PVP 23

Code: 23CE3401

II B.Tech - II Semester – Regular Examinations - MAY 2025

CONCRETE TECHNOLOGY
(CIVIL ENGINEERING)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	What are the factors influencing the setting of cement?	L2	CO1
1.b)	Mention the different grades of cement.	L3	CO1
1.c)	What is the significance of compaction in fresh concrete?	L2	CO2
1.d)	What is segregation in concrete, and how does it affect quality?	L3	CO2
1.e)	What is gel/space ratio?	L2	CO3
1.f)	List out non-destructive methods of concrete.	L2	CO3
1.g)	How is the dynamic modulus of elasticity different from the static modulus of elasticity?	L3	CO4
1.h)	What are the effects of creep on concrete structures?	L2	CO4
1.i)	What is ready-mixed concrete, and how is it different from site-mixed concrete?	L2	CO5
1.j)	List different types of fibers used in fiber-reinforced concrete.	L2	CO5

PART – B

		BL	CO	Max. Marks
	UNIT-I			
2	Discuss the chemical composition of Portland cement and explain its impact on the properties of cement.	L2	CO1	10 M
	OR			
3	What are the roles of fly ash and silica fume as supplementary cementing materials in concrete? How do they improve the performance of concrete?	L2	CO1	10 M
	UNIT-II			
4	What is workability in fresh concrete? Explain the factors that influence workability and their significance in concrete production.	L2	CO2	10 M
	OR			
5	Describe the process of shotcrete application. What are its benefits, and where is it commonly used in construction projects?	L3	CO5	10 M
	UNIT-III			
6	What is the flexure test for hardened concrete? Discuss the test procedure and its significance in evaluating the bending strength of concrete.	L2	CO2	10 M
	OR			

7	Discuss the role of curing in the strength development of hardened concrete. What are the effects of improper curing on concrete strength and durability?	L2	CO3	10 M
	UNIT-IV			
8	Explain types of shrinkage.	L3	CO4	10 M
	OR			
9	Discuss how creep can affect the serviceability and long-term performance of concrete elements.	L2	CO4	10 M
	UNIT-V			
10	Explain the process of quality control in concrete. Why is quality control essential in ensuring the desired properties and consistency of the final concrete mix?	L3	CO3	10 M
	OR			
11	Illustrate mix proportioning of M35 grade of concrete as per IS code specifications.	L2	CO2	10 M

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Concrete Technology

(Civil Engineering)

Scheme of Valuation

Part-A

1.a) Mentioning factors influencing the setting of cement - 2marks
1.b) Mentioning different grades of cement - 2marks
1.c) Mentioning significance of compaction in concrete - 2marks
1.d) Explaining segregation of concrete and it's effects - 2marks
1.e) Explaining gel-space ratio - 2marks
1.f) Listing non-destructive methods of concrete - 2marks
1.g) Difference between dynamic modulus of elasticity and static modulus of elasticity - 2marks
1.h) effects of creep on concrete structures - 2marks
1.i) Ready mixed concrete and mentioning how it is different from site-mixed concrete - 2marks
1.j) Listing different types of fibers used in fiber-reinforced concrete - 2marks

Part-B

2. Explanation of chemical composition of cement and its impact on the properties of cement - 10marks.
3. Explanation of flyash and silica fume as a mineral admixtures - 10marks
4. Explanation of workability of concrete and it's factors ~~affecting~~ affecting - 10marks
5. Explanation of Shotcrete - 10marks

6. Explanation of flexure test of concrete – 10 marks
7. Explanation of curing of concrete – 10 marks
8. Explanation of types of shrinkage – 10 marks
9. Explanation of creep affecting concrete – 10 marks
10. Explanation of quality control in concrete – 10 marks
11. Illustrating mix proportion for M35 grade of concrete using IS code specifications – 10 marks

KEY- part-A

1.a) * Time is the factor influencing the setting of cement.

