DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

Subject	:	**CONCRETE TECHNOLOGY**
Regulations	:	**2017**
Course Code	:	**CE 6404**
Branch	:	**CIVIL ENGINEERING**
Year & Semester	:	**II & IV**

CE6002 CONCRETE TECHNOLOGY L T P C

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OBJECTIVES:

- To impart knowledge to the students on the properties of materials for concrete by suitable tests, mix design for concrete and special concretes.

UNIT I CONSTITUENT MATERIALS 9

Cement-Different types-Chemical composition and Properties - Tests on cement-IS Specifications- Aggregates-Classification-Mechanical properties and tests as per BIS grading requirements-Water- Quality of water for use in concrete.

UNIT II CHEMICAL AND MINERAL ADMIXTURES 9

Accelerators-Retarders- Plasticizers- Super plasticizers- Water proofers - Mineral Admixtures like Fly Ash, Silica Fume, Ground Granulated Blast Furnace Slag and Metakaoline -Their effects on concrete properties

UNIT III PROPORTIONING OF CONCRETE MIX 9

Principles of Mix Proportioning-Properties of concrete related to Mix Design-Physical properties of materials required for Mix Design - Design Mix and Nominal Mix-BIS Method of Mix Design - Mix Design Examples

UNIT IV FRESH AND HARDENED PROPERTIES OF CONCRETE 9

Workability-Tests for workability of concrete-Slump Test and Compacting factor Test-Segregation and Bleeding-Determination of Compressive and Flexural strength as per BIS - Properties of Hardened concrete-Determination of Compressive and Flexural strength-Stress-strain curve for concrete-Determination of Young‟s Modulus.

UNIT V SPECIAL CONCRETES 9

Light weight concretes - High strength concrete - Fibre reinforced concrete – Ferrocement - Ready mix concrete - SIFCON-Shotcrete – Polymer concrete - High performance concrete-Geopolymer Concrete

TOTAL: 45 PERIODS

OUTCOMES:

- The student will possess the knowledge on properties of materials required for concrete tests on those materials and design procedures for making conventional and special concretes.

TEXT BOOKS:

1. Gupta.B.L., Amit Gupta, "Concrete Technology", Jain Book Agency, 2010

2. Shetty,M.S, "Concrete Technology", S.Chand and Company Ltd, New Delhi, 2003

REFERENCES:

1. Santhakumar,A.R; "Concrete Technology" , Oxford University Press, New Delhi, 2007

2. Neville, A.M; "Properties of Concrete", Pitman Publishing Limited, London, 1995

3. Gambir, M.L; "Concrete Technology", 3rd Edition, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2007

4. IS10262-1982 Recommended Guidelines for Concrete Mix Design, Bureau of Indian Standards, New Delhi, 1998

UNIT I - CONSTITUENT MATERIALS

1. What is cement?

Cement is a substance which acts as a binding agent for materials. It is obtained by burning the mixtures of calcareous material such as lime stone and argillaceous materials such as clay at very high temperature.

2. What are the types of cement?

(i) Acid-resistance cement
(ii) Blast-Furnace cement
(iii) Colored cement
(iv) Expanding cement
(v) High alumina cement
(vi) Hydrophobic cement
(vii) Low heat cement
(viii) White cement

3. Manufacture of Portland cement.

There are three main operations involved in the manufacture of ordinary or Portland cement.

(i) Mixing of raw materials a) Dry process b) Wet process
(ii) Burning
(iii) Grinding

4. What are the various types of testing for cement?

(i) Field Tests for cement
    a) Color test
    b) Physical properties
    c) Presence of lumps
    d) Strength
(ii) Laboratory Tests for cement
    a) Chemical composition
    b) Fineness
    c) Compressive strength
    d) Tensile Strength
    e) Consistency

f) Setting times

g) Soundness

5. What are the properties of cement?

The important properties of good cement are

(i) It gives strength to the masonry

(ii) It is easily workable

(iii) It is an excellent binding material

(iv) It offers good resistance to the moisture.

(v) It should be free from lumps.

(vi) It possesses a good plasticity.

(vii) It stiffens or hardens easily.

6. What is the chemical composition of cement?

Chemical composition of cement is lime, silica, alumina, calcium sulphate Iron oxide Magnesium oxide Sulphur trioxide Alkali oxides.

7. List various types of cement.

(i) Ordinary Portland cement

(ii) High alumina cement

(iii) Portland Pozzolana cement

(iv) Quick setting cement

8. What is grade of cement? List any three grades of cement with their strengths.

Grade of cement represents the specific 28 days compressive strength. The following three grades are given along with their compressive strengths

(i) 33 Grade OPC –33 MPa

(ii) 43 Grade OPC – 43 MPa

(iii) 53 Grade OPC – 53 MPa

9. Give step by step method of manufacture of cement by wet process.

(i) Limestone is first crushed

(ii) Mixed with clay or shale and ground

(iii) The ground material is corrected and mixed with water

(iv) Corrected slurry is sprayed on to the upper end of a rotary kiln

(v) Slurry looses moisture and forms as flakes

(vi) Clinker forms

(vii) Clinker is cooled and gypsum is formed

10. What is meant by hydration of cement?

Cements used for making concrete have the property of reacting chemically with water in an exothermic process called hydration that results in water treatment products.

11. What are the two process of manufacturing of cement?

(i) Wet process

(ii) Dry process

12. What is the common classification of aggregates?

The most common classification of aggregates on the basis of bulk specific gravity is

(i) Lightweight,

(ii) Normal-weight, and

(iii) Heavyweight aggregates.

13. What is a Lightweight aggregate?

Lightweight concrete contains aggregate that is natural or synthetic which weighs less than 1100 kg/m3. The lightweight is due to the cellular or high internal porous microstructure, which gives this type of aggregate a low bulk specific gravity. The most important aspect of lightweight aggregate is the porosity. They have high absorption values, which require a modified approach to concrete proportioning.

