MADE EASY PUBLICATIONS

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CONTENTS

CIVIL ENGINEERING

Objective Practice Sets

RCC & Prestressed Concrete

1 CHAPTER
Fundamentals of RCC (Introduction)

Q.1 Consider the following statements regarding concrete mix constituents as given in IS 456:2000:
1. Total water-soluble sulphate content of concrete mix, expressed as SO_3, should not exceed 8% by mass of cement in the mix.
2. Use of super sulphated cement is generally restricted where the prevailing temperature is above 40°C.
3. Cement content not including fly ash and ground granulated blast furnace slag in excess of 450 kg/m^3 should be used.

Which of the above statement(s) is(are) CORRECT?
(a) 1 and 2 (b) 2 only
(c) 1 and 3 (d) 3 only

Q.2 Consider the following statements regarding testing of concrete:
1. The mean strength determined from any group of four consecutive test results should be more than or equal to $f_{ck} + 1.65\sigma$.
2. Minimum 30 samples are required to be tested for the establishment of value of standard deviation.
3. Individual test results should not fall below $f_{ck} - 3$.

Which of the above statements are CORRECT?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

Q.3 Consider the following statements regarding various exposure conditions :
1. Concrete surfaces exposed to sea water spray is *extreme* environment exposure.
2. Minimum cement content for reinforced concrete in *very severe* exposure condition should be 340 kg/m^3.
3. Maximum grade of concrete exposed to *extreme* environment should be M40.
4. Maximum free water-cement ratio can go upto 0.55 for reinforced concrete in *mild* exposure.

Which of the above statements are INCORRECT?
(a) 2 and 4 (b) 1 and 3
(c) 1 and 2 (d) 3 and 4

Q.4 The characteristic strength of concrete is
(a) higher than the average cube strength
(b) lower than the average cube strength
(c) the same as the average cube strength
(d) higher than 90% of the average cube strength

Q.5 Stress-strain curve of concrete is
(a) A perfect straight line upto failure
(b) Straight line upto 0.002 strain value and then parabolic upto failure.
(c) Nearly parabolic upto 0.002 strain value and then a straight line upto failure
(d) Hyperbolic upto 0.002 strain value and then a straight line upto failure

Q.6 The target mean strength of M25 grade concrete which shows standard deviation of 4 N/mm^2 is equal to _____ N/mm^2.

Q.7 Creep in concrete increases when
(a) relative humidity is high
(b) temperature is high
(c) size of member is large
(d) loading is sustained over a short period

Q.8 For under water concrete, water cement ratio should not exceed
(a) 0.45 (b) 0.50
(c) 0.55 (d) 0.60

Q.9 Which of the following statements refer to correct purposes as regards testing of concrete by ultrasonic pulse velocity method?
1. To assess the quality of concrete in-situ.

2. To determine the dynamic modulus of elasticity of concrete.
3. To locate the presence of cracks in it.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Q.10 Consider the following statements:
1. In reinforced cement concrete, modular ratio is defined by the ratio (modulus of elasticity of steel)/(Modulus of elasticity of concrete).
2. Modulus of rupture of cement concrete is a function of its characteristic compressive strength.
3. The characteristic compressive strength of M 20 grade cement concrete at 7 days is 20N/mm^2.

Which of these statements are correct?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

Q.11 The target mean strength f_{cm} for concrete mix design obtained from the characteristic strength f_{ck} and standard deviation σ, as defined in **IS 456 : 2000**, is
(a) $f_{ck} + 1.35\,\sigma$ (b) $f_{ck} + 1.45\,\sigma$
(c) $f_{ck} + 1.55\,\sigma$ (d) $f_{ck} + 1.65\,\sigma$

Q.12 Let the characteristic strength be defined as that value, below which not more than 50% of the results are expected to fall. Assuming a standard deviation of 4 MPa, the target mean strength (in MPa) to be considered in the mix design of a M25 concrete would be
(a) 18.42 (b) 21.00
(c) 25.00 (d) 31.58

Q.13 The flexural tensile strength of M25 grade of concrete, in N/mm^2, as per **IS 456 : 2000** is _____.

