IES MASTER

Institute for Engineers (IES/GATE/PSUs)

ESE 2024 Prelims Exam

Paper - II

CIVIL ENGINEERING

Detailed Solution

(SET-D)

Office Address

DELHI: F-126, Katwaria Sarai, New Delhi - 110 016

Ph: 011-41013406, Mobile: 8130909220, 9711853908

Web: www.iesmaster.org | E-mail: info@iesmaster.org

The colour of the Questions show the difficulty level of questions as per below mentioned colour code:

- Easy
- Moderate
- Hard

1. In the conveying of most building concrete from the mixer or truck to the form is done in bottom-dump buckets, then the chief danger during conveying is that of

(a) Transferring

(b) Moisture and temperature

(c) Segregation

(d) Vibrations

Sol: (c)

In conveying of most building concrete from mixer to truck to the form is done in bottom dump buckets the chief danger during conveying is that of segregation.

2. Which one of the following is NOT a property of an admixture?

(a) Improve workability

(b) Increase strength

(c) Improve durability

(d) Increase permeability

Sol: (d)

- Ad mixtures are the materials added in the concrete mix before or during mixing to improve its properties.

Functions performed by admixtures

(i) To accelerate the initial set of concrete, i.e., to speed up the rate of development of strength at early ages.

(ii) To retard the initial set

(iii) To increase the strength of concrete

(iv) To improve workability

(v) To reduce heat of evolution

(vi) To increase durability of concrete resistance to freezing and thawing

(vii) To control expansion caused by aggregate alkali reaction

(viii) To decrease capillary flow of water and to make it impermeable

(ix) To increase the penetration and pumpability of concrete

(x) To reduce segregation in grouts, strengthen the bond between old and new concrete surface and that between steel reinforcement and concrete, inhibit corrosion of concrete, increase resistance to chemical attack.

Some other functions are: Produce coloured and cellular concrete, produce concrete of fungicidal, germicidal and insecticidal properties, and produce non-skid concrete surfaces.

3. Which one of the following is the creep coefficient at any time? (Where C_{ct} is the creep coefficient at any time and C_{cu} is the ultimate creep co-efficient and t is the time in days after loading)

(a) $C_{ct} = \frac{t^{0.60}}{10 + t^{0.60}} C_{cu}$

(b) $C_{ct} = \frac{t^{0.50}}{10 + t^{0.50}} C_{cu}$

(c) $C_{ct} = \frac{t^{0.40}}{10 + t^{0.40}} C_{cu}$

(d) $C_{ct} = \frac{t^{0.70}}{10 + t^{0.70}} C_{cu}$

Sol: (a)

- Creep is the time-dependent deformation of a member under sustained load.
- The magnitude of the total creep is partially a function of the concrete strength.
- Higher strength concrete has relatively less creep than lower strength concrete (ACI SP-227).
- Creep coefficients C_c are commonly used to calculate the creep effects.

- Creep coefficient is the ratio of the total deformation (ε_{cu}) at the end of the specified time period divided by the initial elastic deformation (ε_{ci}) when subjected to sustained load.

$$C_c = \frac{\varepsilon_{cu}}{\varepsilon_{ci}}$$

- Branson suggests that the creep coefficient C_{ct} at any time t can be related to the long-term creep by the relationship as following.

$$C_{ct} = \frac{t^{0.6}}{10 + t^{0.6}} C_c$$

where, t is the time in hours after the load is applied.

4. Consider the following statements regarding the design of T-beams:

1. To establish flange thickness h_f based on flexural requirements of the slab, which normally spans transversely between perpendicular T beams.
2. Determine the effective flange width b_f according to ACI limit.
3. Choose web dimensions b_w and d based on either negative bending requirements at the supports or shear requirements by setting a reasonable upper limit on the nominal unit shear stress V_u in the beam web.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: (d)

- In case of T beam when the slab span perpendicular to T beam then thickness if slab i.e., flange thickness can be calculated based on flexural requirement of the slab.
- The effective flange thickness can be calculated using ACI methods
- Also, web width and depth can be calculated based on negative bending moment at support and shear requirements these are maximum at support.

Hence option (d) is correct.

5. What is the minimum thickness 'h' of nonprestressed one-way slabs of length 'L' for simply supported?

(a) L/24 (b) L/10

(c) L/20 (d) L/28

Sol: (c)

As per ACI code: One-way construction (nonprestressed)

Minimum thickness stipulated in following table shall apply for one-way construction not supporting or attached to partitions or other construction likely to be damaged by large deflections, unless computation of deflection indicates a lesser thickness can be used without adverse effects.

Table: Minimum thickness of nonprestressed beams or one-way slabs unless deflections are calculated

	Minimum thickness, h			
	Simply supported	One end continuous	Both ends continuous	Cantilever
Member	Members not supporting or attached or partitions or other construction likely to be damaged by large deflection			
Solid one-way slabs	//20	//24	//28	//10
Beams or ribbed one way slabs	//16	//18.5	//21	//8

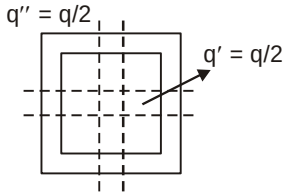
6. What is the maximum bending moment of elastic plates in a square slab where q is the load shared on length ℓ?

(a) 0.625 $q\ell^2$ (b) 0.00625 $q\ell^2$

(c) 0.0625 $q\ell^2$ (d) 0.000625 $q\ell^2$

Sol: (c)

In a simply supported square slab,



Maximum bending moment of elastic plates

$$= \frac{(q')\ell^2}{8} = \frac{\left(\frac{q}{2}\right)\ell^2}{8} = 0.06259\ell^2$$

7. What is the load factor for stem in the design procedure for cantilever retaining walls with safety?

(a) 1.2 (b) 1.6

(c) 2 (d) 2.5

Sol: (b)

As per ACI code: In the design of retaining wall lateral earth pressure are multiplied by load factor of 1.6

8. Which one of the following types of equipment is used in topographic surveys and also for recording the shapes of buildings?

(a) Electromagnetic distance measurement devices

(b) GPS

(c) Satellite camera

(d) Aerial camera

Sol: (d)

Mainly a topographical map shows the elevation, natural and artificial features and forms of earth surface. Arial photographic methods are extensively used in preperation of topographic maps.

9. Match the following lists:

List-I (Correction)	List-II (Formula)
P. Absolute length (c_a)	1. $\frac{1}{24}\left(\frac{W}{P}\right)^2 L$
Q. Sag (c_g)	2. $\frac{h^2}{2L}$
R. Alignment (c_m)	3. $\frac{c}{\ell}L$

Select the correct answer using the code given below:

	P	Q	R
(a)	2	1	3
(b)	3	2	1
(c)	3	1	2
(d)	2	3	1

Sol: (c)

10. If sensitivity of a bubble tube is 30" per 2 mm division what would be the error in staff reading on a vertically held staff at a distance of 200 m, when the bubble is out of centre by 2.5 divisions?

(a) 0.073 m (b) 0.73 m

(c) 0.0073 m (d) 7.3 m

Sol: (a)

$$Q = \frac{S}{nL} \times 206265$$

$$30 = \frac{S}{2.5 \times 200} \times 206265$$

$$S = 0.0727 \text{ m} \approx 0.073 \text{ m}$$

11. When a celestial body crosses the observer's meridian, it is said to be

(a) culminate (b) vernal equinox

(c) obliquity (d) celestial pole

Sol: (a)

Celestial body crosses the observer's meridian twice and they are known as upper and lower culmination and transit.

12. Why the observations of field astronomy do not involve the measurement of declination and right ascension?

(a) Because the altitude and azimuth are constantly changed to the motion of the celestial body

(b) Because the starts do not occupy fixed positions on the celestial sphere

(c) Because the distance of the sun from the earth is variable

(d) Because of the obliquity of the ecliptic

Sol: **(b)**

A source of error in the magnitude of declination or right ascension is from the fact that the stars do not occupy fixed positions on the celestial sphere. The variation is more for the sun than for the stars.

Because of the reasons stated above, the observations of field astronomy do not involve the measurement of declination and right ascension.

13. If the equality of back sight distance and foresight cannot be maintained, under such condition, which one of the following levelling types is most important part of geodetic surveying?

(a) Spirit levelling

(b) Reciprocal levelling

(c) Trigonometric levelling

(d) Ordinary levelling

Sol: **(b)**

The error due to curvature refraction and collimation got minimized if we balance the back sight and foresight distance. If we cannot perform this the reciprocal levelling may also serve the same purpose.