14. Define Heavyweight aggregates.

Heavyweight concrete contains aggregates that are natural or synthetic which typically weigh more than 2,080 kg/m3 and can range up to 4,485 kg/m3. Heavy weight aggregate is most commonly used for radiation shielding, counterweights and other applications where a high mass-to-volume ratio is desired.

15. Define Aggregate.

Aggregates are defined as inert, granular, and inorganic materials that normally consist of stone or stone-like solids. Aggregates can be used alone (in road bases and various types of fill) or can be used with cementing materials (such as Portland cement or asphalt cement) to form composite materials or concrete.

16. Mention the Classification of aggregate In accordance with size.

Coarse aggregate: Aggregates predominately retained on the No. 4 (4.75 mm) sieve. For mass concrete, the maximum size can be as large as 150 mm.

Fine aggregate (sand): Aggregates passing No.4 (4.75 mm) sieve and predominately

retained on the No. 200 (75 µm) sieve.

17. Mention the Classification of aggregate In accordance with source.

Natural aggregates: This kind of aggregate is taken from natural deposits without changing their nature during the process of production such as crushing and grinding. Some examples in this category are sand, crushed limestone, and gravel.

Manufactured (synthetic) aggregates: This is a kind of man-made materials produced as a main product or an industrial by-product. Some examples are blast furnace slag, lightweight aggregate (e.g. expanded perlite), and heavy weight aggregates (e.g. iron ore or crushed steel).

18. What are the properties of Aggregate?

Moisture conditions: The moisture condition of aggregates refers to the presence of water in the pores and on the surface of aggregates.

Density and specific gravity: Density (D): weight per unit volume (excluding the pores inside a single aggregate) SolidVweightD= Bulk density: the volume includes the pores inside a single aggregate.

19. Give the Grading of aggregates. Grading - size distribution

The particle size distribution of aggregates is called grading. The grading determine the paste requirement for a workable concrete since the amount of void requires needs to be filled by the same amount of cement paste in a concrete mixture.

20. Define Fineness modulus of aggregate.

(i) To characterize the overall coarseness or fineness of an aggregate, a concept of fineness modulus is developed.

(ii) To calculate the fineness modulus, the sum of the cumulative percentages retained on a definitely specified set of sieves needs to be determined, and the result is then divided by 100. The sieves specified for the determination of fineness modulus are No. 100, No. 50, No. 30, No. 16, No. 8, No. 4, 3/8", 3/4", 1.5", 3", and 6".

21. Define Fineness modulus for blending of aggregates.

Blending of aggregates is undertaken for a variety of purposes, for instance, to remedy deficiencies in grading. The fineness modulus of blended aggregates can be calculated if the values for the component aggregates are known.

22. What are the Physical Quality requirements of aggregates?

These requirements can be divided into five distinct groups as follows:

(i) Absorption;

(ii) Abrasion resistance;

(iii) Soundness;

(iv) Restrictions on deleterious constituents; and

(v) Special requirements

23. What are the various tests which are to be done on aggregates?

Various test which are done on aggregates are listed below

(i) Sieve Analysis

(ii) Water Absorption

(iii) Aggregate Impact Value

(iv) Aggregate Abrasion Value

(v) Aggregate Crushing Value

UNIT II - CHEMICAL AND MINERAL ADMIXTURES

1. What is an admixture?

It is defined as a material other than water, aggregate and cement that is used as an ingredient of concrete to modify the properties of fresh or hardened concrete.

2. What are the functions of admixture?

(i) To improve workability of fresh concrete
(ii) To improve durability by entrainment of air
(iii) To reduce the water required
(iv) To accelerate setting & hardening & thus to produce high early strength
(v) To aid curing
(vi) To impart water repellent / water proofing property
(vii) To cause dispersion of the cement particles when mixed with water
(viii) To retard setting
(ix) To improve wear resistance (hardness)
(x) To offset / reduce shrinkage during setting & hardening
(xi) To cause expansion of concrete and automatic prestressing of steel
(xii) To aerate mortar / concrete to produce a light-weight product
(xiii) To impart colour to concrete
(xiv) To offset or reduce some chemical reaction
(xv) To reduce bleeding
(xvi) To reduce the evolution of heat

3. What is the purpose of an accelerator?

(i) Added to increase the rate of hydration of concrete mix which then lead to the increases in the rate of development of strength and greater heat evolution.
(ii) And to shorten the setting time
(iii) More rapid gain of strength & rapid setting

4. State the benefits of water reducing admixture.

(i) Used to reduce the amount of water necessary to produce a concrete of a given consistency
(ii) To increase the slump for a given water content
(iii) To obtain specified strength at lower cement content

(iv) Increases workability with faster gain of strength

(v) Increase the slump, reduce water content, save cement

5. **What is the use of super plasticizer?**

(i) By adding to a hydraulic binder, gives very high workability and allows a large decrease in water content for a given workability

(ii) Allows the particles to be more workable where it enable working with low w/c ratio

(iii) Enhances hydration process, increases strength

(iv) Eliminate concrete segregation & allow good dispersion of cement particles in water, accelerating the rate of hydration.

6. **What are the advantages of super plasticizer?**

(i) Decreased time to place and finish

(ii) Accelerated curing period

(iii) Early removal of formwork

7. **What is the purpose of air entraining admixture?**

(i) An entraining concrete containing air in a rather special form of a bubble that trapped in concrete

(ii) Workability improved, increase in slump, easier placing, increased durability, better resistance to frost action

(iii) Able to reduce segregation tendency and control of bleeding

(iv) It is necessary to have a careful control of air content and mixing time

(v) What is a retarding admixture?

(vi) Prolong or delay the setting time of cement paste in concrete

(vii) Used in hot weather to reduce any premature stiffening of the concrete and consequent loss of workability

(viii) Often carried by ready mixed concrete vehicles to prevent the concrete setting in the drum in the event of breakdown

(ix) Disadvantage is, it may promote bleeding

(x) What are corrosion inhibitors?

