine aggregates
    b. Coarse aggregates

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7.What is the Specific gravity of aggregates?

Specific gravity:

In concrete technology ,specific gravity of aggregates is made use of in design calculations of concrete mixes. With the specific gravity of constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Specific gravity of aggregate is also required in calculating the compacting factor in connection with the workability measurements. Similarly, specific gravity of aggregates is required to be considered when we deal with light weight and heavy weight concrete. Average specific gravity of the rock vary from 2.6 to 2.8

8.What is bulk density of aggregates?

Bulk density of aggregates:

Bulk density of aggregates is the mass of aggregates required to fill the container of a unit volume after aggregates are batched based on volume. It depends on the packing of aggregate i.e. Either loosely packed aggregates or well dense compacted aggregates**.**

For determination of bulk density the aggregates are filled in the container and then they are compacted in a standard manner. The weight of the aggregate gives the bulk density calculated in kg/lit or kg/cubic meter. Knowing the specific gravity of aggregate in saturated and surface dry condition, the void ratio can also be calculate.

Percentage voids= (Gs-r)/Gs *100

Where,

Gs= specific gravity of aggregate, r= bulk density in kg/lit

Bulk density of aggregate is of interest when we deal with light weight aggregate and heavy weight aggregate. The parameters of bulk density is also used in concrete mix design for converting the proportions by weight into proportions by volume when weigh batching equipments is not available at the site.

9.What is porosity of aggregates?

Porosity:

Porosity or **void fraction** is a measure of the **void** (i.e. "empty") spaces in a material, and is a fraction of the volume of voids over the total volume, between 0 and 1, or as a percentage between 0% and 100%. Strictly speaking, some tests measure the "accessible void", the total amount of void space accessible from the surface (cf. closed-cell foam). There are many ways to test porosity in a substance or part, such as **industrial CT scanning.** The term porosity is used in multiple fields including **pharmaceutics, ceramics, metallurgy, materials, manufacturing, earth sciences, soil mechanics and engineering.**

10. Write about moisture content and water absorption?

Moisture content:

Since aggregates contain some porosity, water can be absorbed into the body of the particles or retained on the surface of the particle as a film of moisture. The following four moisture states are defined:

Oven-dry (OD): All moisture is removed from the aggregate by heating in an oven at 105 C to constant weight (overnight heating usually is sufficient). All pores are empty.

Air-dry (AD): All moisture removed from surface, but internal pores partially full.

Saturated-surface-dry (SSD): All pores filled with water, but no film of water on the surface.

Wet: All pores completely filled with water with a film on the surface.

Of these four states, only OD and SSD states correspond to specific moisture contents, and either of these states can be used as reference states for calculating moisture contents. The AD and wet states represent the variable moisture contents that will exist in stockpiled aggregates. The SSD state is the best choice as a reference state for the following reasons:

It represents the "equilibrium moisture" state of the aggregate in concrete; that is, the aggregate will neither absorb water nor give up water to the paste.

The moisture content of aggregates in the field is much closer to the SSD state than the OD state.

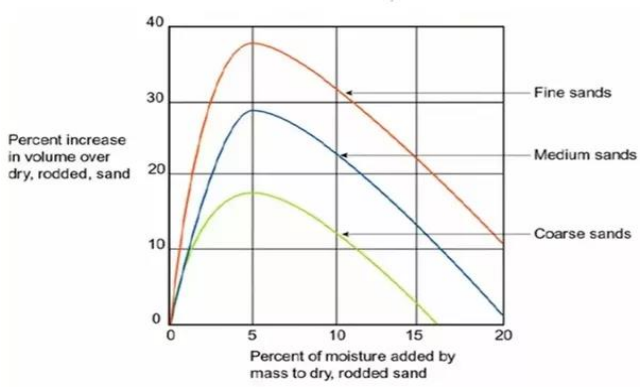
Absorption:

Absorption, which is also determined by the same test procedure, is a measure of the amount of water that an aggregate can absorb into its pore structure. Pores that absorb water are also referred to as “water permeable voids”.

11.What is bulking of sand?

Bulking Of Sand:

The volume of dry **sand** increases due to absorption of moisture. These volume increase of dry **sand** is known as **bulking of sand**. When dry**sand** comes in contact with moisture, a thin film is formed around the particles, which causes them to get apart from each other



12. What are the Deleterious Substances in Aggregates for Concrete?

Deleterious substances in aggregates:

Deleterious substances present in aggregates that influence concrete properties will be discussed here. In the next post we will learn about permissible limit of such substances in

aggregate as per ASTM C33. Here we are not including organic impurities it will be discussed elaborately in upcoming posts.

The substances that are harmful to concrete performance are:

a. Clay lumps and other friable particles

b. Materials that are finer than 75µm (No. 200 sieve)

c. Lignite and coal

d. Soft particles

e. Lightweight chert

Now we will discuss about impacts of each types on concrete properties and performance.

13. What is soundness of aggregates?

Soundness of aggregate:

Soundness of aggregates is the ability of aggregates to resist change of volume due to change of physical condition. These physical conditions include freezing and thawing,temperature change, alternative change of drying and wetting in normal condition and alternative change of drying and wetting in salt water. The aggregates which are weak, porous and containing undesirable materials undergo large volume change in change of those physical conditions.