14. Consider the following statements regarding global positioning system (GPS):

1. GPS cannot be used in all weather conditions.
2. In GPS surveying inter visibility between stations or points surveyed is not necessary.
3. High cost of GPS surveying has restricted the realization of the full potential of GPS.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: **(b)**

GPS can be used day night as well as in different weather condition, but its major disadvantage is it is costly.

15. Consider the following statements regarding remote sensing surveys:

1. Different types of land use are distinguishable on images.
2. Most images lack the horizontal perspective.
3. For surveys of small areas, the cost of mobilizing a remote sensing mission may be uneconomical.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3

(c) 2 only (d) 3 only

Sol: **(b)**

16. If γ_s = unit weight of the material of falling sphere in g/cm^3, γ_t = unit weight of the liquid medium in g/cm^3, μ_t = viscosity of the liquid medium in g sec/cm^2 and D = diameter of the spherical particle in cm. According to Stoke's law, what is the formula for the terminal velocity (ν) of the spherical particle?

(a) $\nu = \frac{1}{18}\left[\frac{(\gamma_s - \gamma_t)}{\mu_t}\right]D^2$

(b) $\nu = \frac{1}{8}\left[\frac{(\gamma_s + \gamma_t)}{\mu_t}\right]D^2$

(c) $\nu = \frac{1}{12}\left[\frac{(\gamma_s - \gamma_t)}{\mu_t}\right]D^2$

(d) $\nu = \frac{1}{2}\left[\frac{(\gamma_s + \gamma_t)}{\mu_t}\right]D^2$

Sol: **(a)**

17. Consider the following statements regarding sedimentation analysis of soil particles based on Stoke's law:

1. The finer soil particles are never perfectly spherical.
2. All the soil grains may have the same specific gravity.
3. Particles constituting to fine soil fraction may carry surface electric charges.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

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

Sol: (b)

Stokes law has following discrepancies

1. Stokes law assumed all particles to be spherical but fines particles are never perfectly spherical.
2. All particle may not have same specific gravity but we assume the average value of specific gravity in stokes law.
3. Particles are assumed to settle independently but since fine particles have surface charge they may join together.

18. What is meant by Thixotropy?

(a) Property of a material which is manifested by its resistance to flow

(b) The ratio of the unconfined compression strength in the natural or undisturbed state to that in the remolded state

(c) The compressive stress at failure, giving due allowance to the reduction in area of cross-section

(d) Phenomenon of strength loss strength gain, with no change in volume or water content

Sol: (d)

19. Consider the following statements regarding energy heads:

1. The velocity head in soils is negligible.
2. Direction of flow is determined by the difference in total head.
3. Negative pore pressure cannot exist.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

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

Sol: (a)

20. What is the value of coefficient of permeability for coarse gravel?

(a) Greater than 100 mm/s

(b) Greater than 10 mm/s

(c) Greater than 1 mm/s

(d) Greater than 0.1 mm/s

Sol: (a)

21. A reinforced concrete foundation of dimensions 18 m × 36 m, exerts a uniform pressure of 180 kN/m^2 on a soil mass, with E-value 45 MN/m^2. What is the value of immediate settlement under the foundation?

(a) 1 m (b) 1.54 m

(c) 18 mm (d) 54 mm

Sol: (d)

Immediate settlement = $S_i = \frac{qB(1-\mu^2)}{E} I_f$

(assuming clayey soil)

$q = 180 \times 10^3$ N/m^2

$B = 18$ m

$\mu = 0.5$ (assume)

$E = 45 \times 10^6$ N/m^2

$S_i = \frac{180 \times 10^3 (18)(1-(0.5)^2)}{45 \times 10^6} I_f$

$S_i = 0.054 I_f$ meta

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Although I_f wil depend on L/B ratio, and the foundation rigidity and also the location where settlement to be calculated

If we take $I_f = 1$

$$\boxed{S_i = 54 \text{ mm}}$$

22. Which one of the following terms is defined as "Maximum pressure which a foundation can withstand without the occurrence of shear failure of the foundation"?

(a) Gross bearing capacity

(b) Bearing capacity

(c) Ultimate bearing capacity

(d) Safe bearing capacity

Sol: (c)

23. If S_i = immediate settlement at a corner of a rectangular flexible foundation of size L × B, B = Width of the foundation, q = Uniform pressure on the foundation, E_S = Modulus of elasticity of the soil beneath the foundation, ν = Poisson's ratio of the soil, and I_t = Influence value, which is dependent on L/B. What is the immediate settlement of a flexible foundation?

(a) $S_i = q \cdot B\left(\frac{1+\nu^2}{E_s}\right) \cdot I_t$

(b) $S_i = q \cdot B\left(\frac{1-\nu}{E_s}\right) \cdot I_t$

(c) $S_i = q\left(\frac{1+\nu^2}{BE_s}\right) \cdot I_t$

(d) $S_i = q \cdot B\left(\frac{1-\nu^2}{E_s}\right) \cdot I_t$

Sol: (d)

24. Consider the following statements regarding bearing capacity values specified in building codes:

1. The codes tacitly assume that the allowable bearing capacity is dependent only on the soil type.
2. The codes assume that the bearing capacity is dependent of the size, shape and depth of foundation.
3. Building codes are usually not up-to-date.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

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

Sol: (a)

25. Which one of the following comprises two or more footings connected by a beam called strap?

(a) Continuous footing

(b) Spread footing

(c) Combined footing

(d) Cantilever footing

Sol: (b)

26. A one way slab has effective span 3.6 m and is 150 mm thick. The live-load expected on it is 3 kN/m^2. What are the design shear and loads for checking serviceability respectively?

(a) 18.225 kN, 6.75 kN

(b) 16.225 kN, 5.75 kN

(c) 18.225 kN, 7.75 kN

(d) 15.225 kN, 8.75 kN

Sol: (a)

Effective span ℓ_e = 3.6 m

Thickness = 150 mm

Live load = 3 kN/m^2

Dead load per meter width = 0.15 × 1 × 25

= 3.75 kN/m

Live load per meter width = 3 × 1 = 3 kN/m

$\Rightarrow$ Total load = 3.75 + 3 = 6.75 kN/m

Design load = 1.5 × 6.75 = 10.125 kN/m

$\Rightarrow$ Design shear = $\frac{w_u \ell_e}{2} = \frac{10.125 \times 3.6}{2}$

= 18.225 kN

So, the service load is 6.75 kN/m and design shear is 18.225 kN

However in the option, the load is also given in kN unit which is not correct.

Hence, the best option is (a)

27. Consider the following statements regarding the strength of flanged sections in flexure where the moment of resisting capacity of the flanged sections depends upon the depth of neutral axis χ_u :

1. If $\chi_u \le D_f$, compressive force is in the flange only.
2. If $\frac{3}{7}\chi_u > D_f$, compressive stress in the flange is uniform.
3. If $\chi_u > D_f$ and $\frac{3}{7}\chi_u > D_f$, compressive stress in flange is non uniform.

Which of the above statements is/are correct?

(a) 1 and 3 (b) 2 and 3

(c) 1 and 2 (d) 1 only

Sol: (c)

- When $x_u \le D_f$, NA lies in the flange and hence, compressive force is in flange only.
- If $\frac{3}{7}x_u > D_f \Rightarrow x_u > \frac{7}{3}D_f$ then neutral axis is in a zone such that flange is in uniform compressive stress
- When $D_f < X_u < \frac{7}{3}D_f$, then the stress diagram is such that in the flange rectangular + parabolic variation of stress will be there.

Hence, option (1) and (2) are correct.

Hence, (c) is the correct option.

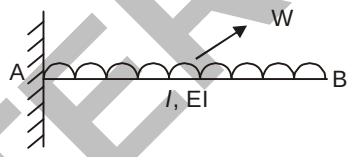
28. What is the maximum deflection for cantilever subjected to udl throughout? (Where E is the modulus of elasticity of concrete, I is the moment of inertia, L is the length of the span, P is the point load).

(a) $\frac{5\omega L^3}{384EI}$ (b) $\frac{PL^3}{3EI}$

(c) $\frac{\omega L^4}{8EI}$ (d) $\frac{PL^3}{84EI}$

Sol: (c)

As these is contradiction in question asked and data given, but still one can choose option (c) as per the language of question asked.



$$\delta_{max} = \delta_B = \frac{\omega l^4}{8EI}$$

29. Which one of the following is the equation for width of the step in a staircase, consider R being the rise, T being tread, D/2 being the depth and b is the width?