(xi) Able to reduce the rate of corrosion to a level that major damage to concrete will be avoided or at least greatly reduced.

(xii) What is the purpose of shrinkage reducing admixture?

(xiii) Able to reduce the amount of shrinkage that occurs as hardened concrete dries.

8. What is a mineral admixture?

Mineral Admixture is natural pozzolanic materials or industrial by-products that are commonly used in concrete to replace part of the cement or sand.

9. What are the different types of mineral admixture?

Types of mineral admixtures are:

(i) Fly ash

(ii) Silica Fume

(iii) Blended hydraulic cement

10. What are the different types of chemical admixtures?

(i) Water-reducing admixtures (Plasticizers, Super plasticizers)

(ii) Retarding admixtures

(iii) Accelerating admixtures

(iv) Air entraining admixtures

11. What are the beneficial effects of admixtures on concrete properties?

Beneficial effects of admixtures on concrete properties are:

Concrete property	Admixture
Workability	• Super plasticizer • Air-entraining agents
Setting	• Accelerators • Retarders
Strength	• Silica fume • Polymers
Durability	• Air-entraining agent • Silica fume

12. What are the two kinds of water reducing admixture?

Two kinds of water-reducing admixture:

(i) Normal range (WR):

a) Reduce 5 – 10% of water

(ii) High range water reducing admixture (HRWR):

a) Super plasticizer

b) Reduce water in a range of 15-30%

13. What are the two main purpose of super plasticizer?

Super plasticizers are used for two main purposes:

(i) To produce high strength concrete at w/c ratio in a range of 0.23 – 0.3 (60 – 150MPa)

(ii) To create "flowing" concrete with high slumps in the range of 175 to 225mm. Self compacting concrete: for beam-column joint and footing (heavy reinforced)

14. What are the major drawbacks of super plasticizer?

The major drawbacks of super plasticizers are:

(i) Retarding of setting (especially at large amount addition)

(ii) Causing more bleeding

(iii) Entraining too much air.

15. What is the mechanism involved in setting control admixtures?

Mechanisms

(i) Change the rate of the crystallization of portland cement by adding certain soluble chemicals to influence the ion dissolution rate.

a) Anions (silicate and aluminate)

b) Cations (calcium)

(ii) The setting will be speeded up when dissolution rates of cations and anions are higher. On the other hand, the setting will be slow down when dissolution rates of cations and anions are lower.

16. What are the applications of retarding admixtures?

Retarding admixtures:

(i) Offset fast setting caused by hot weather

(ii) Setting control of large structural units

(iii) Setting control of long distance transport

17. What are the applications of accelerators?

Accelerators:

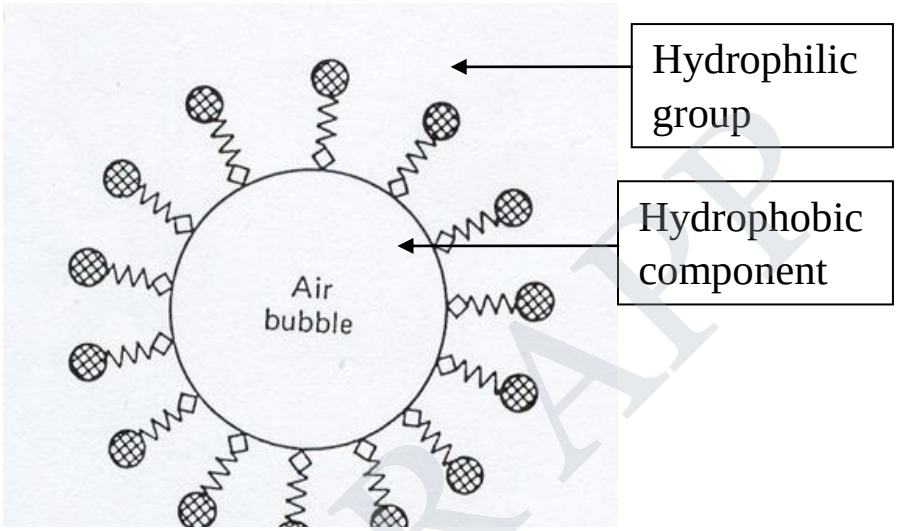
(i) Plugging leaks:

(ii) Emergency repair: High way; Bridge

(iii) Winter construction in cold region

E.g. use calcium chloride ($CaCl_2$)

18. Draw the Schematic representation of air entrainment by surface active molecule



19. What are the physical characteristics of Fly ash?

(i) Grain size distribution

(ii) Fineness

(iii) Specific Gravity

20. What are the applications of Fly ash?

(i) Blended cements

(ii) Fly ash Concrete

a) High Volume Fly Ash Concrete

b) Self Compacting Concrete

c) Roller Compacting Concrete

(iii) Geo-technical Applications

(iv) Building blocks

(v) Structural fills

(vi) Fine Aggregate

(vii) Agricultural applications

(viii) Waste stabilization

(ix) Others (as filler in paints, metal castings etc.)

21. What are the chemicals used in super plasticizers?

(i) Sulphonated melamine formaldehyde (SMF)

(ii) Sulphonated naphthalene formaldehyde (SNF)

(iii) Modified lignosulphonates (MLS)

(iv) Poly Carboxylated Ethers (PCE)

22. Can chemical admixtures be trusted?

(i) A usual question. Especially when the marketing pressures are high. The answer is yes, but.

(ii) The 'but' arises from a need of the user to ensure compatibility of a commercial product with the cement he has at hand. This is done not only by going through chemical manufacturer's technical information but also testing.

(iii) Testing is done on cement, mortar and concrete with and without chemical admixture. IS 9103 prescribes physical requirements.

(iv) The bigger the job the more elaborate can be the tests, including chemical tests on the cement itself.

23. What is Air Entrainment?

(i) The production within the concrete mix of a large number of small bubbles of air.