14. What is the sieve analysis of aggregates?

Sieve analysis:

Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates. This is done by sieving the aggregates as per IS: 2386 (Part I) – 1963. In this we

use different sieves as standardized by the IS code and then pass aggregates through them and thus collect different sized particles left over different sieves.
The apparatus used are –
i) A set of IS Sieves of sizes – 80mm, 63mm, 50mm, 40mm,31.5mm, 25mm, 20mm, 16mm, 12.5mm, 10mm, 6.3mm,4.75mm, 3.35mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm.
ii) Balance or scale with an accuracy to measure 0.1 percent of the weight of the test sample.

15. What are gap-graded aggregates and how are they used in concrete construction?
Gap-graded aggregates:
Aggregate is gap-graded when intermediate sizes are essentially absent from the gradation curve. Usual gap-graded mixes contain aggregate retained on a 3/4- or 1 1/4-inch sieve, and particles passing the No. 4 sieve. Gap-graded mixes are used to obtain uniform textures for exposed-aggregate concrete and can also increase strength and reduce creep and shrinkage. Though the intermediate sizes usually can be omitted without making the mix unduly harsh or prone to segregation, choose the fine-aggregate percentage with care for gap-graded concrete. Use about 25% by volume with rounded aggregate and 35% with crushed material. Air entrainment usually is required to improve the workability of low-slump, gap-graded mixes.

PART B (SHORT QUESTIONS)

1. How does alkali aggregate reaction affect concrete?
2. What is the maximum amount of dust which may be permitted in aggregates?
3. Explain the bulking phenomenon of aggregates.
4. Explain mechanical properties of aggregate?
5. What is grading of fine and coarse aggregate?
6. Explain Bond and Strength of the aggregate?
7. List various application of light weight aggregate?
8. What is bulking of sand?
9. Explain about gap grading of aggregate.
10. What is fineness modulus of aggregate? What does indicate?

PART-C (LONG QUESTIONS)

1. What is alkali-aggregate reaction? And how will it affect the concrete properties?
2. Bring out the detailed classification of aggregates and explain each one of them briefly?
3. What is aggregates and explain classifications of aggregates?
4. What is alkali-aggregate reaction? And how will it affect the concrete properties
5. Bring out the detailed classification of aggregates and explain each one of them briefly?
6. Explain the different Properties of aggregates?
7. What is bulk density of aggregates?
8. What is porosity of aggregates?

9. Write about moisture content and water absorption?
10. Explain about bulking of sand?
11. What are the Deleterious Substances in Aggregates for Concrete?
12. What is soundness of aggregates?
13. What is the sieve analysis of aggregates? and explain Procedure to determine particle size distribution of Aggregates
14. Write briefly about the maximum aggregate size?
15. Explain different method of measurement of moisture content of aggregate?
16. What are the merits and demerits gap graded aggregate
17. Determine the fineness modulus of following aggregate sample of 5 kg

S.No	Sieves sizes	Weight retained in grams
1	40mm	0
2	20mm	1500
3	10mm	3500
4	4.75mm	500
5	2.36mm	0

18. What is bulking of fine aggregate? Explained how bulking chart is prepared?
19. Explain the shape test on aggregate.
20. Explain the abrasion test on aggregate.

OBJECTIVES

1. Workability of concrete can be improved by?
   a) Increasing size of aggregates
   b) Decreasing size of aggregates
   c) Increasing fine aggregates
   d) Increasing flaky aggregates

2. Workability of concrete is directly proportional to
a) Grading of the aggregates
b) Time of transit
c) Aggregates cement ratio
d) Water cement ratio

3. Workability of concrete is inversely proportional to
a) Grading of the aggregates
b) Time of transit
c) Aggregates cement ratio
d) Water cement ratio

4. If compaction factor of concrete is .90, then workability is
a) Low

b) Very low
c) Medium
d) High

5. A compaction factor of .85 for a cement concrete sample indicates
a) Low workability
b) Medium workability
c) Good workability
d) Very good workability

6. Adding water increases
a) Workability
b) Strength
c) Fame
d) Quality

7. Why Shape and texture of aggregates is must?
a) Smooth surfaces give better workability
b) Smooth surfaces give poor workability
c) Rough surfaces give better workability
d) Rough surfaces give poor workability

8. How many types of tests are there to find workability?
a) 3
b) 4
c) 5
d) 6

9. These test find workability
a) Directly
b) Indirectly
c) 0
d) Equals to the weight of the cement

10. Workability of concrete is measured by
a) Vicat apparatus test
b) Slump test
c) Minimum void method
d) Talbot Richard test

UNIT III
FRESH CONCRETE

1. Define the Fresh concrete

- The strength of concrete of a given mix proportions is very seriously affected by the degree of its compaction
- It is vital, that the consistency (ability to flow) of the mix be such that, the concrete can be transported, placed and finished sufficiently easily and without segregation.

2. Define the Workability

- The ease with which concrete mixes can be compacted as completely as possible while using the lowest possible water/cement ratio.
- Should be obtained by the use of a well-graded aggregate which has the largest maximum particle size possible.
- The use of smooth_and rounded, rather than irregularly shaped aggregate also increase workability,
- Air entraining admixtures improve the workability of mixes but cause a loss of strength up to about 15 percent.

3. Factors affecting workability

Water content of the mix: Adding water increases workability and decreases strength.

Maximum size of aggregate: Less surface area to be wetted and more water in medium.

Grading of aggregate: Poor grading reduces the consistency.

Shape and texture of aggregates: Smooth surfaces give better workability.

4. Measurement of Workability test on concrete?

There is no accepted test, which measure directly the workability. There are indirect methods. There are 5 types of test, which can measure workability indirectly. Unfortunately, there are no accepted tests, which can measure directly the workability.