(a) $b = \sqrt{\frac{R^2}{T^2}}$ (b) $b = \sqrt{R^2 + T^2}$

(c) $b = \sqrt{R^2 \cdot T^2}$ (d) $b = \sqrt{R^2 - T^2}$

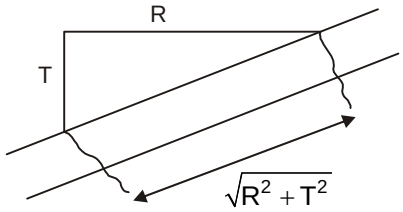
Sol: (b)

In general, the spanning of staircase can be of two types

(i) Transverse spanning/horizontal spanning i.e., along the width of staircase.

(ii) Spanning longitudinally i.e., along the incline

For transversely horizontal spanning the width for design is considered as $\sqrt{R^2 + T^2}$ and main reinforcement is provided in the direction of stair width and distribution reinforcement is provided parallel to flight direction.



30. Which one of the following statements is correct under safety provisions of the ACI code?

(a) Design strength is greater than required strength and design moment is greater than required moment

(b) Design strength is greater than required strength and design moment is less than required moment

(c) Design strength is less than required strength and design moment is greater than required moment

(d) Design strength is less than required strength and design moment is less than required moment

Sol: (a)

31. Consider the following statements regarding aerial photogrammetry:

1. Aerial photogrammetry has the ease with which topography of inaccessible areas can be detailed.
2. In aerial photogrammetry, there is possibility of omitting of few field data.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

Sol: (a)

Axial photogrammetry has lot of advantage, such as speed, early to survey inaccessible area and there is no possibility of omitting field data.

32. Match the following lists:

	List-I (Region)	List-II (Wavelength)
P.	Reflected IR band	1. Less than 0.03 nm
Q.	X-ray	2. 0.1 – 30 cm
R.	Gamma ray	3. 0.7 – 3.0 μm
S.	Microwave	4. 0.03 – 3.0 nm

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	4	1	2
(c)	4	1	3	2
(d)	4	1	2	3

Sol: (b)

33. Accurate transfer of surface alignment down a vertical shaft using two plumb wires can be achieved by

(a) Rise and fall method

(b) Collimation method

(c) Bowditch's method

(d) Weisbach triangle method

Sol: (d)

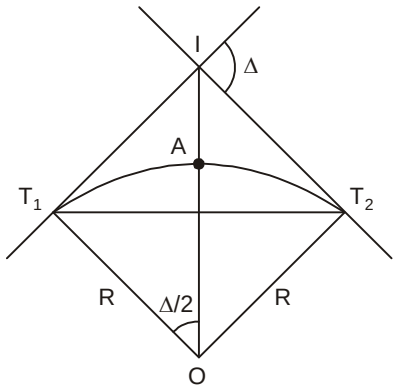
Transfer of surface alignment down through a vertical shaft in tunnel is done through Weisbach triangle method.

34. If R is the radius of the circle and Δ is deflection angle, what is the formula for external distance (E) in circular curve for use in design and settling out?

(a) $E = R\left(\sec\frac{\Delta}{2} - 1\right)$ (b) $E = R\left(1 - \sec\frac{\Delta}{2}\right)$

(c) $E = R\left(\cos\frac{\Delta}{2} - 1\right)$ (d) $E = R\left(1 - \cos\frac{\Delta}{2}\right)$

Sol: (a)



External distance (AI) = OI – R

From $\Delta T, IO$,

$$\cos\frac{\Delta}{2} = \frac{R}{OI}$$

$$\therefore \quad OI = R\sec\frac{\Delta}{2}$$

$$\therefore \quad \text{External distance} = R\left(\sec\frac{\Delta}{2} - 1\right)$$

35. Which one of the following situations is NOT at all suitable for tunneling?

(a) If the beds are parallel to horizontal or have approximately zero degree inclination

(b) If the beds are vertically dipping and the axis of the tunnel is perpendicular to the strike

(c) If the strike of involved beds is parallel to the axis of the tunnel

(d) If the dip of involved beds is parallel to the axis of the tunnel

Sol: (b)

36. Which one of the following is NOT a necessity of specifications for construction?

(a) Specification of a work is required to specify the quality and quantity of different materials required for a construction work and is one of the essential contract documents.

(b) Specification is necessary to specify the equipment, tools and plans to be engaged for a work and thus enables to procure them beforehand.

(c) Specification is an essential contract document and is required for Arbitration.

(d) Specification has no impact on changes of cost of materials and tools i.e. the tender rate.

Sol: (a)

- A specification is a specific description of a a particular subject.
- An engineering specification contains detailed description of all workmanship and materials which are required to complete an engineering project in accordance with its drawings and details.

The necessities of specifications are the following:

1. The cost of a unit quantity of work is governed by its specification.
2. Specification of a work are required to describe the quality and quantity of different materials required for a construction work and is one of the essential contract documents. Thus a contractor can make a programme to procure the materials required for a project and the owner can check the quality of materials conforming to the specification avoiding dispute with the contractor.
3. This also specifies the workmanship and the method of doing the work. Thus specification of a work serves as a guide to the supervising staff of the contractors as well as to the owners to execute the work to their satisfaction.
4. A work is carried out according to its speficiation and the contractor is paid for the same. Any change in specification changes the tendered rate.
5. As the rate of a work is based on specification, a contractor can calculate the rates of various items of works in a tender with his procurement rates of materials and labour. Thus tender paper without specifications of works is baseless, incomplete, and invalid.
6. Specification is necessary to specify the equipments, tools, and plants to be engaged for a work and thus enables to procure them beforehand.

7. The necessity of specification is to verify and check the strengths of materials for a work involved in a project.

8. Specification is an essential contract document and is required for arbitration or court cases.

37. What is the capital value of a premises consisting of land and a well-built house, let out for ` 800/- per month inclusive of all taxes. The house is in good condition. The rent by comparison with other premises is fair and is likely to be maintained. Assume the following data:

Outgoings: 18% of the gross rent, expected rate of return : 8%, future life of the building : 60 years.

(a) ` 98,400/- (b) ` 141,687.50/-

(c) ` 110,687.50/- (d) ` 88,400/-

Sol: (a)

Gross rent per annum = 800 × 12 = ` 9600/-

Outgoings 18% of the gross rent

$$= 9600 \times \frac{18}{100} = ` 1,728.00$$

Net rent = Gross rent – Outgoings

= ` 9,600 – ` 1,728

= ` 7872/-

The life of the building being 60 years the income is considered perpetual.

$$\text{Year's purchase} = \frac{100}{\text{Rate of interest}}$$

$$= \frac{100}{8} = 12.5$$

Capitalised value = Net rent per year × Year's purchase

= ` 7,872 × 12.5

= ` 98,400/-

38. Which one of the following is the advantage of lump sum contract?

(a) In case of unforeseen hazards during construction, the contractor is put to unlimited hardship.

(b) There may not be any hazard which could not be visualized beforehand.

(c) It becomes intricate to accommodate additions, alterations of design and specifications.

(d) Lump sum contract works better in civil engineering construction than for mechanical and electrical installations.

Sol: (b)

Lump sum contract:

- In lump sum contract a single lump sum is quoted for the job and is accepted as a fixed price.
- A bill of quantity may also be attached to help the contractor to have a better picture of the job and sometimes a schedule of rate is also presented which may be used in pricing the variations in quantities.
- This contract is better suited for over ground jobs and not so much for structures below ground as overground structures are always visible and quantities could be measured at any time.

This is found to be very effective when:

1. The job is comparatively small
2. The job is precisely and exactly described in all details.
3. There is not much risk attached to its construction, i.e., there may not be any hazard which could not be visualised beforehand.

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The advantages of lump sum contract:

1. It avoids a lot of detailing and accounting thereby making the job easy.
2. It offers the owner a fixed total price and the owner is happy with it
3. The contractor gets a chance to do the work without much hindrance.
4. Lump sum contract works better for mechanical and electrical installations than in civil engineering construction.

The disadvantages of lump sum contract:

1. It becomes difficult to accommodate additions, alterations of design and specifications.
2. In case of unforeseen hazards during construction, the contractor is put to unlimited hardship.

Although option (b) is prerequisite for lumpsum contract, we can go with option 'b' as other options are highly in appropriate.