(ii) Normally these bubbles are less than 1mm in diameter.

(iii) The bubbles must be stable and remain in the concrete as it is transported and placed so that they are still present in the hardened mass of concrete.

(iv) To provide freeze thaw resistance the bubbles must be evenly spread throughout the concrete

24. What is the chemistry behind air entrainment?

Air entrainers are almost all anionic surfactants

(i) Natural wood resins

a) Vinsol, Wood resins

(ii) Animal and vegetable fats and oils

a) Oleic acid, coconut oil derivatives

(iii) Synthetic materials

b) Alkyl/aryl sulphates and sulphonates

Non ionic and cationic materials can be used but are usually not as stable. They may

be useful in blends with particular objects.

25. Why to use air entrain concrete?

Frequently, most consideration is given to the effects of air entrainment in hardened concrete, primarily freeze-thaw protection, but it must be remembered that there are considerable benefits to be gained in the fresh concrete.

(i) Freeze - Thaw resistance

(ii) Increasing mix cohesion

(iii) Improved mix workability

(iv) Improved surface finish

(v) Increased mix volume - yield

Many of these benefits can be obtained with only small increases in air content and do not necessarily require the addition of a specific air entraining admixture.

26. What are the effects of improved cohesion?

Segregation reduces, minimizing problems of settlement of aggregates.

(i) Water is held within the concrete, reducing bleed and cutting down surface finish problems

(ii) Lack of excessive bleed water means that the surface is not weakened through having increased water: cement ratio and does not have the same tendency to show shrinkage cracks.

27. What are the reasons for retardation?

(i) To overcome the faster set of concrete at higher temperatures

(ii) To allow for longer delivery and placing times

(iii) To allow later deliveries of concrete to be added without causing “cold joints”

(iv) To meet the needs of particular construction methods, Such as slip forming.

28. What are the reasons for acceleration?

(i) To overcome the slower setting of concrete at low temperatures

(ii) To meet the needs of particular construction methods, such as floor finishing

(iii) To produce rapid early strength gain

(iv) To allow rapid turnover of moulds

29. What are the chemicals used in accelerators?

Accelerators - mostly inorganic chemicals

(i) Calcium chloride, Formates, Nitrates

(ii) Thiocyanates

(iii) Silicates

(iv) Aluminates

30. What are the chemicals used in retarders?

Retarders - mostly organic chemicals

(i) Carbohydrates

(ii) Hydroxy carboxylic acids and salts

(iii) Phosphates

31. What are the effects of plasticizers on fresh concrete?

Improvement in workability when used as plasticizer

(i) Better appearance and uniformity

(ii) Better finishing characteristics

(iii) Less bleeding; greater pump ability

(iv) Some retardation of setting times

UNIT III - PROPORTIONING OF CONCRETE MIX

1. What do you mean by concrete mix design?

Cement Concrete Mix Design means, determination of the proportion of the concrete ingredients i.e. Cement, Water, Fine Aggregate, Coarse Aggregate which would produce concrete possessing specified properties such as workability, strength and durability with maximum overall economy.

2. What are the methods of Concrete Mix Design?

(i) I.S. Method

(ii) British Method

(iii) A.C.I. Method etc.

3. What are the assumptions made in concrete mix design?

(i) Compressive Strength of Concrete is governed by its Water-Cement Ratio

(ii) Workability of Concrete is governed by its Water Content

4. What are the data required for concrete mix design?

Data required for concrete mix design

(i) Grade of Concrete

a) Eg: RCC-M30-A20

(ii) Slump required in mm

a) **Eg: 25 – 75 mm**

(iii) Degree of Site Control

b) **Eg: Good**

(iv) Type of Exposure

c) **Eg: Moderate**

(v) Grade of Cement

d) **Eg: OPC 43 Grade**

5. What is the approximate Quantity of Materials required for concrete mix design?

Approximate Quantity of Materials required for concrete mix design

(i) Cement: 200 Kg.

(ii) Fine Aggregate: 240 Kg.

(iii) Coarse Aggregate : 180 Kg. (20 mm)

180 Kg. (10 mm)

6. What are the steps involved in concrete mix design?

(i) Step I: - Determine the physical properties of concrete ingredients.

(ii) Step II:-Compute Target Mean Compressive Strength:

(iii) Step III:- Select the Water-Cement ratio of trial mix from experience

(iv) Step IV: - Select the water content per cubic metre of concrete from table2 of I.S: 10262-2009.

(v) Step V:- Compute the quantity of cement

(vi) Step VI: - Then we find the quantities of Fine & Coarse aggregate by absolute volume method.

(vii) Step VII: - Make slump trials to find out the actual weight of water to get required slump. Make corrections to the water content & %FA, if required.

(viii) Step VIII: - Compute 2 more trial mixes with W/C ratios as 0.40 & 0.50, taking %FA as 34% and 38% respectively.

(ix) Step IX: - Cast atleast 3 cubes for each trial mix.

(x) Step X: - Test the cubes for compressive strength at 28 days.

(xi) Step XI: - Draw a graph between compressive strength Vs C/W Ratio.

(xii) Step XII: - From the graph, find the W/C ratio for the required target mean compressive strength.

(xiii) Step XIII: - Calculate the mix proportions corresponding to the W/C ratio, obtained from the graph.

(xiv) Step XIV: - Check the cement content & W/C ratio against the limiting values given in Table-5 of I.S: 456-2000 for given type of exposure & type of Concrete.

7. What are the requirements of concrete mix design?

The requirements which form the basis of selection and proportioning of mix ingredients are:

(i) The minimum compressive strength required from structural consideration

(ii) The adequate workability necessary for full compaction with the compacting equipment available.