- Slump Test: Gives good results for rich mixes.
- Compacting Factor Test: Used for low workable concretes.
- Flow Table Test: Used for high workable concretes.
- VeBe Test: Used for low workable concretes (fiber reinforced concrete).
- Kelly Ball Test: It is practical in field test.

5. Segregation

- Segregation is separation of the constituents of a heterogeneous mixture so that their distribution is no longer uniform.

- There are two forms of segregation:
  - **First** form: Coarse particles tend to separate out since they tend to settle more than fine particles.
  - **Second** form: Occurs in wet mixes; it is manifested by the separation of (cement+ water) from the mix.

6. What are the Causes of segregation?

Dropping concrete from a considerable height, Passing along a chute, particularly with changes of direction and discharging against an obstacle,

Concrete should always be placed direct in the position in which it is to remain and must not be allowed to flow or be worked along the form.

Improper use of a vibrator increases segregation.

Use of coarse aggregate whose specific gravity differs appreciably from that of fine aggregate would lead to increased segregation.

Segregation of a reinforced concrete column

7.Bleeding

- Bleeding (water gain) is a form of segregation, in which some of the water in the mix tends to rise to the surface of freshly placed concrete.

Reason: Caused by the inability of the solid constituents of the mix to hold all of the mixing water when they settle downwards.

Result: Top of every lift may become too wet and if the water is trapped by concrete, porous, weak, and non-durable concrete will result.

If the bleeding water is remixed during finishing of the top surface a weak wearing surface will be formed.

This can be avoided by delaying the finishing operations until the bleeding water has evaporated.

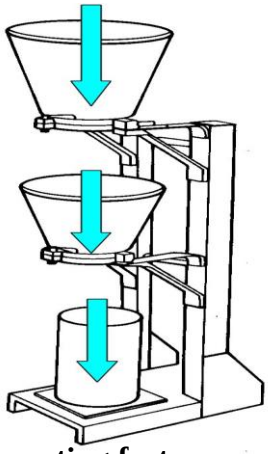
- Some of the rising water becomes trapped on the underside of coarse aggregate particles or of reinforcement, thus creating zones of poor bond.

8. What are the Causes of Bleeding:

Bleeding need not necessarily be harmful. If it is undisturbed and the water evaporates the effective water/cement ratio may be lowered with a resulting increase in strength. If the rising water carries with it a considerable amount of the finer cement particles a layer of scum will be formed. At the top of a slab a porous surface will form and result with a permanently dusty surface. At the top of a lift a plane of weakness would form and the bond with the next lift would be inadequate. For this reason, scum should always be removed by brushing and washing.

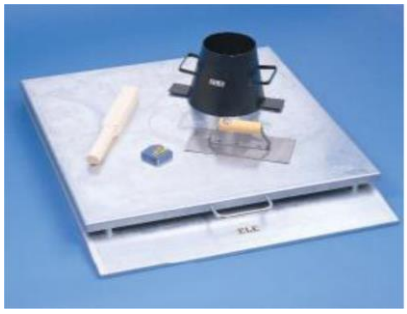
- How can we reduce bleeding?
- Bleeding is decreased by increasing the fineness of cement or adding of Calcium chloride to cement.
- Rich mixes are less prone to bleeding than lean ones.
- Reduction in bleeding is obtained by the addition of pozzolans or of aluminum powder.
- Air entrainment effectively reduces bleeding so that finishing can follow casting without delay.

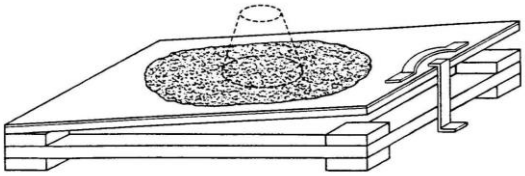
9. Draw the diagram of slump cone, compacting factor, flow table and vee bee consistometer.



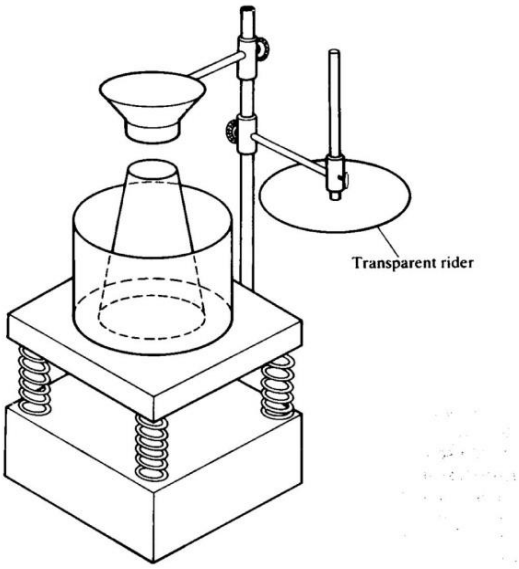
compacting factor

slump cone





flow table



vee bee consistometer.

10. Write about the compaction of Concrete?

- In the process of compacting the concrete consists essentially of the elimination of entrapped air in concrete.

This can be achieved by:

1. Ramming (manually by hand)
2. Vibration (by machines)

- The two basic means of compaction require mixes of different work abilities: too dry mix cannot be sufficiently worked by hand; and, conversely, too wet mix should not be vibrated as segregation may result.
- A drier mix needs stronger formwork compared to wet mixes. This will increase the cost.
  – Types **of Vibrators**
- Internal vibrator
- External vibrators
- Vibrating tables & surface vibrators
-

11. What are the purposes of Internal Vibrators (immersion vibrator)?

Consists of a poker, housing an eccentric shaft driven through a flexible drive from a motor. The poker is immersed in concrete and thus applies vibration to it.