Q.14 Modulus of rupture for M40 grade concrete is approximately
(a) 4.43 MPa (b) 3.56 MPa
(c) 4.0 MPa (d) 3.32 MPa

Q.15 If elastic deformation of a concrete member is 8 mm then, assuming that member is loaded after 7 days of casting, ultimate creep deformation will be
(a) 8.8 mm (b) 12.8 mm
(c) 17.6 mm (d) 10.8 mm

Q.16 What should be the minimum grade of reinforced concrete in and around sea coast construction?
(a) M 35 (b) M 30
(c) M 25 (d) M 20

Q.17 The modulus of elasticity, $E = 5000\sqrt{f_{ck}}$ where f_{ck} is the characteristic compressive strength of concrete, specified in **IS 456 : 2000** is based on
(a) tangent modulus
(b) initial tangent modulus
(c) secant modulus
(d) chord modulus

Q.18 For computing the 'instantaneous' elastic deflection, which one of the following will be useful?
(a) long-term static modulus of elasticity.
(b) short-term static modulus of elasticity.
(c) dynamic modulus of elasticity.
(d) None of these

Q.19 The slope of the line joining any point on stress-strain curve of concrete to the origin is known as
(a) Initial tangent modulus of elasticity
(b) Tangent modulus of elasticity
(c) Secant modulus of elasticity
(d) Long term modulus of elasticity

Q.20 Statistically, the variation in concrete strength is studied in terms of standard deviation and coefficient of variation, where the later is given by
(a) $\dfrac{\text{Mean strength}}{\text{Standard deviation}}$
(b) $\dfrac{\text{Standard deviation}}{\text{Mean strength}}$
(c) $\dfrac{\text{Characteristic strength}}{\text{Mean strength}}$
(d) $\dfrac{\text{Characteristic strength}}{\text{Standard deviation}}$

Q.21 The long-term static modulus of elasticity as per **IS 456:2000 Code** for M40 grade concrete having creep coefficient of 1.8 is
(a) 5647 MPa (b) 8470 MPa
(c) 11294 MPa (d) 16941 MPa

Q.22 Consider the following statements regarding Test Results of Samples:
1. The test results of the sample shall be the average of the strength of three specimens.

2. The individual variation should not be more than ±15% of the average.
3. If the variation is found more than ±5%, the test results of the sample are invalid.

Which of the above statements are CORRECT?

(a) 1 and 3 (b) 2 and 3
(c) 1 and 2 (d) 1, 2 and 3

Q.23 The minimum number of samples for the 140 m^3 of concrete are

(a) 6 (b) 5
(c) 7 (d) 8

Q.24 The frequency distribution of the compressive strength of 20 concrete cube specimen is given in the table.

f (MPa)	Number of specimens with compressive strength equal to f
23	4
28	2
22.5	5
31	5
29	4

If μ is the mean strength of the specimens and σ is the standard deviation, the number of specimens (out of 20) with compressive strength less than $\mu - 3\sigma$ is _____.

Q.25 The static modulus of M20 grade concrete after 1 year of loading is

(a) 5.647×10^3 N/mm^2
(b) 15.647×10^3 N/mm^2
(c) 10.647×10^3 N/mm^2
(d) 20.647×10^3 N/mm^2

Directions: Each of the next items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are individually true; and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true; but Statement (II) is NOT the correct explanation of Statement (I)
(c) Statement (I) is true; but Statement (II) is false
(d) Statement (I) is false; but Statement (II) is true

Q.26 **Statement (I):** Design of concrete mix involves economical selection of relative proportions of various ingredients of concrete.
Statement (II): Nominal mix concrete is permitted only for concrete grades upto M15. For higher grade, design mix is adopted.

Q.27 **Statement (I) :** The stress block used in the limit state design method is obtained by testing of concrete cylinder under uniform rate of strain.
Statement (II) : If a uniform rate of strain is not adopted it is not possible to obtain the descending portion of stress and strain curve beyond maximum stress.

Q.28 **Statement (I):** As per IS 456:2000, under more adverse environmental exposure conditions, higher grades of concrete are recommended.
Statement (II): Higher grades of concrete possess higher compressive strength.

Q.29 **Statement (I):** Tensile strength of concrete is measured using flexure test or the cylinder splitting test.
Statement (II): It is difficult to perform direct tension test on a concrete specimen, as it requires a purely axial tensile force to be applied, free of any misalignment and secondary stresses in the specimen at the grips of the testing machine.

Q.30 **Statement (I):** Limit state method aims for a comprehensive and a rational solution to the design problem.
Statement (II): This method considers safety at ultimate loads and serviceability at working loads.

Q.31 **Statement (I):** The stress-strain curve for concrete in tension is generally approximated as a straight line from the origin to the failure point.
Statement (II): Concrete has a high failure strain in unaxial tension.

Multiple Select Questions (MSQ)

Q.32 Which of the following case(s) is/are considered for safe design of reinforced concrete members in flexure?

(a) Over-reinforced section
(b) Secondary compression failure
(c) Primary compression failure
(d) Under-reinforced section

Q.33 Which of the following statement(s) is/are correct?

(a) Modulus of elasticity of concrete increases with increase in workability

(b) Maximum compressive strength of structural concrete is taken as approximately 0.8375 times the strength of cylindrical specimen.

(c) Target mean strength is always greater than characteristic strength.

(d) The strength of concrete under biaxial compression is greater than uniaxial compression.