39. Consider the following statements regarding the right of the contractor to terminate:

1. If the work is stopped by a court order for three months or more for any reasons.
2. If the architect fails to issue the certificate of payment in the stipulated period.
3. If the owner fails to pay the contractor after the stipulated period or certification for the payment from the consultant or the arbitrator.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3

(c) 1 and 3 (d) 2 only

Sol: (c)

Termination of contract is the process of ending a contract before the obligation with in it has been fulfilled

1. When the owner may terminate the contract:
   (a) If the contractor becomes bankrupt or insolvent;
   (b) If he refuses or fails to finish on time in spite of all commitments or if the delay is caused only because of his inefficiency;
   (c) If he fails to pay the subcontractors employed;
   (d) If he disregards laws, ordinances or instructions of architects or violates any provision of the contract;
   (e) If there is any breach of contract resulting in an emergency; or
   (f) If he neglects to protect the work from damages.
2. **When the contractor attains the right to terminate:**
   (a) If the work is stopped by a court order for three months or more for any reason;
   (b) If the architect/consultant fails to issue the certificate of payment after the stipulated periods;
   (c) If the owner fails to pay the contractor after the stipulated period of certification for the payment from the consultant or the arbitrator.

40. How many number of bricks are required in 10 m^3 of brick work?

(a) 3000 numbers (b) 5000 numbers

(c) 2000 numbers (d) 4000 numbers

Sol: (b)

No. of bricks required for 1 m^3 brickwork = 500

$\therefore$ No. of bricks required for 10 m^3 brickwork

$= 10 \times 500 = 5000$

41. Consider the following statements regarding the essential insurance record to be maintained:

1. Workmen's compensation and employer's accountability insurance in accordance with applicable laws should be maintained.

2. Comprehensive general liability insurance to cover any solitary whichever body or the property should be maintained.
3. Comprehensive automobile liability insurance to cover any solitary whichever body or the property damage should be maintained.

Which of the above statements is/are correct?

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

Sol: (b)

42. A supplier sends steel plates in a huge quantity to a contractor. The first batch was exhaustively examined for thickness and gave a standard deviation of 1.80. The contractor feels that the knowledge of mean within a range of 0.5 to its true value for a probability of 95% would be satisfactory. What is the size of sample?

(a) 40 numbers (b) 30 numbers
(c) 60 numbers (d) 50 numbers

Sol: (d)

For 95% probability, z = 1.96

Standard deviation (σ) = 1.80

Confidence limit (m) = 0.5

$$\therefore \text{ Size of sample (N)} = \left(\frac{z\times\sigma}{m}\right)^2$$

$$= \left(\frac{1.96\times1.80}{0.5}\right)^2$$

$$= 49.787 \simeq 50$$

43. A preliminary survey indicates that 20% of the time of a gang of workers is spent ideally. What is the total number of observations required to determine the proportion of idle time within ±5% with 95% confidence limit?

(a) 216 observations (b) 226 observations
(c) 246 observations (d) 236 observations

Sol: (c)

% of time spent ideally (P) = 20% = 0.2

Confidence limit (L) = ±5% with 95% confidence

For, P = 95%, z = 1.96

$$\therefore \boxed{\text{No. of observation (N)} = \frac{Z^2\times P\times(1-P)}{L^2}}$$

$$\therefore \quad N = \frac{1.96^2\times0.2\times(1-0.2)}{0.05^2}$$

$$= 245.86 \text{ observations}$$

$$\simeq 246 \text{ observations}$$

44. Consider the following statements regarding the dependency of crane load capacity:

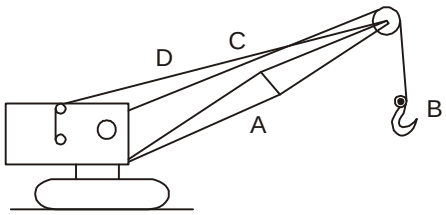
1. The size of the crawlers is not a factor due to diminutive mounting which decreases the stability of any footing.
2. The strength of the boom is also one of the major governing factors in establishing load ratings, and any extension of the boom reduces the rating. Lowering the boom also increases the clearance radius and thus reduces the rated capacity.
3. The counterweight is added to the after-end of the machine. Manufacture's specifications provided standard and maximum counterweights and also the crane ratings. Counter weights may be increased to a specified maximum, but the operating radius must not exceed that given by the manufacturer.

Which of the above statements is/are correct?

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

Sol: (d)

- A crane is a machine designed primarily for lifting but also adopted for many other uses.
- It consists basically of a power unit mounted on crawler tracks or wheels, with a boom and control cables for raising and lowering the load and the boom.



A Boom
B Load carrier single line
C Hoist cable
D Boom hoist cable for lowering and hoisting the boom

The load capacity of a crane depends on:

1. **The stability of the footing:** The size of the crawlers is a factor because a longer or wider mounting increases the stability of any footing.
2. **The strength of the boom:** This is one of the major governing factors in establishing load ratings, and these should never be exceeded.

- Ratings vary with the boom length, and any extension of the boom reduces the rating.
- Lowering the boom also increases the clearance radius and thus reduces the rated capacity.

3. **The counterweight:** This is added to the after-end of the machine.

- Manufacturer's specification provide standard and maximum counterweights and also the crane ratings.
- Counterweights may be increased to a specified maximum, but the operating radius must not exceed that given by the manufacturer.
- The working range of a crane is limited horizontally for the maximum lift only by the boom length.
- The reach below the footing level is limited only by the length of the hoist cable.

45. Match the following lists regarding the physical properties of cement:

	List-I		List-II
P.	Loss on ignition	1.	Causes expansion
Q.	Insoluble residues	2.	Due to evaporation of moisture and carbon dioxide
R.	Lime and alumina content	3.	Due to inactive materials like gypsum
S.	Sulphur content	4.	Causes unsoundness

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	1	2
(c)	4	1	2	3
(d)	2	4	1	3

Sol: **(a)**

Loss of ignition

- Due to the ignition of cement at a high temperature, loss in weight occurs due to the evaporation of moisture and carbon dioxide, which are present in combination with free lime or magnesia.
- Loss in weight is a measure of the freshness of cement.
- Hydroxides and carbonates of magnesium and lime do not contain any cementing properties; thus, they are called inert substances.

Insoluble residue

- Insoluble residue in cement is due to inactive material like gypsum.

Lime and alumina content

- Lime controls and strength and soundness. Presence of unburnt lime causes unsoundness i.e., expansion after setting and hardening.

Sulphur content

- Excess of sulphur in cement makes cement unsound.

46. Which of the following is not a factor in the design of tension members?

(a) Length of the connection

(b) Type of fabrication

(c) Connection eccentricity

(d) Gross area of the cross-section

Sol: **(d)**

In the design of tension members, effect of shear lag, unbuttoning effect, partial safety factors with respect to type of fastner i.e., welding or bolting, type of fabrication i.e., field fabrication or shop fabrication etc are taken into account.

Also, gross area yielding is considered in limit state method.

However in working stress method design for bolted and riveted connections, gross area of the cross-section is not considered.

Hence, the best option is (d)

47. Match the following lists:

List-I (Members)

P. A tension member in which a reversal of direct stress occurs due to loads other than wind or seismic forces.

Q. A member subjected to compressive forces resulting only from a combination of wind actions.

R. A member normally, acting as a tie in a roof truss which is not considered effective when subject to reversal of stress resulting from the earthquake.

S. Members always in tension

List-II (Maximum effective slenderness ratio)

1. 350
2. 400
3. 180
4. 250

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	1	2
(c)	3	4	2	1
(d)	2	4	1	3

Sol: **(b)**

As per IS 800 – 2007, clause 3.8, the maximum values of slenderness ratio for different types of members is tabulated below:

Maximum values effective slenderness ratio

S. No.	Member	Maximum effective slenderness ratio (KL/r)
(1)	(2)	(3)
(i)	A member carrying compressive loads resulting from dead loads and imposed loads	180
(ii)	A tension member in which is reversal of direct stress occurs due to loads other than wind or seismic forces	180
(iii)	A member subjected to compression forces resulting only from combination with wind/earthquake actions, provided the deformation of such member does not adversely affect the stress in any part of the structure	250
(iv)	Compression flange of a beam against lateral torsional buckling	300
(v)	A member normally acting as a tie in a roof truss or a bracing system not considered effective when subject to possible reversal of stress into compression resulting from the action of wind or earthquake forces*	350
(vi)	Members always under tension* (other than pre-tensioned members)	400

*Tension members, such as bracing's, pre-tensioned to avoid sag, need not satisfy the maximum slenderness ratio limits.

Hence the correct option is (b)

48. Which one of the following is NOT a parameter for determining the strength of the column?

(a) Material of the column

(b) Cross-sectional configuration

(c) Width of the column

(d) Residual stress

Sol: **(c)**

The column strength is given by

$$P_d = f_{cd}A_e$$

f_{cd} = design compressive stress

A_e = effective sectional area

f_{cd} is dependent on grade of steel i.e., material of the column, slenderness ratio i.e., cross-sectional configuration, type of imperfections i.e., residual stress, transport, storage etc.