Gradual withdrawal of the poker is recommended, so that the hole left by the vibrator closes fully without any air being trapped.

Time required: Every 0.5-1.0 m for 5 seconds to 2 minutes depending on the consistence of the mix.

12. What is the purpose of External Vibrators?

- Vibrator is rigidly clamped to the formwork resting on an elastic support, so that both the form and the concrete are vibrated.
- External vibrators are used for precast or in situ sections of such shape or thickness that an internal vibrator cannot be used.
- When an external vibrator is used, concrete has to be placed in layers of suitable depth as air cannot be expelled through too great a thickness of concrete. The position of the vibrator may have to be changed as concreting progress.

13. What is the purpose of Quality of Mixing Water?

- In many specifications, the quality of water is covered by a clause saying that water should be fit for drinking.
- Seawater has a total salinity of about 3-5 per cent, and produces a slightly higher early strength but a lower long-term strength; the loss of strength is usually no more than 15 percent and can therefore often be tolerated.
- Water containing large quantities of chlorides (e.g. sea water) tends to cause persistent dampness and surface efflorescence. Such water should therefore, not be used where appearance of the concrete is important.
- In the case of reinforced concrete, seawater is believed to increase the risk of corrosion of the reinforcement, although there is no experimental evidence that the use of sea water in mixing leads to attack on the reinforcing steel.
- However in practice it is generally considered inadvisable to use sea water for mixing unless this is unavoidable.

PART A

1. What is meant by proportioning of concrete?
2. Can sea water be used for making concrete? Explain.
3. What is meant by curing of concrete?
4. Define Workability.
5. What are the Causes of bleeding and segregation?
6. What are the Methods for Control of Bleeding?
7. Define segregation of concrete.
8. Define bleeding of concrete.
9. What does proper batching ensure?
10. How is workability of concrete mix with low water cement ratio determined?

PART B

1. What are the various steps involved in concrete manufacturing?
2. What is segregation describe briefly?
3. Explain Compaction factor test in detail.

4. What are the methods available for measuring air content in fresh concrete? Explain one of the methods in detail.
5. Define measurement of workability by different tests?
6. Describe briefly about segregation?
7. What is mixing and vibration of concrete?
8. Describe briefly about bleeding?
9. What are the factors affecting workability of concrete?
10. Describe the importance of the quality of water used for concreting.
11. How does high temperature affect fresh concrete?
12. How does segregation affect concrete?
13. Describe the setting time of concrete?
14. What are the effects of time and temperature on workability?
15. Write effect of time on workability?
16. Discuss the effect of quality mixing water on the performance of concrete.
17. Explain the concept of segregation and bleeding of fresh concrete .
18. Explain the setting time of concrete
19. Explain the slump cone test and sketch the neat diagram
20. What are the properties of fresh concrete?

OBJECTIVES

1. Workability of concrete is inversely proportional to
a) Grading of the aggregates
b) Time of transit
c) Aggregates cement ratio
d) Water cement ratio

2. If compaction factor of concrete is .90, then workability is
a) Low
b) Very low
c) Medium
d) High

3. A compaction factor of .85 for a cement concrete sample indicates
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4. Adding water increases
a) Workability
b) Strength
c) Fame
d) Quality

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6. How many types of tests are there to find workability?
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b) 4
c) 5
d) 6

7. These test find workability
a) Directly
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8. Workability of concrete is measured by
a) Vicat apparatus test
b) Slump test
c) Minimum void method
d) Talbot Richard test

9. Which test gives good results for rich mixes?
a) Slump test
b) Compacting factor test
c) Flow table test
d) VeBe test

10. Which test used for low workable concretes?
a) Slump test
b) Compacting factor test
c) Flow table test
d) VeBe test

11. Which test Used for high workable concretes?
a) Slump test
b) Compacting factor test
c) Flow table test
d) VeBe test

UNIT IV
HARDEN CONCRETE
PART - A

1. What is meant by harden concrete?

A. Cement hardens when it comes into contact with water. This **hardening** is a process of crystallization. The **cement** and water mixture that has crystallized in this way encloses the aggregate particles and produces a dense material. The **concrete** continues to **harden** over several months.

2. What is meant by water / cement ratio?

A. The **water–cement ratio** is the **ratio** of the weight of **water** to the weight of **cement** used in a **concrete mix**. A lower **ratio** leads to higher strength and durability, but may make the **mix** difficult to work with and form. Workability can be resolved with the use of plasticizers or super-plasticizers.

(OR)

Water-to-cement (w/c) mass ratio is important because it controls the mechanical properties and durability of hardened concrete. When problems occur and/or non-compliance with the specification is suspected, it is often desirable to be able to determine the w/c ratio. There are two existing methods to estimate the w/c ratio, the physico-chemical method described in BS1881:124:1988 and the fluorescence microscopy method described in Nordisk NT361-1999.

3. Explain abram's law?

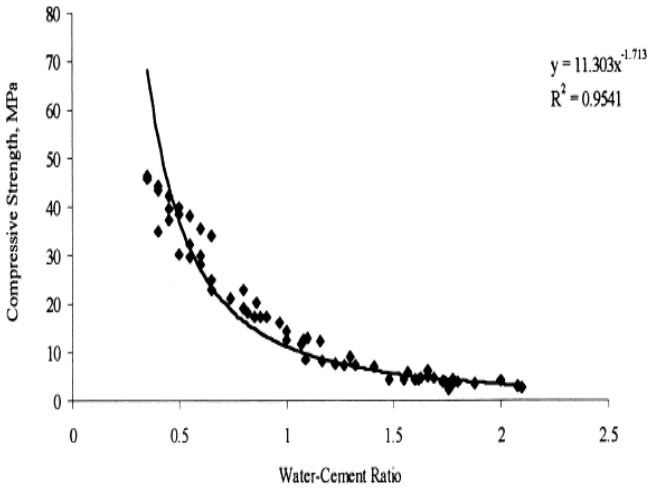
A. Abrams' law (also called **Abrams' water-cement ratio law**) is a concept in civil engineering. The law states the strength of a concrete mix is inversely related to the mass ratio of water to cement. As the water content increases, the strength of concrete decreases.