* Initial setting times of cement need to be > 30 minutes.

* final setting time of cement need not be more than 10 hr.

1.b) * 33 grade of cement compressive strength ranging 33 to 43 N/mm²

* 43 grade of cement compressive strength ranging 43 to 53 N/mm²

* 53 grade of cement compressive strength more than 53 N/mm²

1.c) * The process of removal of entrapped air and of uniform placement of concrete to form a homogeneous dense mass is termed compaction.

* The compaction helps to overcome the frictional forces i.e.; a) between particles forming the concrete, b) between concrete and reinforcement, c) between concrete and formwork

1.d) * Segregation can be defined as seperating out of the ingredients of concrete mix, so that the mix is no longer in a homogeneous condition.

* The stability of a concrete mix requires that it should not segregate during transportation and placing.

1.e) * Gel-space ratio is defined as the ratio of the volume of the hydrated cement paste to the sum of volumes of the hydrated cement and of the capillary pores.

* Gel space ratio (x) = $\dfrac{\text{Volume of gel}}{\text{Space available}}$ (on full hydration)

$$x = \frac{0.657C}{0.319C + W_o}$$

where C = weight of cement in gm.

W_o = volume of mixing water in ml.

1.f) * Rebound hammer test

* Ultrasonic pulse velocity test.

1.g) * The value of E found out by methods through velocity of sound or frequency of sound is referred as dynamic modulus of elasticity.

* The value of E found out by actual loading of the specimen and from stress-strain relationship is known as static modulus of elasticity.

14

12

26 27

1.h) * Influence of aggregate
* Influence of mixproportions.
* Influence of age.
* time and level of stress in structural elements

1.i) * A concrete whose constituents are weight batched at a central batching plant mixed either at the plant itself (or) a truck mixer and then transported to the construction site and ~~in a def~~ deliver in a condition to use ready mix concrete.

1.j) * Natural fibers {asbestos, sisal, cellulose}
* Artificial fibers {glass, steel, carbon, polymer}.

2) Chemical composition of cement:

* The raw material used for manufacture of cement consist mainly of lime, silica, alumina and iron oxide. These oxides interact with one another in the kiln at high temperature to form more complex compounds. The relative proportions of these oxide compositions are responsible for influencing the various properties of cement.
* Table showing the approximate oxide composition limits of ordinary Portland cement.

Oxide	Percent content
CaO	60-67
SiO_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-6
MgO	0.1-4
Alkalies (K_2O, Na_2O)	0.4-1.3
SO_3	1.3-3.0

* The oxides present in the raw materials when subjected to high temperature combine with each other to form complex compound largely based on R. H. Bogue's work. The Bogue's compounds are a) Tricalcium silicate ($3CaO\,SiO_2$ - C_3S), b) Dicalcium silicate ($2CaO\,SiO_2$ - C_2S), c) Tricalcium aluminate ($3CaO\,Al_2O_3$ - C_3A), d) Tetracalcium alumino ferrite ($4CaO\,Al_2O_3\,Fe_2O_3$ - C_4AF).
* Impact on properties of cement represented as below:

Raw material for cement		Limestone, clay, shale (calcareous & argillaceous material)
	↓	
Components element in raw materials		O_2, Si, Ca, Al, Fe.
on burning	↓	clinker formed
Compound Composition		C_3S, C_2S, C_3A, C_4AF
on grinding	↓	clinker
Portland Cements		various types
on	↓	hydration
Products of hydration		C-S-H gel + $Ca(OH)_2$

3) Mineral admixtures:

* The Indian Standard IS-456-2000 permits the use of admixtures for modifying the properties of concrete. The following mineral admixtures can be added to concrete either as admixtures or as part of cement.