(iii) Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions

(iv) Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

8. What are the factors affecting the choice of mix proportion?

The various factors affecting the mix design are:

(i) Compressive strength

(ii) Workability

(iii) Durability

(iv) Maximum nominal size of aggregate

(v) Grading and type of aggregate

(vi) Quality Control

(vii) Mix Proportion designation

9. What are the factors to be considered for mix design?

The grade designation giving the characteristic strength requirement of concrete

(i) The type of cement influences the rate of development of compressive strength of concrete.

(ii) Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS 456:2000.

(iii) The cement content is to be limited from shrinkage, cracking and creep.

(iv) The workability of concrete for satisfactory placing and compaction is related to the size and shape of section, quantity and spacing of reinforcement and technique used for transportation, placing and compaction.

10. What are the types of mixes available for mix design?

(i) Nominal Mixes

(ii) Standard mixes

(iii) Designed Mixes

11. What is a nominal mix?

In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates. These mixes of fixed cement-aggregate ratio which ensures adequate strength are termed nominal mixes. These offer simplicity and under normal circumstances, have a margin of strength above that specified. However, due to the variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

12. What do you mean by standard mix?

(i) The nominal mixes of fixed cement-aggregate ratio (by volume) vary widely in strength and may result in under- or over-rich mixes. For this reason, the minimum compressive strength has been included in many specifications. These mixes are termed standard mixes.

(ii) IS 456-2000 has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40. In this designation the letter M refers to the mix and the number to the specified 28 day cube strength of mix in N/mm2. The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

13. What is meant by design mix?

In these mixes the performance of the concrete is specified by the designer but the mix proportions are determined by the producer of concrete, except that the minimum cement content can be laid down. This is most rational approach to the selection of mix proportions with specific materials in mind possessing more or less unique characteristics. The approach results in the production of concrete with the appropriate properties most economically. However, the designed mix does not serve as a guide since this does not guarantee the correct mix proportions for the prescribed performance.

14. What is meant by proportioning of concrete?

Proportioning concrete is use of certain quantity of cement, sand and coarse aggregate and specific water cement ratio.

15. What is the sequence of steps should be followed in ACI method?

(i) Determine the job parameters - aggregate properties,

(ii) Maximum aggregate size, slump, w/c ratio, admixtures,

(iii) Calculation of batch weight, and

(iv) Adjustments to batch weights based on trial mix.

16. Mention the Maximum aggregate size to be used in Mix Design as per ACI.

Maximum size should not be larger than 1/5 the minimum dimension of structural members, 1/3 the thickness of a slab, or 3/4 the clearance between reinforcing rods and forms. These restrictions limit maximum aggregate size to 1.5 inches.

17. What are the Requirements of concrete mix design as per BIS?

(i) The minimum compressive strength required from structural consideration

(ii) The adequate workability necessary for full compaction with the compacting equipment available

(iii) Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions

(iv) Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete

18. What are the Factors affecting the choice of mix proportions?

The various factors affecting the mix design are:

(i) Compressive strength

(ii) Workability

(iii) Durability

(iv) Maximum nominal size of aggregate

(v) Grading and type of aggregate

(vi) Quality Control

19. Mention the Target Strength for Mix Proportioning.

$f'_{ck} = f_{ck} + 1.65\ s$

Where f'_{ck} = Target average compressive strength at 28 days,

f_{ck} = Characteristic compressive strength at 28 days,

s= Standard deviation

UNIT IV - FRESH AND HARDENED PROPERTIES OF CONCRETE

1. What is a slump test?

It is the most commonly used method of measuring consistency of concrete. This test can be conducted in the field or in laboratory. This test is not suitable for very wet or dry climate.

2. Mention the Properties of concrete at Early Ages.

(i) Workability
(ii) Slump Loss
(iii) Segregation/Bleeding
(iv) Plastic Shrinkage
(v) Time of Set
(vi) Temperature

3. What are the Causes of bleeding and segregation?

(i) Improper slump
(ii) Excessive amount of coarse aggregate
(iii) Lack of fines
(iv) Inappropriate placing and compacting

4. What are the Methods for Control of Bleeding?

(i) Reduction of water
(ii) Introduction of fines and air
(iii) Proper Compaction (too much compaction Causes bleeding)

5. Define Workability

Effort required manipulating a concrete mixture with a minimum of segregation. It is not a fundamental property of concrete consistency (slump) --> how easy to flow cohesiveness --> tendency to bleed and segregate.

6. Is Concrete Really Elastic?

In a word, yes. But the elasticity is a way to characterize the mechanical response of the material body for applied stresses that stay within the linear regime. Very large stresses, which are high enough to fracture the material, cause non-linear deformations.

These values vary greatly depending on the overall makeup of the concrete mixture.

Many of the non-fracture-related mechanical properties of concrete are characterized by the elastic moduli.

For example, in many buildings the stiffness of the structure, made up of reinforced-steel concrete beams, is more important than the strength of the structure. The stiffness of the structure is directly related to the stiffness of the concrete, which is a function of its elastic moduli.

7. Why is Elastic Moduli Important for Concrete?

The elastic moduli prediction code is set up to compute the elastic moduli of an arbitrary material. As long as the microstructure can be represented by a 3- D digital image, and the individual phase elastic moduli are known, the program can be used to compute the overall moduli.

The overall elastic moduli are functions of the microstructure as well as of the elastic moduli of the individual chemical phases in the cement paste. These can be as many as 20 or 30, since cement paste by itself is a chemically complex material.

8. Define concrete Expansion and shrinkage.

Concrete has a very low coefficient of thermal expansion. However, if no provision is made for expansion, very large forces can be created, causing cracks in parts of the structure not capable of withstanding the force or the repeated cycles of expansion and contraction. The coefficient of thermal expansion of Portland cement concrete is 0.000008 to 0.000012 (per degree Celsius) (8 to 12 microstrains/°C)(8-12 1/MK)

9. Define Shrinkage cracking

Shrinkage cracks occur when concrete members undergo restrained volumetric changes (shrinkage) as a result of drying, autogenuous shrinkage or thermal effects. Restraint is provided either externally (i.e. supports, walls, and other boundary conditions) or internally (differential drying shrinkage, reinforcement).