Option (b) i.e., cross-sectional configuration can be considered as superset of option 'c'.

Hence the best option is (c).

49. Consider the following modes regarding the failure of an axially loaded column:

1. Local buckling
2. Squashing
3. Joint buckling

Which of the above modes are correct?

(a) 2 and 3 only (b) 1 and 2 only

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

Sol: **(b)**

The different modes of failure in a compression member are:

(i) Local buckling

(ii) Squashing/crushing

(iii) Flexural buckling

(iv) Torsional buckling

(v) Flexural torsional buckling

However there can not be joint buckling as fastners are placed very closely in a joint and hence the joints behave as short column i.e., failure will be squashing failure.

Hence, the correct option is (b)

50. Match the following lists:

	List–I (Sections)	**List–II (Limiting width to thickness ratio)**
P.	Rolled section	1. $88\varepsilon^2$
Q.	Welded section	2. 42ε
R.	Circular hollow section	3. 15.7ε
S.	Hot rolled RHS	4. 13.6ε

	P	Q	R	S
(a)	2	3	4	1
(b)	3	1	4	2
(c)	3	4	1	2
(d)	2	4	3	1

Sol: **(c)**

The values given in list–II correspond to the limiting values for semi-compact section for different types of section given in list–I.

As per IS 800 – 2007, clause 3.7.2,

Compression element		Ratio	Plastic	Compact	Semi-compact
Outstanding element of compression flange	Rolled section	b/t_f	9.4ε	10.5ε	15.7ε
	Welded section	b/t_f	8.4ε	9.4ε	13.6ε
Circular hollow tube, axial compression		D/t	Not applicable		$88\varepsilon^2$

Hence, the correct option is (c)

51. Match the following lists:

List–I (Type of beams with)

P. Angles

Q. Rolled I-sections

R. Castellated beams

S. Plate girders

List–II (Applications)

1. Long spans and heavy loads
2. Roof purlin and sheeting rail

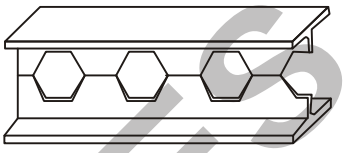
3. Most frequently used as a beam
4. Long spans and light loads

Select the correct answer using the code given below:

	P	Q	R	S
(a)	3	4	1	2
(b)	3	1	4	2
(c)	2	3	4	1
(d)	2	4	1	3

Sol: (c)

- Angles are smaller sections and can not carry heavy loads. So can be used for roof purlins and sheeting rail.
- Rolled I-sections are most frequently used as beams and columns.
- Plate girders are heavy flexural member and can be used for long spans and heavy load, where bending moment and shear force are high.



Castellated beam

- Castellated beams are beams having perforated web as shown below. These beams can be used for long spans and light load.

Hence, the correction option is (c).

52. Consider the following statements regarding the lateral torsional buckling of symmetric sections:

1. The beam has no initial imperfections and its behavior is elastic.
2. It is loaded by unequal and opposite end moments in the plane of the web.
3. The beam have residual stresses and its ends are simply supported vertically and laterally.

Which of the above statements is/are correct ?

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

Sol: (d)

Lateral torsional buckling of a symmetric section is a type of failure in which the beam buckles about its weak axis although it is loaded in the strong plane. This is considered with the following assumptions:

1. The beam is initially undistorted.
2. Its behaviour is elastic (no yielding).
3. It is loaded by equal and opposite end moments in the plane of the web.
4. The loads act in the plane of the web only (there are no externally applied lateral or torsional loads)
5. The beam does not have residual stresses.
6. Its ends are simply supported vertically and laterally.

Hence, the correct option is (d)

53. Which of the following is NOT a functional requirement of a girder ?

(a) Strength to carry bending moment
(b) Vertical stiffness to satisfy any deflection limitation
(c) Strength to carry shear i.e., adequate web area
(d) Stiffness to reduce the buckling or post-buckling strength of the web

Sol: (d)

The functional requirements of girder are:

(i) Strength to carry bending moment
(ii) Vertical stiffeners to satisfy any deflection limitations
(iii) Strength to carry shear

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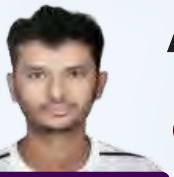

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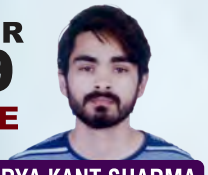

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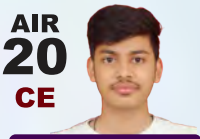

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AIR 39 CE

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AIR 40 CE

RISHABH SHARMA

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AIR 45 CE

SACHIN SINGHAL

AIR 46 CE

AYUSH JAIN

AIR 47 CE

ADIL SABIH

AIR 48 CE

ABHISHEK KUMAR

AIR 50 CE

PAWAN SINGH NEGI

AIR 51 CE

SATYAM

AIR 52 CE

SAHIL SIJARIYA

AIR 54 CE

AATESH KUMAR MEENA

AIR 55 CE

SUBHADRA SUBHADARSHINI

AIR 56 CE

SHASHANK SHEKHAR MISHRA

AIR 57 CE

BHAWANA JOSHI

AIR 58 CE

SAKSHAM SHARMA

AIR 59 CE

KAMIDI NITESH REDDY

AIR 61 CE

LOHARKAR KARISHMA SUNIL

AIR 62 CE

SANDEEP KUMAR

AIR 63 CE

UTKARSH MISHRA

AIR 64 CE

SHUBHAM PAWAR

AIR 66 CE

SHIVASHISH GAUTAM

AIR 67 CE

YASHWANT KUMAR

AIR 68 CE

SHAHEZAMA

AIR 71 CE

BOLLA USHNEESH NANDAN

AIR 72 CE

SAUMYA CHANDRA

AIR 73 CE

ANKIT TAILOR

AIR 74 CE

HEMANT SINGH

AIR 75 CE

GARIMA KATIYAR

AIR 76 CE

REALTU KUMAR

AIR 78 CE

VAIBHAV BIHANI

AIR 79 CE

SATYAM DEWANGAN

AIR 81 CE

ATIKANT KUMAR

AIR 82 CE

MAYANK RANJAN

AIR 83 CE

SATYAM KUMAR

AIR 85 CE

SAURAV KUMAR

AIR 89 CE

SATYA PRABHAT RANJAN

AIR 92 CE

NAKKA DURGA PRASANNA KUMAR

AIR 93 CE

RISHITA SINGH

AIR 96 CE

SANDEEP SONI

AIR 97 CE

ABHISHEK ANAND

AIR 98 CE

PUSHPENDRA SRIVASTAVA

AIR 99 CE

ANUPAMA

AIR 101 CE

ROHIT KUMAR SINGH

AIR 103 CE

RAHUL KUMAR MINA

AIR 104 CE

RAJJAT SINGLA

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(iv) Stiffness to increase the buckling or post-buckling strength of web

So in the question option 'd' is not correct as it is given "stiffness to reduce".

Hence the correct option is (d)

54. Which one of the following is NOT a difference between the behavior of the beam-columns subject to the bending moment about minor axis to major axis ?

(a) In the case of slender members under small axial load, there is very little reduction of moment capacity below M_P, since lateral torsional buckling is not a problem in weak axis bending

(b) The moment of magnification is larger in the case of beam-columns bending about their weak axis

(c) As the slenderness decreases, the failure curves in the P/P_n, y-y axis plane change from convex to concave, showing decreasing dominance of minor axis buckling

(d) The failure of short/stocky members is either due to section strength being reached at the ends or at the section of larger magnified moment

Sol: (c)

The behaviour of beam columns subject to bending moment about minor axis is similar to that subjected to major axis bending with the following exceptions

1. In the case of slender members under small axial load, there is very little reduction of moment capacity below M_P, since lateral-torsional buckling is not a problem in weak axis bending.
2. The moment magnification is larger in the case of the beam-columns bending about their weak axis.
3. As the slenderness increases, the failure curves in the P/P_n, y-y axis plane change from convex to concave, showing increasing dominance of minor axis buckling.
4. The failure of short/stocky members is either due to section strength being reached at the ends (under small axial load) or at the section of larger magnified moment (under large axial load)

Hence the correct option is (c)

55. In practical design of steel structures, on the vertical walls, external pressure coefficient on windward wall is

(a) 0.8 (b) 0.5

(c) –0.5 (d) –0.8

Sol: (a)

The correct option is (a)

56. Consider the following statements regarding the behaviour of a column under a compression load:

1. The stress-strain properties do not remain constant throughout the section.
2. Residual stresses due to cooling after rolling the steel section and those imposed by welding during construction exist in the section before loading.
3. Due to construction details, the load is perfectly concentric and the end conditions will not vary from case to case.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 1 only

(c) 2 only (d) 1 and 3

Sol: (c)

In a column under compression load,

The stress-strain properties remain constant throughout the section. Also, due to construction, the load is not perfectly concentric and the end conditions will vary from case to case.