* Flyash can be grouped under either high calcium (15-35%) or low calcium (< 10%) type depending upon its CaO content. The unburnt carbon content in flyash should be less than 5%. Electron microscope photograph shows that the particles in flyash occur as solid spheres of silica glass, the particle size varying from < 1 μm to 100 μm. The majority of particles are of 20 μm size. 10% to 15% of the particles should have a size more than 45 μm. The surface area of the particles are in the range of 300-400 m^2/kg. The use of flyash is recommended from the point of view of it's durability, economy and energy saving considerations.

* Silica fume, at a very fine non-crystalline SiO_2, is a by-product of ferro silicon industry. It is made at a temperature of approximately 2000°c. It's size is about 0.1 μm. The surface area is in the range of 20-25 m^2/gm. Compared to cement, the particle size of silica fume is 2 order's finer. It acts as an excellent pore filling material. It can be used in proportions of 5-10% of the cement content in a mix.

4) Workability:

* The factors helping concrete to have more lubricating effect to reduce internal friction for easy compaction are mentioned below.

* Water content in a given volume of concrete will have significant influences on the workability. The higher the water content per cubic meter of concrete, the higher will be the fluidity of concrete.

* Mix proportions: Aggregate/cement ratio is an important factor influencing workability. The higher the aggregate/cement ratio, the leaner is the concrete mix.

* Size of aggregate: The bigger the size of the aggregate, the less paste required for lubricating the surface to reduce internal friction.

* Shape of aggregate: Angular, elongated or flaky aggregates makes the concrete very harsh when compared to rounded aggregates and cubical shaped aggregates.

* Surface texture: The influence of surface texture on workability is again due to the fact that the total surface of rough textured aggregate is more than the surface area of ~~same~~ smooth rounded aggregate of same volume.

* Grading of aggregates: The better the grading, the less is the void content and higher the workability.

* Use of admixtures: Plasticizers and superplasticizers greatly improve the workability many folds.

5) Shot crete :-

* Shotcrete or Guniting is mortar (or) very fine concrete deposited by jetting it with high velocity.

* The shotcrete system has different proprietory names in different countries such as blowcrete, guncrete, Jetcrete, spraycrete etc.

* It is more economical than conventional concrete because less formwork is required and only a small portable plant for manufacture and ~~re~~placement.

* Shotcrete has been sucessfully used in stabilization of rock slopes and protection of freshly excavated ~~slopes~~ rock surfaces.

* It's utility has been proved against long term corrosion of pilling, coal bunkers, oil tanks, steel building frames and other structures as well as encasing structural steel for fireproofing.

* Special shotcrete has been developed for high temperatures applications such as refractory linings of kilns, chimneys, furnaces etc.

6)

Flexural strength of concrete:

APPARATUS:

Beam moulds of 150 x 150x 700 mm (when size of aggregate is less than 38 mm) or of size 100 x 100 x 500 mm (when size of aggregate is less than 19 mm), weighing machine, mixer, tamping rod, flexural testing machine.

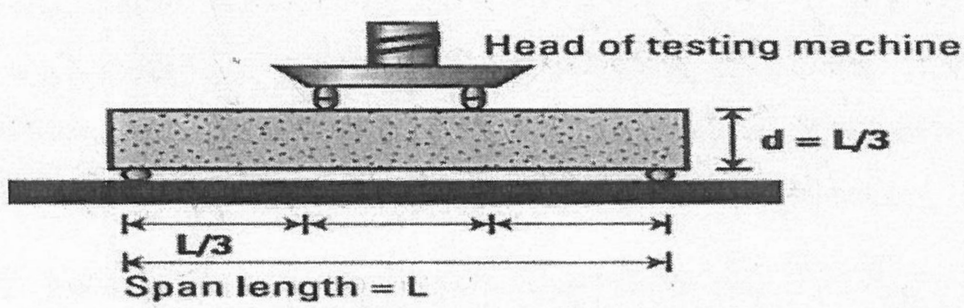
PROCEDURE:

Preparing mould:

- Weigh cement, sand, coarse aggregate and water based on trial design mix. These materials will be sufficient for casting of 3 beams. Mix them thoroughly in the mechanical mixer until uniform colour concrete is obtained.
- Pour the concrete so prepared in the moulds which have been oiled with a medium viscosity oil, in three layers each of approximately equal thickness.
- Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross section of the beam mould and throughout the depth of each layer.
- Remove the specimens from the moulds after 24 hours and immerse them in water for the final curing. The age shall be calculated from the time of addition of water to the dry ingredients.
- Test at least 3 specimens for each age of test.