Abrams' law is a special case of a general rule formulated empirically by Ferret: $S=A/B^{w/c}$

S = strength of concrete

A and B are constants

w/c is water-cement ratio varies from 0.3 to 1.20



4. Explain strength in tension and compression of concrete?

A. Concrete is brittle in **tension**, but relatively tough in **compression**. σt (**tensile strength**) is almost 1/10th of σc (**compressive strength**). At a given w/c ratio, mortar is stronger than the corresponding **concrete**.

5. What are the factors affecting strength in concrete?

A. Concrete strength is affected by many factors, such as quality of raw materials, water/cement ratio,
Coarse/fine aggregate ratio,
Age of concrete,
Compaction of concrete,
Temperature,
Relative humidity and curing of concrete.

6. Explain about the aggregate cement ratio?

Aggregate / Cement Ratio

Following points must be noted for aggregate cement ratio:

- If the volume remains the same and the proportion of cement in relation to that of sand is increased the surface area of the solid will increase.
- If the surface area of the solids has increased, the water demand will stay the same for the constant workability.
- Assuming an increase in cement content for no increase in water demand, the water cement ratio will decrease.
- If the water cement ratio reduces, the strength of the concrete will increase.

7. Explain about the reality humidity on hardened concrete?

Relative humidity

If the concrete is allowed to dry out, the hydration reaction will stop. The hydration reaction cannot proceed without moisture. The three curves show the strength development of similar concretes exposed to different conditions.

8. Define curing?

It should be clear from what has been said above that the detrimental effects of storage of concrete in a dry environment can be reduced if the concrete is adequately cured to prevent excessive moisture loss.

9. Testing of hardened concrete?

A. Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control programme for concrete, which helps to achieve higher efficiency of the material used and greater assurance of the performance of the concrete with regard to both strength and durability. The test methods should be simple, direct and convenient to apply. One of the purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength. As the hardening of the concrete takes time, one will not come to know, the actual strength of concrete for some time. This is an inherent disadvantage in conventional test. But, if strength of concrete is to be known at an early period, accelerated strength test can be carried out to predict 28 days strength. But mostly when correct materials are used and careful steps are taken at every stage of the work, concretes normally give the required strength. The tests also have a deterring effect on those responsible for construction work. The results of the test on hardened concrete, even if they are known late, helps to reveal the quality of concrete and enable adjustments to be made in the production of further concretes. Tests are made by casting cubes or cylinder from the representative concrete or cores cut from the actual concrete. It is to be remembered that standard compression test specimens give a measure of the potential strength of the concrete, and not of the strength of the concrete in structure. Knowledge of the strength of concrete in structure cannot be directly obtained from tests on separately made specimens.

10. Explain the compression test in hardened concrete?

A. Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.

Moulds

The compression test is carried out on specimens cubical or cylindrical in shape. Prism is also sometimes used, but it is not common in our country. Sometimes, the compression strength of concrete is determined using parts of a beam tested in flexure. The end parts of beam are left intact after failure in flexure and, because the beam is usually of square cross section, this part of the beam could be used to find out the compressive strength. The cube specimen is of the size 15 x 15 x 15 cm. If the largest nominal size of the aggregate does not exceed 20 mm,

10 cm size cubes may also be used as an alternative. Cylindrical test specimens have a length equal to twice the diameter. They are 15 cm in diameter and 30 cm long. Smaller test specimens may be used but a ratio of the diameter of the specimen to maximum size of aggregate, not less than 3 to 1 is maintained.

11. What is shrinkage?

A. The volumetric changes of concrete structures due to the loss of moisture by evaporation are known as concrete shrinkage or shrinkage of concrete. It is a time-dependent deformation which reduces the volume of concrete without the impact of external forces.

12. What are the types of shrinkage?

A. 1. Plastic shrinkage
2. Drying shrinkage
3. Carbonation shrinkage
4. Autogenously shrinkage.

13. Define creep and factors affecting creep?

A. Concrete creep is defined as: deformation of structure under sustained load. Basically, long term pressure or stress on concrete can make it change shape. This deformation usually occurs in the direction the force is being applied. Like a concrete column getting more compressed, or a beam bending. Creep does not necessarily cause concrete to fail or break apart. Creep is factored in when concrete structures are designed.

Factors affecting creep:

1. Aggregate
2. Mix proportions
3. Age of concrete

PART A (SHORT QUESTION)

1. Define Water/cement ratio.
2. What is meant by gel-space ratio?
3. Why is Elastic Modulii Important for Concrete?
4. Define Shrinkage cracking
5. Define Tension cracking
6. Define Creep.
7. Which factors lead to strength in hardened concrete?
8. Discuss the relation between creep and time.
9. How does creep affect hardened concrete?
10. write short notes on the following: Alkali attack

ART-B (LONG QUESTION)

1. What is Abram's law? How does it affect concrete?
2. What are the various factors affecting strength of hardened concrete?
3. What is curing? What are the different methods of curing?
4. Explain briefly about Tension test?
5. Write a short note on Flexural test

6. Explain nondestructive tests.
7. Write a short note on Elasticity of concrete
8. Write a short note on Creep
9. What is creep of concrete
10. What is shrinkage?
11. Explain briefly about Compression test?
12. Describe briefly about Split tensile test
13. Write a short note on Shrinkage
14. Write a short note on Durability of concrete
15. What are the factors influencing creep?
16. What is the relation between creep & time?
17. What are effects of creep?
18. What are the types of shrinkage?
19. What are the codal provisions for NDT?
20. Describe types of NDT tests?