■■■■

Answers Fundamentals of RCC (Introduction)

1. (b)	2. (b)	3. (b)	4. (b)	5. (c)	6. 31.6	7. (b)	8. (d)	9. (d)	10. (b)
11. (d)	12. (c)	13. 3.5	14. (a)	15. (c)	16. (b)	17. (c)	18. (b)	19. (c)	20. (b)
21. (c)	22. (c)	23. (a)	24. 0	25. (c)	26. (c)	27. (a)	28. (b)	29. (a)	30. (a)
31. (c)	32. (b, d)		33. (b, c, d)						

Explanations Fundamentals of RCC (Introduction)

1. (b)

Refer clause 8.2.4.2, clause 8.2.5.3 and Table 4 of IS-456 : 2000.

2. (b)

Refer Clause 16.2 and Table 11 of IS 456 : 2000.

3. (b)

Concrete surfaces exposed to sea water spray is said to be in very severe exposure condition.

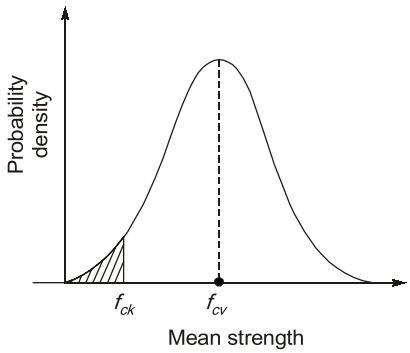
Minimum grade of concrete exposed to extreme environment for RCC should be M40.

4. (b)

Characteristics strength = f_{ck}

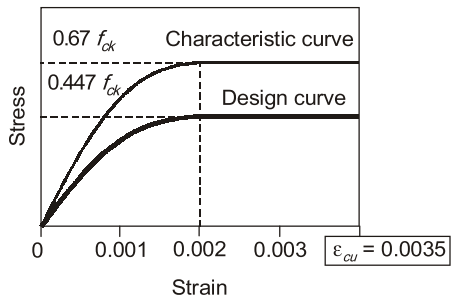
$$f_{av} = f_{ck} + 1.65s$$

$$\therefore \quad f_{ck} < f_{av}$$



5. (c)

The characteristic and design stress–strain curves specified by the Code for concrete in flexural compression are depicted in Figure below. The maximum stress in the concrete in the structure is restricted to 0.67 f_{ck}. The curves consist of a parabola in the initial region up to a strain of 0.002 (where the slope becomes zero), and a straight line thereafter, at a constant stress level up to an ultimate strain of 0.0035.



6. 31.6 (31 to 32)

Target mean strength,

$$f_{cm} = f_{ck} + 1.65\sigma$$
$$= 25 + 1.65 \times 4$$
$$= 31.6 \text{ N/mm}^2$$

7. (b)

Creep increases when

1. cement content is high
2. w/c ratio is high
3. aggregate content is low
4. air entrainment is high
5. relative humidity is low

6. temperature (causing moisture loss) is high
7. size/thickness of the member is small
8. loading is sustained over a long period

8. (d)

Refer clause 14.2.2 of **IS-456:2000**

9. (d)

Ultrasonic pulse velocity test is an in-situ test of hardened concrete when it is already acting as a structural member.

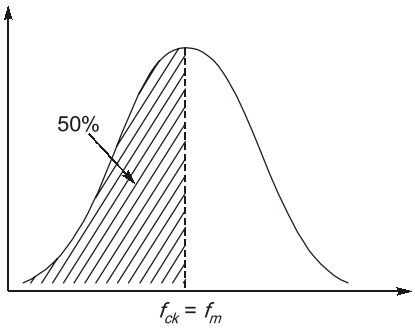
This test is based on the principle that the velocity of sound in a solid material is a function of the square root of the ratio of its modulus of elasticity E to its density, ρ.

Higher the velocity of pulses greater is the strength of concrete.

10. (b)

The characteristic compressive strength is measured at 28 days.

12. (c)



If f_{ck} is the value below which not more than 50% of test results are expected then,

$$f_m = f_{ck}$$

[Mean strength = Characteristics strength]

So target mean strength of concrete to be considered in design mix.