Hence, the correct option is (c)

57. What is the minimum load factor for dead load as per IS 800 : 1984 ?

(a) 1.3 (b) 1.7

(c) 2.3 (d) 2.7

Sol: **(b)**

As per IS 800 – 1984, clause 9.2, in plastic design the minimum load factor for dead load is 1.7.

Hence, the correct option is (b).

58. What is the grain specific gravity for humus type soil?

(a) 2.37 (b) 1.37

(c) 4.37 (d) 3.37

Sol: **(b)**

Humus generally have specific gravity < 2.

59. When the specific gravity of solids is known, which one of the following types of methods is used to determine the water content ?

(a) Pycnometer method

(b) Rapid moisture tester method

(c) Oven-drying method

(d) Sand-replacement method

Sol: **(a)**

$$\omega = \left[\left(\frac{W_2 - W_1}{W_3 - W_4}\right)\left(\frac{G_s - 1}{G_s}\right) - 1\right]$$

60. Which one of the following soils are transported by wind ?

(a) Alluvial soils (b) Lacustrine soils

(c) Aeolian soils (d) Marine soils

Sol: **(c)**

61. What is the proportion of acid and alkalis permitted in the water used in construction ?

(a) A 100 ml sample of water should be neutralized by not more than 2 ml of 0.1 normal NaOH of 10 ml of 0.1 normal HCl

(b) A 200 ml sample of water should be neutralized by not more than 2 ml of 0.1 normal NaOH of 10 ml of 0.1 normal HCl

(c) A 300 ml sample of water should be neutralized by not more than 2 ml of 0.1 normal NaOH of 10 ml of 0.1 normal HCl

(d) A 50 ml sample of water should be neutralized by not more than 2 ml of 0.1 normal NaOH of 10 ml of 0.1 normal HCl

Sol: **(b)**

- Water used for both mixing and curing should be free from injurious amount of deleterious materials.
- Potable waters are generally considered satisfactory for mixing and curing of concrete.
- If water contains any sugar or an access of acid, alkali or salt, it should not be used.
- As a guide, the following concentrations represent the maximum permissible:

  (a) To neutralize 200 ml sample, it should not require more than 2 ml 0.1 Normal NaOH.

  (b) To neutralize 200 ml sample, it should not require more than 10 ml of 0.1 Normal NaCl.

  (c) Percentage of solids should not exceed the following:

	Percent
Organic	0.02
Inorganic	0.30
Sulphates	0.05
Alkali-Chlorides	0.10

Note: However, as per IS 456 : 2000, the above values have been revised and are as following:

(a) To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH.

(b) To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal H_2SO_4.

62. Match the following lists regarding different types of bricks with their applications:

List–I

P. Sand lime bricks

Q. Face bricks

R. Paving bricks

S. Sewer bricks

List–II

1. Tough, durable
2. Edges and curves to suit the shape
3. Cheaper and used only for backup
4. Where distinct brick work finish is intended

Select the correct answer using the code given below:

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	3	4	1	2
(d)	4	1	2	3

Sol: **(c)**

Sand lime bricks:

- The autoclaved calcium silicate bricks are popularly known as sand lime bricks.
- The raw materials required for manufacture of – lime bricks are
  - (i) sand
  - (ii) lime
  - (iii) water
  - (iv) pigment

Uses:

- Sand lime bricks are used for ornamental works and they can be used in place of ordinary clay bricks.
- These bricks are cheaper and reduce the cost of construction to about 40% due to following factor.
  - (i) less wastage during handling and transportation,
  - (ii) reduction in cost of maintenance and avoiding the provision of facia stones,
  - (iii) reduction in cost of mortar as quantity of mortar required of facia compared to the conventional clay bricks,
  - (iv) reduction in wall thickness because of higher compressive strength resulting in more carpet area for every room,
  - (v) saving due to cost of plastering because of smooth finish, etc.

Paving bricks:

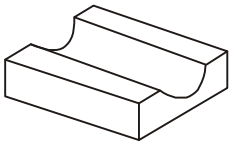
- These bricks are tough and durable and resist the abrasive action of traffic in better way.

Face bricks:

- Face bricks are used when distinct brick work finish is intended

Sewer bricks:

- Sewer bricks are intended for the lining of wall, roof, and floors of severs used for ordinary sanitary (domestic sewage).



Edges and curves to suit shape

63. What are the two main categories of embankment slopes ?

(a) Flat and Steep

(b) Recoverable and Non-recoverable

(c) Desirable and Undesirable

(d) Hazardous and Non-hazardous

Sol: **(b)**

Recoverable slope: A slope on which a motorist may, to a greater or lesser extent, retain or regain control of a vehicle by slowing or stopping, slopes

flatter than 1 V : 4 H are generally considered recoverable.

Non-recoverable slope: A non recoverable slope is a slope which is considered transversible but on which an errant vehicle will continue to bottom. Embankment slopes betwen 1 V : 3 H and 1 V : 4 H may be considered traversable but non-recoverable if they are smooth and free of fixed objects.

64. Match the following lists:

List–I (Median widths at intersections)

P. Four feet or wider

Q. Twenty-eight feet or wider

R. Sixteen feet or wider

S. Twenty feet or wider

List–II (Key features)

1. Provides a pedestrian refuge and room for a dual left-turn bay
2. Provides a pedestrian refuge and room for a left turn-bay
3. Provides a pedestrian refuge
4. Provide refuge for a crossing passenger car

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	1	2	3
(b)	3	1	2	4
(c)	3	4	2	1
(d)	2	3	4	1

Sol: (c)

65. If V_d is design speed (mph), t_{p-r} is perception-reaction time (sec), a is deceleration rate (ft/sec^2) and G is longitudinal grade of the road (%/100). What is the expression for stopping sight distance?

(a) $SSD = 1.468V_d t_{p-r} + \dfrac{V_d^2}{30\left(\left(\dfrac{a}{32.2}\right) \pm G\right)}$

(b) $SSD = 1.468V_d t_{p-r} + \dfrac{V_d^2}{\left(\dfrac{a}{32.2}\right) \pm G}$

(c) $SSD = 1.468V_d t_{p-r} - \dfrac{V_d^2}{30\left(\left(\dfrac{a}{32.2}\right) \pm G\right)}$

(d) $SSD = 1.468V_d t_{p-r} - \dfrac{V_d^2}{\left(\dfrac{a}{32.2}\right) \pm G}$

Sol: (a)

$$SSD = vt_r + \frac{v^2}{2g(\mu \pm 0.01n)}$$

(in meters when v is in m/sec and g is in m/sec^2)

But as per options of the question, the SSD required is in feet

Velocity in feet/sec = 1.468 × velocity in miles/hr

Also taking "a" as deceleration on level road, we have

$$a = \mu g$$

$$\Rightarrow \quad \mu = \frac{a}{g} \text{ (when a \& g are in m/sec}^2\text{)}$$

$$= \frac{a}{32.2}$$

(when a & g are in ft/sec^2 as 9.81 m/sec^2 = 32.2 ft/sec^2)

Hence, SSD in feet will be

$$SSD = \left[(1.468V_d)t_{p-r}\right] + \left[\frac{(1.468V_d)^2}{2g(\mu + 0.01n)}\right]$$

$$= 1.468V_d t_{p-r} + \frac{V_d^2}{\frac{2 \times 32.2}{1.468^2}\left(\frac{a}{32.2} \pm G\right)}$$

(as G = 0.01 n)

$$= 1.468V_d t_{p-r} + \frac{V_d^2}{30\left(\frac{a}{32.2} \pm G\right)}$$

66. If V_d is design speed (mph), e_{max} is maximum rate of superelevation, f_{max} is co-efficient of side friction. What is the expression for minimum radius of curvature (R_{min}) ?