OBJECTIVES

1. Which test used for fiber reinforced concrete?
a) Slump test
b) Compacting factor test
c) Flow table test
d) VeBe test

2. _____ is practical in field test.
a) Slump test
b) Compacting factor test
c) Flow table test
d) Kelly Ball Test

3. What is the compaction factor for medium degree of workability?
a) .78
b) .85
c) .92
d) .95

4. What is the Vee-Bee time for medium degree of workability?
a) 10-20 sec
b) 5-10 sec
c) 2-5 sec
d) 35 sec

5. The accumulation of water on outer surface of concrete is:
a) Transpiration
b) Bleeding

c) Guttation
d) Ponding

6. Properties of concrete can broadly be divided into:
a) 8
b) 6
c) 4
d) 2

7. How does the strength of concrete differ with age of concrete?
a) Increases
b) Decreases
c) No effect
d) Increases, then decreases

8. Bleeding of concrete may be due to
1. excess of water
2. too much finishing
3. coarse aggregates
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1,2 and 3

9. Bleeding can be prevented by
(a) controlling water content
(b) using finely ground cement
(c) controlling compaction
(d) all the above

10. Consider the following statements
Sand in mortar is needed for
1. decreasing the quantity of cement
2. reducing shrinkage
3. decreasing the surface area of the binding material
4. increasing the strength
Of these statements
(a) 2,3, and 4 are correct
(b) 1,2 and 3 are correct
(c) 1,3 and 4 are correct
(d) 1,2 and 4 are correct

11. Separation of cement paste from sand in the mortar allowing the water or cement paste to appear at the surface is called
(a) bleeding
(b) segregation
(c) honeycombing

(d) none of these

12. Concrete grows with age. This statement is
(a) true
(b) false
(c) debatable
(d) given by Duff Abrams

UNIT V
MIX DESIGN
PART - A

1. What is concrete mix design?

Concrete mix design is defined as the appropriate selection and proportioning of constituents to produce a concrete with pre-defined characteristics in the fresh and hardened states. Moreover, concrete mixes are designed in order to achieve a defined workability, strength and durability. Finally, this article presents factors affecting the choice of concrete mix design.

2. **What is the difference between nominal mix and design mix concrete?**

Mix design is a process of selecting suitable ingredients and determining their relative proportions with the objective of producing concrete of having certain minimum workability, strength and durability as economically as possible.

A mix design can be designed in two ways as explained below

1. Nominal Mix
2. Design

3. Write about the nominal mix design

It is used for relatively unimportant and simpler concrete works. In this type of mix, all the ingredients are prescribed and their proportions are specified. Therefore there is no scope for any deviation by the designer. Nominal mix concrete may be used for concrete of M-20 or lower. The various ingredients are taken as given in the table below

Grade	Max. quantity of dry Aggregates per 50 kg of cement	Fine Aggregate to Coarse Aggregate Ratio, by mass	Max. Quantity of water in litres
M-5	800	Generally 1:2 but may varies from 1:1.5 to 1:2.5	60
M-7.5	625		45
M-10	480		34
M-15	330		32
M-20	250		30

4. Write about the design mix concrete?

It is a performance based mix where choice of ingredients and proportioning are left to the designer to be decided. The user has to specify only the requirements of concrete in fresh as well as hardened state. The requirements in fresh concrete are workability and finishing

characteristics, whereas in hardened concrete these are mainly the compressive strength and durability.

5. What are the various factors affecting the choice of concrete mix design?Compressive strength of concrete

1. Concrete compressive strength considered as the most important concrete property. It influences many other describable properties of the hardened concrete.
2. The mean compressive strength (fcm) required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix.
3. ISO 456-200, British Standard, and Eurocode utilize the term mean compressive strength which is slightly greater than characteristic compressive strength. However, ACI Code do not use such term.
4. Other factors which influences the concrete compressive strength at given time and cured at a specified temperature is compaction degree.
5. Finally, it is demonstrated that, concrete compressive strength of fully compacted concrete is inversely proportional to the water-cement ratio.