Test:

- Clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers.
- Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The distance between the outer rollers (i.e. span) shall be 3d and the distance between the inner rollers shall be d as shown in figure. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.
- The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. For moulded specimens, the mould filling direction shall be normal to the direction of loading.
- The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.



CALCULATION:

The Flexural Strength or modulus of rupture (**fb**) is given by

f_b = **pl/bd²** (when **a** > 200mm for 150mm specimen or > 130mm for 100mm specimen)

or

f_b = **3pa/bd²** (when **a**<200mm but > 170 for 150mm specimen or
a<133mm but > 110mm for 100mm specimen)

Where,

a = the distance between the line of fracture and the nearer support, measured on the center line of the tensile side of the specimen

b = width of specimen (mm)

d = failure point depth (mm)

l = supported length (mm)

p = max. Load (N)

1) Curing :

* The physical properties of concrete depends largely on extent of hydration of cement & resultant microstructure of hydrated cement. Thus concrete continues gaining strength with time provided sufficient moisture is available for the hydration of cement which can be assured only by creation of favourable conditions of temperature & humidity. This process of creation of an environment during a relative short period immediately after the placing and compaction of the concrete, favourable to the setting & hardening of concrete is termed ~~as~~ curing.

* The strength can be visualised as a function of period and temperature of curing. The product (period x temperature) is called maturity of concrete measured in °c.hrs. This maturity of concrete is not applicable to hot weather conditions and applicable to well defined concrete environment.

* Curing periods IS:456 stipulates minimum of 7 days moist curing, while IS:1786 stipulates minimum of 10 day under hot weather conditions.

* Methods of curing of concrete are 1) ponding of water over the concrete surface after it has set, 2) covering the concrete with wet burlap, 3) covering the surface with water proof paper, 4) leaving the shuttering or formwork on, 5) Membrane curing of the concrete, 6) Steam curing (IS : 9013) 7) Curing of concrete by infrared radiation, 8) Electrical curing, 9) Sprinkling of water

* Delay of effects of delayed curing are 1) If concrete specimen left 3 days in air, 10% of compressive strength loss exists. 2) If concrete specimen left 28 days in air, 25% of compressive strength loss exists.

) Shrinkage :-

* The term shrinkage is loosely used to describe the various aspects of volume changes in concrete due to loss of moisture at different stages due to different reasons.

* Plastic shrinkage :- shrinkage of this type manifests itself soon after the concrete is placed in the forms while the concrete is still in plastic state. Loss of water by evaporation from the surface of concrete or by the absorption by aggregate or subgrade, is believed to be the reasons of plastic shrinkage. The loss of water results in the reduction of volume.

* Drying shrinkage :- Just as the hydration of cement is an ever lasting process, the drying shrinkage is also an everlasting process when concrete is subjected to drying conditions. The loss of free water contained in hardened concrete, does not result in any appreciable dimensional change. It is the loss of water held in gelpores that causes the change in the volume. The finer the gel, the more is the shrinkage.

* Autogeneous shrinkage :- In a conservative system i.e; where no moisture movement to or from the paste is permitted, when temperature is constant some shrinkage may occur. The shrinkage of such a conservative system is known as autogeneous shrinkage. It is of minor importance and is not applicable in practice to many situations except that of mass of concrete in the interior of a concrete dam.

* Carbonation shrinkage :- It is probably caused by the dissolution crystals of calcium hydroxide and deposition of calcium carbonate in its place. As the new product is less in volume than the product replaced, shrinkage takes place.