(a) $R_{min} = \dfrac{V_d^2}{15(0.01e_{min} - f_{max})}$

(b) $R_{min} = \dfrac{V_d^2}{15(e_{min} + f_{max})}$

(c) $R_{min} = \dfrac{V_d^2}{15(e_{min} - f_{max})}$

(d) $R_{min} = \dfrac{V_d^2}{15(0.01e_{min} + f_{max})}$

Sol: **(d)**

$$R_{min} = \frac{v^2}{g(\mu + e)_{max}}$$

where R_{min} is in m, v is in m/sec and g is in m/sec^2 and e is in decimal

However it R_{min} is required in feet

then, $$R_{min} = \frac{v^2}{g(\mu + e)_{max}}$$

where, R_{min} is in feet, v is in feet/sec, g is in feet/sec^2, e is in decimal

Thus $$R_{min} = \frac{(1.468V_d)^2}{32.2(0.01\, e_{max} + f_{max})}$$

(Assuming in e_{max} given is in %)

$$= \frac{V_d^2}{15(0.01e_{max} + f_{max})}$$

67. What is the major difficulty in establishing human surveillance in freeway management systems ?

(a) Difficulty in integrating electronic detection with human surveillance

(b) Infrastructure for providing vide to the location of the human operator

(c) Human operators have superior judgment, but they may lose attention

(d) Lack of qualified human operators

Sol: **(c)**

Highway surveillance is complex due to the expansive and dynamic nature of roads, therefore it requires advanced solutions. Traffic violation detection, accident prevention and incident management are crucial tasks where traditional surveillance often falls short. Highways present challenges in establishing extensive surveillance network due to their sheer size. Varying lighting conditions hinder visibility, complicating real-time monitoring and incident detection. Responding quickly to incidents on highways is difficult for traditional systems that lack real-time analysis and automated detection. Manual monitoring is inefficient and labour-intensive, leading to blind spots and delayed incident reporting.

68. The weighted average of the damages caused by the individual axle load group with respect to the corresponding volume of the traffic of each group is known as

(a) Lane distribution factor

(b) Load safety factor

(c) Vehicle damage factor

(d) Heavy-vehicle adjustment factor

Sol: **(c)**

69. Which one of the following is a factor that is to be multiplied by the total traffic repetitions in a lane to convert it to equivalent repetitions along the maximum distressed path ?

(a) Lane distribution factor

(b) Load safety factor

(c) Vehicle damage factor

(d) Lateral distribution factor

Sol: **(d)**

70. Consider the following statements regarding tunnel:

1. In hills with soft rocks, a tunnel is cheaper than a cutting.

2. The maintenance cost of a tunnel is considerably higher than that of a bridge.
4. The construction of a tunnel is costly as it requires special construction.

Which of the above statements are correct ?

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

Sol: (c)

71. Match the following lists:

List–I (Size of the tunnel)

P. Circular
Q. Elliptical
R. Horseshoe

LIst–II (Purpose of the tunnel)

1. Water and sewage mains
2. Roads and railways
3. Water and sewage

Select the correct answer using the code given below:

	P	Q	R
(a)	2	1	3
(b)	3	1	2
(c)	3	2	1
(d)	2	3	1

Sol: (b)

72. Consider the following statements regarding full face method for tunneling in hard rocks:

1. An entire section of the tunnel is tackled at one time.
2. Mucking tracks can be laid on the tunnel floor and extended as the work progresses.
3. It is suitable for unstable rocks.

Which of the following statements are correct ?

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

Sol: (a)

73. Match the following lists:

List–I (Type of soil)

P. Silt
Q. Clay
R. Sand

List–II (Method of tunneling)

1. One or two ports are opened and the material flows continuously into the tunnel
2. One or two port doors are opened. The material is excavated and deposited at the bottom of the tunnel.
3. Tunneling is of the open type. The material settles on the floor of the shield and it should be continuously removed.

Select the correct answer using the code given below:

	P	Q	R
(a)	2	1	3
(b)	3	1	2
(c)	3	2	1
(d)	2	3	1

Sol: (a)

74. Which one of the following methods is achieved by drilling a drift through the tunnel from portal to portal ?

(a) Blow-in method (b) Exhaust method
(c) Blow-out method (d) Natural method

Sol: (d)

While drifting tunnel from portal to portal it provides natural ventilation whereas to get blow in as blow out mechanical ventilation will be provided.

75. Which one of the following types of soils will usually shrink if drained or if subjected to repeated loading ?

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(a) Non-cohesive soils (b) Cohesive soils

(c) Peat (d) Silts

Sol: **(b)**

76. What is the temperature of the tensile strength of the stone in water for 3 days ?

(a) 40°C to 50°C (b) 10°C to 15°C

(c) 20°C to 30°C (d) 5°C to 15°C

Sol: **(c)**

As per IS 1121 (Part-3), the specimens selected for conducting the test shall be saturated by vacuum saturation by immersing in water maintained at 20° to 30°C in an evacuation vessel under a vacuum of about 50 mm of Hg to 100 mm of Hg.

Specimens shall also be tested in a dry condition and shall be dried in an oven at 70 ± 5°c for 48 hr and colled in a desiccator to room temperature (20°C to 30°C) to constant mass.

77. The decomposition of felspar is represented as

(a) $\underset{\text{(Orthoclase)}}{K_2AlO_3 \cdot 6H_2O} + CO_2 + nH_2O =$

$\underset{\text{(Alkaline carbonate)}}{K_2CO_3} + \underset{\text{Kaolinite}}{AlO_3 \cdot 2SiO_2 \cdot 2H_2O} +$

$\underset{\text{(Hydrated silicate)}}{4SiO_2 \cdot nH_2O}$

(b) $\underset{\text{(Orthoclase)}}{K_2Al_2O_3 \cdot 6H_2O} + CO_2 + nH_2O =$

$\underset{\text{(Alkaline carbonate)}}{K_2CO_3} + \underset{\text{(Kaolinite)}}{Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O} +$

$\underset{\text{(Hydrated silicate)}}{4SiO_2 \cdot nH_2O}$

(c) $\underset{\text{(Orthoclase)}}{K_2Al_2O_3 \cdot 6H_2O} + CO_2 + nH_2O =$

$\underset{\text{(Alkaline carbonate)}}{K_2CO} + \underset{\text{(Kaolinite)}}{Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O} +$

$\underset{\text{(Hydrated silicate)}}{4SiO_2 \cdot nH_2O}$

(d) $\underset{\text{(Orthoclase)}}{KAl_2O_3 \cdot 6H_2O} + CO_2 + nH_2O =$

$\underset{\text{(Alkaline carbonate)}}{KCO_3} + \underset{\text{(Kaolinite)}}{Al_2O_2 \cdot 2SiO_2 \cdot 2H_2O} +$

$\underset{\text{(Hydrated silicate)}}{4SiO_2 \cdot nH_2O}$

Sol: **(b)**

The correct option is (b)

78. Match the following lists:

List–I

P. Trap and Basalt

Q. Sandstone

R. Laterite

S. Slate

List–II

1. Damp proofing and partitions
2. Rough stone for masonry work
3. Tile stone for roofing
4. Road metal and concrete aggregate

Select the correct answer using the code given below:

	P	Q	R	S
(a)	1	3	2	4
(b)	4	2	3	1
(c)	3	4	2	1
(d)	4	3	2	1

Sol: **(d)**

Type of stone	Suitability
Trap and Basalt	Suitable for road metal & concrete aggregate
Sand stone	Tile stone for roofing
Laterite	Suitable for rough stone masonary work
Slate	Damp proofing and partitions

79. Consider the following statements regarding the characteristics of poor lime :

1. It requires less slaking time and hydrates very fast.
2. Setting and hardening is very fast.
3. The color varies from yellow to grey.

Which of the above statements is/are correct ?

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

Sol: (c)

Lean or poor lime: It consists of clayey impurities of about more than 7% in the form of silica, Alumina, and iron oxide.

The following are the characteristics of a poor lime:

1. Slaking requires more time and its expansion is less than that of fat lime
2. It makes thin paste with water
3. Setting and hardening is very slow
4. The colour varies from yellow to grey

80. Consider the following statements regarding the advantages of plywood:

1. It has good strength both along as well as across the grains.
2. It will not shrink or swell across the grains.
3. It can be curved into desired shapes.

Which of the above statements is/are correct ?

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

Sol: (a)

The following are the advantages of a plywood:

1. It has good strength both along as well as across the grains.
2. The wood shrinks or swell more across the grains. Since plywood has cross-grained construction, the tendency to shrink or swell is reduced.
3. It has better splitting resistance due to the grains in adjacent veneers in cross direction as such nailing can be done very safely even near the edges.
4. Plywood can be curved into desired shapes.