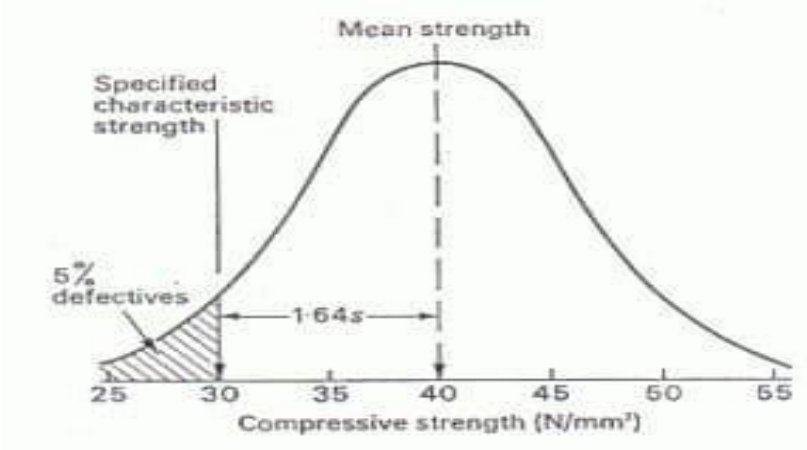


Fig.1: compressive strength vs characteristic compressive strength

Fig.2: compressive strength of concrete

6. Write about the workability of concrete?

1. Concrete workability for satisfactory placement and compaction depends on the size and shape of the section to be concreted, the amount and spacing of reinforcement, and concrete transportation; placement; and compaction technique.
2. Additionally, use high workability concrete for the narrow and complicated section with numerous corners or inaccessible parts. This will ensure the achievement of full compaction with a reasonable amount of effort.
3. Frequently, slump test values used to evaluate concrete workability.
4. Lastly, ACI 211.1 provides slump test values for various reinforced concrete sections which

Fig.3:Workability of concrete

7. Write about the durability of concrete

1. The ability of concrete to withstand harmful environment conditions termed as concrete durability.
2. High strength concrete is generally more durable than low strength concrete.
3. In the situations when the high strength is not necessary but the conditions of exposure are such that high durability is vital, the durability requirement will determine the utilized water-cement ratio.

Fig.5: Durability of concrete

8. What is the proportioning of concrete?

Proportioning of concrete is the process of selecting quantity of cement, sand, coarse aggregate and water in concrete to obtain desired strength and quality.

The proportions of coarse aggregate, cement and water should be such that the resulting concrete has the following properties

9. Fineness Modulus Method of Proportioning Concrete

The term fineness modulus is used to indicate an index number which is roughly proportional to the average size of the particle in the entire quantity of aggregates.

The fineness modulus is obtained by adding the percentage of weight of the material retained on the following sieve and divided by 100.

The coarser the aggregates, the higher the fineness modulus.

Sieve is adopted for:

All aggregates: 80 mm, 40 mm, 20 mm, 10 mm, and Nos. 480, 240, 120, 60, 30 and 15.

Coarse aggregates: mm, 40 mm, 20 mm, 10 mm, and No. 480.

Fine aggregates: Nos. 480, 240, 120, 60, 30 and 15.

Proportion of the fine aggregate to the combined aggregate by weight

$$R = \frac{P_2 - P}{P - P_1} \times 100$$

Where, P = desired fineness modulus for a concrete mix of fine and coarse aggregates.

P_1 = fineness modulus of fine aggregate

P_2 = fineness modulus of coarse aggregate.

Minimum Void Method

(Does not give satisfactory result)

The quantity of sand used should be such that it completely fills the voids of coarse aggregate. Similarly, the quantity of cement used shown such that it fills the voids of sand, so that a dense mix the minimum voids is obtained.

In actual practice, the quantity of fine aggregate used in the mix is about 10% more than the voids in the coarse aggregate and the quantity of cement is kept as about 15% more than the voids in the fine aggregate.

Maximum Density Method:

(Not very Popular)

$$P = 100\left(\frac{d}{D}\right)^{1/2}$$

Where, D = maximum size of aggregate (i.e. coarse aggregate)

P = percentage of material finer than diameter d (by weight)

d = maximum size of fine aggregate.

A box is filled with varying proportions of fine and coarse aggregates. The proportion which gives heaviest weight is then adopted.

10. Water – Cement Ratio Method of Proportioning Concrete

According to the water – cement ratio law given by Abram as a result of many experiments, the strength of well compacted concrete with good workability is dependent only on the ratio.

1. The lower water content produces stiff paste having greater binding property and hence the lowering the water-cement ratio within certain limits results in the increased strength.

2. Similarly, the higher water content increases the workability, but lower the strength of concrete.

3. The optimum water-cement ratio for the concrete of required compressive strength is decided from graphs and expressions developed from various experiments.

4. Amount of water less than the optimum water decreases the strength and about 10% less may be insufficient to ensure complete setting of cement. An increase of 10% above the optimum may decrease the strength approximately by 15% while an increase in 50% may decrease the strength to one-half.

5. According to **Abram's Law water-cement law**, lesser the water-cement ratio in a workable mix greater will be the strength.

6. If water cement ratio is less than 0.4 to 0.5, complete hydration will not be secured.
Some practical values of water cement ratio for structure reinforced concrete

0.45 for 1 : 1 : 2 concrete

0.5 for 1 : 1.5 : 3 concrete

0.5 to 0.6 for 1 : 2 : 4 concrete.

Concrete vibrated by efficient mechanical vibrators require less water cement ratio, and hence have more strength.

Thumb Rules for deciding the quantity of water in concrete:

(i) Weight of water = 28% of the weight of cement + 4% of the weight of total aggregate

(ii) Weight of water = 30% of the weight of cement + 5% of the weight of total aggregate.

11. What are the advantages of light weight concrete?

- Reduces the dead load of the building
- Easy to handle and hence reduces the cost of transportation and handling
- Improves the workability
- Relatively low thermal conductivity

• Comparatively more durable, but less resistant to abrasion

• Has applications in pre-stressed concrete, high rise buildings & shell roofs

• Good resistance to freezing & thawing action when compared to conventional concrete.

• Helps in disposal of industrial wastes like fly ash, clinker, slag etc.

12. Write about the colored concrete?

• Coloured concrete can be produced by using coloured aggregates or by adding colour pigments (ASTM C 979) or both.

• If surfaces are to be washed with acid, a delay of approximately two weeks after casting is necessary.

• Coloured aggregates may be natural rock such as quartz, marble, and granite, or they may be ceramic materials.