10. Define Plastic Shrinkage cracking

Plastic-shrinkage cracks are immediately apparent, visible within 0 to 2 days of placement, while drying-shrinkage cracks develop over time. Autogenous shrinkage also occurs when the concrete is quite young and results from the volume reduction resulting from the chemical reaction of the Portland cement.

11. Define Tension cracking

Concrete members may be put into tension by applied loads. This is most common in

concrete beams where a transversely applied load will put one surface into compression and the opposite surface into tension due to induced bending. The portion of the beam that is in tension may crack. The size and length of cracks is dependent on the magnitude of the bending moment and the design of the reinforcing in the beam at the point under consideration. Reinforced concrete beams are designed to crack in tension rather than in compression. This is achieved by providing reinforcing steel which yields before failure of the concrete in compression occurs and allowing remediation, repair, or if necessary, evacuation of an unsafe area.

12. Define Creep.

Creep is the permanent movement or deformation of a material in order to relieve stresses within the material. Concrete that is subjected to long-duration forces is prone to creep. Short-duration forces (such as wind or earthquakes) do not cause creep. Creep can sometimes reduce the amount of cracking that occurs in a concrete structure or element, but it also must be controlled. The amount of primary and secondary reinforcing in concrete structures contributes to a reduction in the amount of shrinkage, creep and cracking.

13. What is setting?

Setting is the stiffening of the concrete after it has been placed. A concrete can be 'set' in that it is no longer fluid, but it may still be very weak; you may not be able to walk on it, for example.

Setting is due to early-stage calcium silicate hydrate formation and to ettringite formation. The terms 'initial set' and 'final set' are arbitrary definitions of early and later set; there are laboratory procedures for determining these using weighted needles penetrating into cement paste.

14. What is Hardening?

Hardening is the process of strength growth and may continue for weeks or months after the concrete has been mixed and placed. Hardening is due largely to the formation of calcium silicate hydrate as the cement continues to hydrate. The rate at which concrete sets is independent of the rate at which it hardens. Rapid-hardening cement may have similar setting times to ordinary Portland cement.

15. How the concrete strength has measured?

Measurement of concrete strengths: Traditionally, this is done by preparing concrete cubes or prisms, then curing them for specified times. Common curing times are 2, 7, 28 and

90 days. The curing temperature is typically 20 degrees Centigrade. After reaching the required age for testing, the cubes/prisms are crushed in a large press. The SI unit for concrete strength measurement is the Mega Pascal, although 'Newton per square millimetre'

16. What are the Factors affecting concrete strength?

There are many relevant factors; some of the more important follow:

(i) Concrete porosity

(ii) Water/cement ratio

(iii) Soundness of aggregate:

(iv) Aggregate-paste bond

(v) Cement-related parameters

17. Define Concrete porosity.

The voids in concrete can be filled with air or with water. Air voids are an obvious and easily-visible example of pores in concrete. Broadly speaking, the more porous the concrete, the weaker it will be. Probably the most important source of porosity in concrete is the ratio of water to cement in the mix, known as the 'water to cement' ratio. This parameter is so important it will be discussed separately below.

18. Define Water/cement ratio.

This is defined as the mass of water divided by the mass of cement in a mix. For example, a concrete mix containing 400 kg cement and 240 litres (=240 kg) of water will have a water/cement ratio of 240/400=0.6.

The water/cement ratio may be abbreviated to 'w/c ratio' or just 'w/c'. In mixes where the w/c is greater than approximately 0.4, all the cement can, in theory, react with water to form cement hydration products. At higher w/c ratios it follows that the space occupied by the additional water above w/c=0.4 will remain as pore space filled with water, or with air if the concrete dries out.

19. Define Concrete Durability.

"Durability of concrete is the ability of concrete to withstand the harmful effects of environment to which it will be subjected to, during its service life, without undergoing into deterioration beyond acceptable limits".

20. Write the Factors Influencing Consistency.

The consistency of fresh concrete depends on many factors, the main ones being:

(i) Water Content (kg/m^3)

(ii) W/c Ratio

(iii) Fineness Modulus of the Aggregate

(iv) Use of Water Reducers (Plasticizers / Super plasticizers)

(v) Type and shape of Aggregate

(vi) Entrained Air Content

21. What are the Factors affecting Strength of Hardened concrete?

The strength of hardened concrete depends on many factors, the main ones being:

(i) W/C Ratio

(ii) Strength of the Cement

(iii) Type and shape of Aggregate

(iv) Entrained Air Content

22. What are the principal properties of "good" concrete?

(i) Cement

(ii) W/C Ratio

(iii) Aggregate

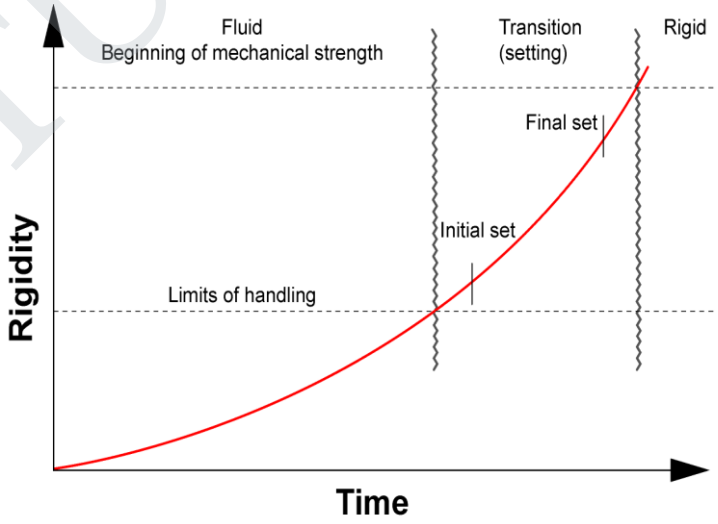
(iv) Cement Paste and Aggregate

(v) Mixing

(vi) Placement and Handling of Fresh Concrete

(vii) Curing

23. State the rate of setting and hardening.

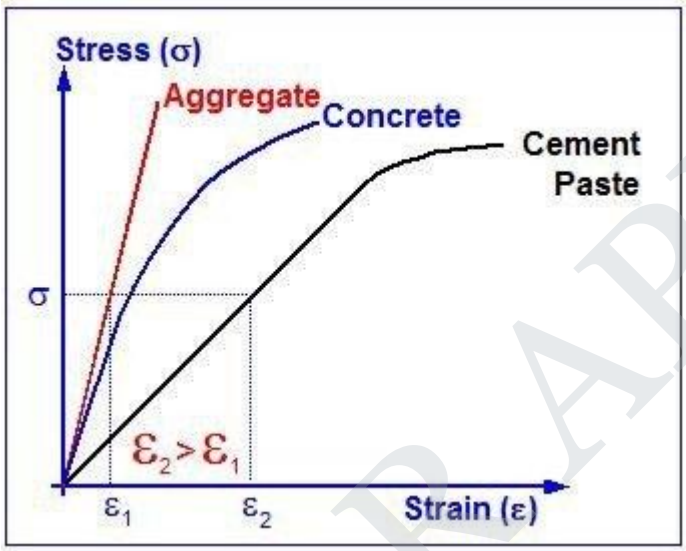


24. Give the standard values of slump for various types of concrete works.

			Water-cement

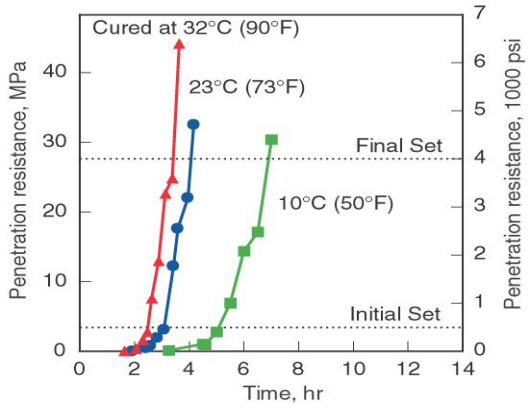
Sl. No.	Name of works	Slump, mm	ratio
1	Concrete for roads and mass concrete	25 to 50	0.70
2	Concrete for R.C.C. beams and slabs	50 to 100	0.55
3	Columns and retaining walls	75 to 125	0.45
4	Mass concrete in foundation	25 to 50	0.70

25. Draw the stress – strain curve for concrete.



UNIT V - SPECIAL CONCRETES

1. **Give the application of special concrete.**
   - (i) Special concrete is used in extreme weather
   - (ii) Good cohesiveness or sticky in mixes with very high binder content
   - (iii) Some delay in setting times depending on the compatibility of cement, fly ash and chemical admixture
   - (iv) Slightly lower but sufficient early strength for most applications
2. **Mention the different types of special concrete.**
   - (i) Concreting in Extreme Climatic Conditions
   - (ii) Polymer Modified Concrete
   - (iii) High Performance Concrete
   - (iv) High Volume Fly Ash Concrete
   - (v) Self-Compacting Concrete
3. **Mention the deleterious effect in cold weather concreting.**
   - (i) Hydration will be hampered
   - (ii) Setting time will be prolong
   - (iii) Disruption of freshly placed concrete because of freezing
   - (iv) Low workability
   - (v) Freezing and thawing effect
   - (vi) Improper curing
   - (vii) Deicing effect
4. **Give the setting times at different temperatures.**



5. **What are the potential problems in hot weather condition?**

(i) Increased water demand
(ii) Increased rate of slump loss
(iii) Increased rate of setting
(iv) Increased tendency for plastic-shrinkage cracking
(v) Increased difficulty in controlling entrained air content
(vi) Decreased 28-day and later strengths
(vii) Increased tendency for differential thermal cracking
(viii) Greater variability in surface appearance
(ix) Increased permeability

6. What are the precautions adopted in hot weather concreting?

(i) Schedule concreting
(ii) Material and mix proportions
(iii) Covered environment
(iv) Chilling
(v) Efficient work force
(vi) Use of low heat cement

7. Define polymer concrete.

Polymer Concrete is a mixture of resin (polyester or epoxy) and aggregate (normally sand). It is used in thin sections for repairs.

8. State PIC.

PIC Polymer Impregnated Concrete is rare and is made by vacuum impregnating a monomer into hardened concrete which is polymerised inside concrete with heat or γ radiation. Only used in factory produced precast units.

The amount of monomer absorbed will depend on the porosity of the concrete, the conditioning of the concrete (drying or vacuum), and the viscosity of the monomer system.

9. State PMC.

PMC Polymer Modified Concrete (Polymer Portland cement Concrete). Catalysed polymer is added into ordinary concrete at the mixer and polymerises insitu. Used for concrete repairs with thicknesses of 50-100mm, overlays for bridge decks etc.

10. What is PCC?

Polymer-cement concrete is concrete modified with polymer admixtures. Modified cement mixes differ from ordinary mixes due to their ability to water keeping that increases

when polymer-cement ratio increases. That permits to improve place ability, prevent "drying" and reach good adhesion with porous base.

11. What do you mean by high performance concrete?

High performance concrete (HPC) was defined by the American Concrete Institute [ACI 1994] as concrete which meets special performance and uniformity requirements that cannot be achieved by using only the conventional materials and normal mixing, placing, and curing practices.