= Mean strength

$= f_m = f_{ck} = 25$ MPa

13. (3.5)

Flexural strength $= 0.7\sqrt{f_{ck}} = 3.5$ N/mm^2

14. (a)

As per **Clause 6.2.2** of **IS 456:2000**, modulus of rupture, f_{cr} is given as

$$f_{cr} = 0.7\sqrt{f_{ck}} = 0.7\sqrt{40} = 4.43 \text{ MPa}$$

15. (c)

Ultimate creep deformation = $\theta \times$ elastic deformation

where θ = creep coefficient

$\theta = 2.2$ for loading after 7 days

So, ultimate creep deformation = 2.2×8

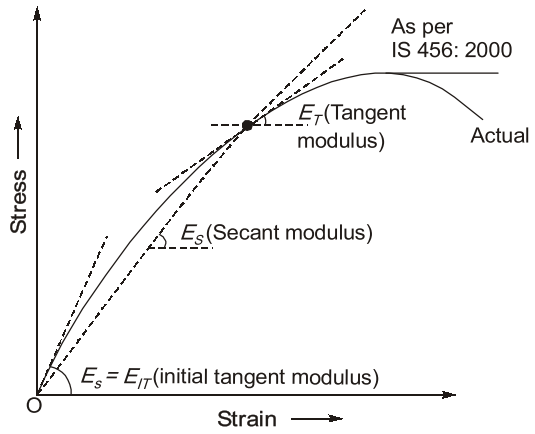
$= 17.6$ mm

16. (b)

Exposure	Minimum grade of plain concrete	Minimum grade of reinforced concrete
(i) Mild	–	M20
(ii) Moderate	M15	M25
(iii) Severe	M20	M30
(iv) Very severe	M20	M35
(v) Extreme	M25	M40

Concrete in sea water or exposed directly along the sea coast shall be at least *M*20 grade in the case of plain concrete and *M*30 in case of reinforced concrete. The use of slag or pozzolana cement is advantageous under such conditions.

19. (c)



21. (c)

Long-term static modulus of elasticity is given by

$$E_\theta = \frac{E_c}{1+\theta} = \frac{5000\sqrt{f_{ck}}}{1+\theta}$$

$$= \frac{5000\sqrt{40}}{1+1.8} \simeq 11294 \text{ MPa}$$

22. (c)

If the variation is found more than ±15%, the test results of the sample are invalid.

Refer **IS 456:2000, Clause 15.4**

23. (a)

As per **IS 456:2000 Code**, Clause 15.2.2

Quantity of concrete (m^3)	Number of samples
1 - 5	1
6 - 15	2
16 - 30	3
31 - 50	4
51 and above	4 plus one additional sample for each additional 50 m^3 or part thereof

$\therefore$ For 140 m^3 of concrete,

Number of samples

$$= 4 + \frac{(140-50)}{50} \times 1 = 4 + 1.8 \simeq = 4 + 2 = 6$$

24. (0)

Average strength,

$$\mu = \frac{(4\times 23)+(2\times 28)+(5\times 22.5)+(5\times 31)+(4\times 29)}{20}$$

$$= 26.575 \text{ MPa}$$

$$\sigma = \sqrt{\frac{\Sigma(\mu - f)^2}{n-1}}$$

$$= \sqrt{\frac{(26.575-23)^2\times 4+(26.575-28)^2\times 2 + (26.575-22.5)^2\times 5+(26.575-31)^2 \times 5+(26.575-29)^2\times 4}{(20-1)}}$$

$$= 3.7$$

Now, $\mu - 3\sigma = 26.575 - 3 \times 3.7 = 15.48$

Thus, no specimen is having compressive strength less than $\mu - 3\sigma$.

No. of specimen = 0.

25. (c)

We know,

As per IS456:2000,

$$E_C = \frac{5000\sqrt{f_{ck}}}{1+\theta}$$

where f_{ck} = characteristic compressive strength
$= 20 \text{ N/mm}^2$
θ = Creep coefficient
= 1.1 for 1 year of loading.

$$\therefore \quad E_C = \frac{5000\sqrt{20}}{1+1.1}$$

$$= 10.647 \times 10^3 \text{ N/mm}^2$$

26. (c)

- For concrete mix design, apart from meeting the criteria for characteristic strength, concrete must be workable in fresh state and impermeable and durable in hardened state.
- Nominal mix concrete is permitted only in ordinary concrete (i.e. upto M20 concrete).

27. (a)

The stress-strain curve of concrete is obtained by testing of cubes under uniform rate of strain. Although it can also be conducted on cylindrical specimen.

For accurate result of cube test, loading is to be done at a uniform rate of strain. if the rate of strain is increased failure takes place showing higher stresses without showing the descending portion of stress-strain curve.

28. (b)

For 'moderate', 'severe', very severe' and 'extreme' exposure conditions, the minimum grades prescribed are M25, M30, M35 and M40 respectively, for reinforced concrete work. It should be noted that the higher grades specified here are dictated, not by need for higher compressive strength, but by need for improved durability.

29. (a)

Both the statements are correct and statement (II) is the correct explanation of statement (I).

30. (a)

There are two types of limit states:

1. Ultimate limit states (or limit states of collapse), which deal with strength, related to shear, flexure and axial forces.
2. Serviceability limit states which deal with discomfort to occupants, caused by excessive deflection, crack-width, vibration, leakage, etc., and also loss of durability, etc.

31. (c)

Failure strain is found to be in the range of 0.0001 to 0.0002.