9) Creep:-

* Under sustained stress, with time, the gel, the adsorbed water layer, the water held in the gel pores and capillary pores yields, flows and readjust themselves, which behaviour is termed as creep in concrete.

* Aggregate undergoes very little creep. It is really the paste which is responsible for the creep. The stronger the aggregate the more is the restraining effect and hence less is the magnitude of creep.

* The amount of paste content and its quality is one of the most important factors influencing creep. A poorer paste structure undergoes higher creep. Therefore, it can be said that creep increases with increase in water/cement ratio. Broadly speaking, all other factors which are affecting the water cement ratio is also affecting the creep.

* The moisture content of the concrete being different at different age, also influences the magnitude of creep.

* In reinforced concrete beams, creep increases the deflection with time and may be a critical consideration in design.

* In reinforced concrete columns, creep property of concrete is useful. Under load immediately elastic deformation takes place. Concrete creeps and deforms. It cannot deform independent of steel reinforcement. There will be gradual transfer of stress from concrete to steel. The extra load in the steel is required to be shared by concrete and this situation results in employment and development of full strength of both the materials. However, in eccentrically loaded columns, creep increases the deflection and can load to buckling.

10) Quality control in concrete :

* The design of a satisfactory mix proportion is by itself no guarantee of having achieved the objective of quality concrete work.

* The batching, mixing, ~~placing~~ transportation, placing compaction, finishing and curing are very complementary operations to obtain good quality concrete.

* Good quality concrete is a homogeneous mixture of water, cement, aggregates and other admixtures. It is not just a matter of mixing these ingredients to obtain some kind of plastic state of mass but it is a scientific process which is based on some well established principles and governs the properties of concrete mixes in fresh as well as hardened state.

* The aim of quality control is to ensure the production of concrete of uniform strength in such a way that there is continuous supply of concrete delivery to the place deposition. Each batch of which is as nearly like the other batches as possible.

* The key aspects of quality control in concrete are

a) Adherence to standards and specifications
b) Sampling and testing
c) Visual inspections
d) Training and supervision
e) Corrective actions.

11) Mix proportioning of M35 grade of concrete as per IS codes:-

* Target strength for mix proportioning :- (IS 10262:2019 & IS 456:2000)

$\rightarrow f'_{ck} = f_{ck} + [1.65 \times S]$
$= 35 + [1.65 \times 5]$
$= 43.25\ N/mm^2$

from Table 2 of IS 10262, $S = 5\ N/mm^2$

$\rightarrow f'_{ck} = f_{ck} + X$
$= 35 + 6.5$
$= 41.5\ N/mm^2$

from Table 1 of IS 10262, $X = 6.5$

→ The higher value is to be adopted.

* Approximate air content :-

→ Considering maximum size of aggregate, from table 3 of IS 10262, air content value need to be ~~took~~ taken.

* Selection of water cement ratio :-

Assuming necessary data
→ from tables of IS 456, w/c ratio selected.
→ from figures of IS 10262, w/c ratio selected.
→ Minimum w/c selected of two values

* Selection of water content :-

Assuming necessary data
→ from table 4 of IS 10262, water content is selected.

* Calculation of cement content :-

→ Based on water cement ratio and water content, cement content is calculated.

→ Calculated cement content need to be checked with minimum cement content ~~450kg/m³~~ (Table 5 of IS 456) and maximum cement content of $450 kg/m^3$

* Proportion of volume of coarse aggregate and fine aggregate

→ from table 5 of IS 10262, the proportionate volume of coarse aggregate corresponding to assumed size of coarse aggregate and zone of fine aggregate for w/c ratio of 0.5 taken.

→ This proportionate volume of coarse aggregate val need to considered for correction for other than

→ Then volume of fine aggregate content = 1

* Mix calculations :-

→ The mix calculations per unit shall be done based on specific gra and masses of fine aggregate and coar were also found out.