12. Give the characteristics of high performance concrete.

(i) High early strength
(ii) High strength
(iii) High modulus of elasticity
(iv) High abrasion resistance
(v) High durability and long life in severe environments
(vi) Low permeability and diffusion
(vii) Resistance to chemical attack

13. Mention the materials used in HPC along with its desired property.

Material	**Primary Contribution/Desired Property**
Portland cement	Cementing material / Durability
Blended cement	Cementing material / Durability / High strength
Fly ash / Slag / Silica fume	
Calcined clay/ Metakaolin	
Calcined shale	
Superplasticizers	Flowability
High-range water reducers	Reduce water-cement ratio
Hydration control admixes.	Control setting
Retarders	Control setting
Accelerators	Accelerate setting
Corrosion inhibitors	Control steel corrosion

Water reducers	Reduce cement and water content
Shrinkage reducers	Reduce shrinkage
ASR inhibitors	Control alkali-silica activity
Polymer/latex modifiers	Improve workability/reduce paste

14. List the advantages of High Performance of Concrete.

(i) Reduction in size of the columns

(ii) Speed of construction

(iii) More economical than steel concrete composite columns

(iv) Workability and pump ability

(v) Most economical material in terms of time and money

(vi) Increased rentable\useful floor space

(vii) Decrease in overall building height

(viii) Higher seismic resistance, lower wind sway and drift

(ix) Improved durability in aggressive environment

15. What is HVFA?

High volume fly ash (HVFA) concrete usually refers to structural concrete with fly ash content substantially higher than that used in conventional fly ash concretes.

HVFA concrete is now commonly specified for concrete exposed to aggressive chloride or sulphate environment

16. What are the applications of HVFA?

(i) Good cohesiveness or sticky in mixes - very high binder content

(ii) Lower heat characteristics

(iii) Low resistance to de-icing salt scaling

17. What is SCC?

A category of High Performance Concrete that has excellent deformability in the fresh state and high resistance to segregation, and can be placed and compacted under its self weight without applying vibration.

18. State the applications of SCC.

(i) Faster construction

(ii) Improved durability

(iii) Reduction in site manpower

(iv) Better surface finish

(v) Easier placing

(vi) Safer working environment

19. How High Early Strength is concrete achieved?

(i) Chemical admixtures

(ii) Silica fume (or other SCM)

(iii) Steam or autoclave curing

(iv) Insulation to retain heat of hydration

(v) Special rapid hardening cements

20. What is FRC?

(i) Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity.

(ii) It contains short discrete fibers that are uniformly distributed and randomly oriented.

(iii) Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers – each of which lends varying properties to the concrete.

21. What are the applications of FRC?

(i) Industrial flooring

(ii) Sprayed concrete

(iii) Slender structures (usually in precast plants)

(iv) Fire resistant structures

(v) mortar applications (rehabilitation)

22. State fibre reinforced concrete.

Steel fiber-reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete.

23. What are the benefits of FRC?

(i) Improve mix cohesion, improving pump ability over long distances

(ii) Improve freeze-thaw resistance

(iii) Improve resistance to explosive spelling in case of a severe fire

(iv) Improve impact resistance

(v) Increase resistance to plastic shrinkage during curing

24. What are the effects of FRC?

(i) Improved durability of the structure

(ii) Increased tensile and flexural strengths

(iii) Higher resistance to later cracking

(iv) Improved crack distribution

(v) Reduced shrinkage of early age concrete

(vi) Increased fire resistance of concrete

(vii) Negative influence on workability

(viii) Improved homogeneity of fresh concrete

25. What is ferro – cement?

(i) Highly versatile form of reinforced concrete.

(ii) It's a type of thin reinforced concrete construction, in which large amount of small diameter wire meshes uniformly throughout the cross section.

(iii) Mesh may be metal or suitable material.

(iv) Instead of concrete Portland cement mortar is used.

(v) Strength depends on two factors quality of sand/cement mortar mix and quantity of reinforcing materials used.

26. What are the constituent materials of ferrocement?

(i) Cement

(ii) Fine Aggregate

(iii) Water

(iv) Admixture

(v) Mortar Mix

(vi) Reinforcing mesh

(vii) Skeletal Steel

(viii) Coating

27. State the advantages of ferrocement.

(i) Basic raw materials are readily available in most countries.

(ii) Fabricated into any desired shape.

(iii) Low labour skill required.

(iv) Ease of construction, low weight and long lifetime.

(v) Low construction material cost.

(vi) Better resistance against earthquake.

28. What are the disadvantages of ferrocement?

(i) Structures made of it can be punctured by collision with pointed objects.

(ii) Corrosion of the reinforcing materials due to the incomplete coverage of metal by mortar.

(iii) It is difficult to fasten to Ferro-cement with bolts, screws, welding and nail etc.

(iv) Large no of labors required.

(v) Cost of semi-skilled and unskilled labors is high.

(vi) Tying rods and mesh together is especially tedious and time consuming.

29. Give the process of ferrocement construction.

(i) Fabricating the skeletal framing system.

(ii) Applying rods and meshes.

(iii) Plastering.

(iv) Curing

30. Mention the applications of Ferrocement.

(i) Housing

(ii) Marine

(iii) Agricultural

(iv) Rural Energy

(v) Anticorrosive Membrane Treatment.

(vi) Miscellaneous.

31. What is the cost effectiveness of ferrocement structures?

(i) The type of economic system.

(ii) Type of applications.

(iii) Relative cost of labor.

(iv) Capital and local tradition of construction procedure.

(v) Doesn't need heavy plant or machinery.

(vi) Low cost of construction materials.

32. What is shotcreting?

(i) Shotcreting is a method in concrete work in which the concrete mix is applied in layers under the pressure of compressed air

(ii) Shotcreting is done with a special unit, which consists of a mortar gun or concrete sprayer and a compressor

33. What are the materials used for shotcreting?

(i) Cement

(ii) Sand

(iii) Coarse Aggregates

(iv) Water

(v) Chemical additives

(vi) Compressed Air

34. What are the precautions to be taken for shotcrete?

(i) The finished shotcrete layer is to be kept wet continuously for at least a week after completion.

(ii) There would be rebound during the operations which shall not be used for shotcrete.

(iii) The time lag between the first layer and the second layer is to be kept as minimum as possible.-say less than 8 hours.