• Synthetic pigments generally give more uniform results.

• The amount of colour pigments added to a concrete mixture should not be more than 10% of the mass of the cement.

13. Types of polymer concrete

- Polymer concrete
- Polymer mix concrete
- Polymer concrete
- Geo polymer cement
- Polymer impregnated concrete

PART-A (SHORT QUESTION)

1. Define Concrete Durability.
2. Define concrete mix design.
3. What are the factors influencing the selection of materials?
4. What are the factors Influencing Consistency?
5. What are the Factors affecting Strength of Hardened concrete?
6. What is the sequence of steps should be followed in ACI method?
7. Mention the Maximum aggregate size to be used in Mix Design as per ACI.
8. What are the Requirements of concrete mix design as per BIS?
9. Factors that influence the choice of mix design.
10. What are the Factors affecting the choice of mix proportions?

PART-B (LONG QUESTION)

1. Describe ACI method of mix design in detail.
2. Describe Indian standard method of mix design in detail.
3. Describe about the Sampling criteria?
4. Design the concrete mix for grade M20 with suitable conditions. Find the quantities of constituents of the mix for a bag of cement.
5. Explain the factors that influence the choice of mix design.

6. Explain in detail about the statistical quality control and acceptance criteria of concrete.
7. Design the concrete mix for grade M30 with suitable conditions. Find the quantities of constituents of the mix for a bag of cement.
8. Explain the procedure of selection of constituent materials of concrete
9. Define Nominal Mixes and Standard mixes. What are Designed Mixes?
10. Describe the recent trends in concrete mix design.
11. Describe briefly about durability of concrete?
12. Describe quality control of concrete?
13. Describe about Acceptance criteria?
14. What is BIS method of mix design?
15. Design the concrete mix for grade M20 with suitable conditions. Find the quantities of constituents of the mix for a bag of cement.
16. Design the concrete mix for grade M30 with suitable conditions. Find the quantities of constituents of the mix for a bag of cement.
17. Design the concrete mix for the following data: characteristic compressive strength= 20MPa, maximum size of aggregate = 20mm (angular), Degree of workability = 0.9 CF, Degree of quality control = good and type of exposure = severe. Water absorption by CA = 0.5% and moisture content in FA = 2.0%. Assume any suitable missing data.
18. Design the concrete mix for the following data: characteristic compressive strength = 35MPa, maximum size of aggregate = 20mm (angular), Degree of workability = 0.9 CF, Degree of quality control = good and type of exposure = severe. Water absorption by CA = 1% and moisture content in FA = 1.5%.Assume any suitable missing data.
19. Design the concrete mix for the following date: characteristic compressive strength=35mpa, maximum size of aggregate =20mm (angular), degree of workability=0.9CF, degree of quality control =good and type of exposure=severe. Water absorption by CA=1% and moisture content in FA =1.5%. Assume any suitable missing data
20. Design the concrete mix for the following data: characteristic compressive strength=20mpa, maximum size of aggregate =20mm (angular), degree of workability =0.9CF, degree of quality control =good and type of exposure=severe. Water absorption by CA =0.5% and moisture concrete FA=2.0%. Assume any suitable missing data.

OBJECTIVES

1. Concrete in the structural member has to pass through
(a) plastic stage
(b) hardened stage
(c) both (a) and (b) above
(d) neither (a) nor (b)

2. Separation of the coarse aggregate from mortar is called
(a) bleeding
(b) segregation
(c) compaction
(d) none of the these

3. The ease with which concrete can be compacted fully without segregation is called
(a) bleeding
(b) segregation
(c) workability

(d) none of these

4. Segregation can be prevented by
(a) properly grading the aggregate
(b) controlling water content in a mix
(c) using correct handling procedures
(d) all the above

5. The light-weight concrete is prepared by
a) Mixing Portlandcement with sawdust in specified proportion in the concrete
b) Using coke-breeze, slag as aggregate in the concrete
c) Mixing Al in the concrete
d) Mixing Fe in the concrete

6. Aerated Concrete is
a) Very heavy weight
b) Heavy weight
c) Medium weight
d) Light weight

7. Entrainment of air also improves workability and durability.
a) True
b) False

8. No fines concrete is manufactured by
a) By adding no fines materials from normal concrete
b) By eliminating no fines materials from normal concrete
c) By reducing its strength
d) By increasing its strength

9. If a process is executing in its critical section
a) any other process can also execute in its critical section
b) no other process can execute in its critical section
c) one more process can execute in its critical section
d) none of the mentioned

10. Density of no fines concrete with light weight aggregate vary from _____ kg/m^3.
a) 1600-1900
b) <300
c) >2500
d) >300

11. What is the value of modulus of elasticity for Sulphur infiltered concrete?
a) 60-115 MPa
b) 10-16 MPa
c) 35-50 GPa
d) 500 GPa

12. Diameter of Round Steel Fiber lies in the range of ___ mm.
a) .3-.5
b) .25-.75
c) .155-.41
d) .25-.90

13. What is curing?
a) Dehydration
b) Hydration
c) Drying
d) Dipping

14. In a dry environment, concrete strength will be loosed as much as _____ % in moist environment.
a) 30
b) 40
c) 50
d) 60

15. Concrete placed in cold weather will take _____ time to gain strength.
a) No
b) Less
c) More
d) Equal to hot weather

16. After finishing concrete surface must be kept _____
a) Dry
b) First dry it and then wet it
c) First wet it and then dry it
d) Wet

17. Dry intervals in surface wetting leads to _____
a) racking
b) Fogging
c) High strength
d) Good workability