81. Match the following lists:

List–I

P. Bridges
Q. Scientific instruments
R. Railway carriage
S. Shuttering

List–II

1. Gamhar, haritaki
2. Red cedar, satin, sissoo
3. Guava
4. Black wood, iron wood

Select the correct answer using the code given below:

	P	Q	R	S
(a)	1	2	3	4
(b)	2	3	4	1
(c)	3	2	4	1
(d)	4	2	1	3

Sol: (b)

The suitability of timber for various purposes is shown as:

Purpose	Nature of tree
Bridges	Babul, Red Cedar, Iron wood, Jarul, Sal, Satin, Sisoo, Nageshwar
Scientific instruments	Guava
Railway carriage	Black wood, Teak, Iron wood, Red wood
Shuttering	Nageshwar, Gamhar, Haritaki

82. Consider the following statements regarding calcined clay:

1. Its chief function is to impart strength and hydraulic properties of mortar.
2. It is dense, compact and impermeable concrete.
3. It increases the temperature of hydration and sets the concrete quickly.

Which of the above statements are correct ?

(a) 2 and 3 only (b) 1 and 2 only

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

Sol: (b)

It is one of the artificial pozzolana obtained by burning clay soils at specified predetermined temperatures. In doing so the water molecules are driven off and a quasi-amorphous material, reactive with lime, is obtained. However, in practice, surkhi is manufactured by grinding the brick bats in the grinding mills until an impalpable powder is obtained. This pozzolana is called surkhi is India.

Surkhi is extensively used in making mortar and concrete as an adulterant for economy. Its chief function is to impart strength and hydraulic properties to mortar. When mixed with cement to react with lime liberated during the setting and hardening of cement it makes dense, compact and impermeable concrete.

83. What are the concrete stages production order respectively ?

(a) Batching, mixing, transporting, placing, curing, compacting, finishing

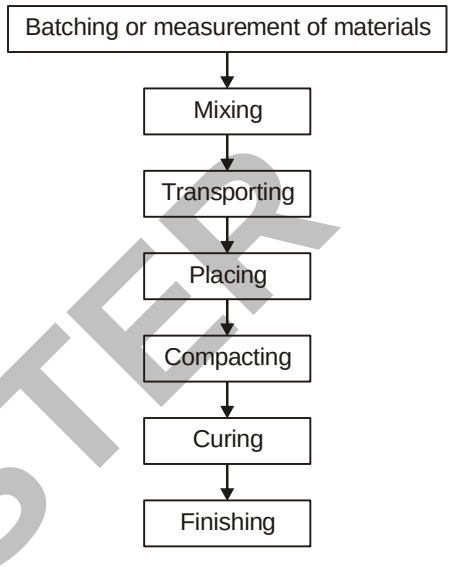
(b) Batching, transporting, mixing, placing, compacting, curing, finishing

(c) Batching, mixing, transporting, compacting, placing, curing, finishing

(d) Batching, mixing, transporting, placing, compacting, curing, finishing

Sol: (d)

The stages of concrete production are represented as:



84. Consider the following statements regarding the functions of admixtures:

1. It is to speed up the rate of development of strength at early ages.
2. It increases the strength of concrete.
3. It increases the heat of evolution and decreases the durability of concrete.

Which of the above statements is/are correct ?

(a) 2 and 3 only (b) 1 and 3 only

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

Sol: (c)

Functions: The functions of admixtures are to speed up the rate of development of strength at early ages, retard the initial set, increase the strength of concrete, improve workability, reduce heat of evolution, increase durability of concrete resistance to freezing and thawing, control expansion caused by aggregate alkali reaction, decrease capillary flow of water and to make it impermeable, increase the penetration and pumpability of concrete, reduce segregation in grouts, strengthen the bond between old and new

concrete surfaces and that between steel reinforcement and concrete, inhibit corrosion of concrete, increase resistance to chemical attack.

85. Consider the following statements regarding the concrete mix design:

1. It is to be compiled with strength of standard test specimens.
2. It is to be compiled with the durability requirements to accept the environment.
3. It is to be capable of mixed, transported, and compacted as efficiently as possible.

Which of the above statements are correct ?

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

(c) 2 and 3 (d) 1 and 2 only

Sol: (b)

The purpose of concrete mix design is to ensure the most optimum proportions of the constituent materials to meet the requirements of the structure being built. Mix design should ensure that the concrete

(i) complies with the specifications of structural strength laid down, which is usually stated in terms of the compressive strength of standard test specimens,

(ii) complies with the durability requirements to resist the environment in which the structure will serve its functional life,

(iii) be capable of being mixed, transported, compacted as efficiently as possible,

(iv) and lastly, but not least, be as economical as possible

Thus concrete mix design may be defined as the art of obtaining a concrete of the required properties, at the lowest cost, by a suitable choice and proportions of available materials.

86. Consider the following statements regarding the design requirements of concrete mix:

1. Grade of concrete : M20, M25 connotes the characteristics strength of 30 N/mm^2 to 35 N/mm^2.
2. Type of cement : The grade of OPC such as of 33, 43, or 53 grade.
3. Type of mixing and curing water: Whether fresh potable water, seawater, ground water is to be used.

Which of the above statements are correct ?

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

(c) 1 and 2 only (d) 1 and 3 only

Sol: (b)

- M20, M25 represents the concrete grades in which the numbers 20 & 25 represents the characteristics compressive strength of 20 N/mm^2 & 25 N/mm^2 at 28 days of a concrete cube sized 150 mm × 150 mm × 150 mm.
- Ordinary portland cement has been classified as 33 grade (IS 269), 43 grade (IS 8112) & 53 grade (IS 12669) & the physical requirements of all these types of cement are almost same except for the compressive strength.
- Water used for mixing & curing shall be clean & free from injurious amount of oils, acids, organic materials and other deleterious material.
- Potable water in generally considered satisfactory but sea water may be used if suitable fresh water is not available for plain cement concretes.

87. Consider the following statements regarding the characteristics of good mortar:

1. The density and strength of mortars made of the same glass of aggregate decrease as the proportion of fine aggregate is increased.
2. It requires about twice as much cement to produce a mortar of given strength when fine sand is used as it does with coarse sand

3. Even small percentage of mica if present considerably increases the tensile strength and adversely affects the compressive strength.

Which of the above statements are correct ?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: (a)

Characteristics of good mortar: The chief properties of hardened mortar are strength, resistance to weathering, and those of green mortar are placability, mobility and water retention.

Strength of hardened mortar depends on the activity of binding materials, the water/cement ratio, binding material and quality of sand. It has been found that:

1. The density and strength of mortars made of the same class of aggregate decrease as the proportion of fine aggregate is increased.
2. It requires about twice as much cement to produce a mortar of given strength when fine sand is used as it does with coarse sand.
3. When the percentage of mixing water is increased beyond that required to form a placeable mix, the density and strength of mortar reduces. The proportionate effect is greatest at the early ages.
4. Even, small percentage of mica if present considerably lowers, the tensile strength and adversely affects the compressive strength.
5. A replacement of less than 15 percent of cement by hydrated lime does not affect the tensile strength. There is a loss of compressive strength by the replacement of less than 25 percent of cement by hydrated lime.
6. The strength of concrete increases with the cement content. A richer concrete requires less water for a definite consistency which may offset the shrinkage. For constant water/cement ratio, an increase in the cement content improves the workability without affecting the strength.

88. How does the bulk modulus of elasticity of a fluid change with increasing pressure ?

(a) It remains constant

(b) It decreases with increase in pressure

(c) It increases with increase in pressure

(d) It becomes zero

Sol: (c)

89. Consider the following statements regarding stability of floating bodies:

1. If metacentre (M) lies above centroid (G), then the body is a said to be in unstable equilibrium.
2. If metacentre (M) lies below centroid (G), then the body is said to be in unstable equilibrium.
3. If metacentre (M) coincides with centroid (G), then the body is said to be in stable equilibrium.

Which of the above statements is/are correct ?

(a) 1 and 2 (b) 2 and 3

(c) 2 only (d) 1 only

Sol: (c)

90. If V_s is the velocity of the vector, r is the radius of curvature and $\frac{\partial V_n}{\partial t}$ is the local normal acceleration; what is the expression for total normal acceleration of fluid particles ?

(a) $\frac{dV_n}{dt} = V_s^2 + r\frac{\partial V_n}{\partial t}$ (b) $\frac{dV_n}{dt} = \frac{V_s^2}{r} + \frac{\partial V_n}{\partial t}$

(c) $\frac{dV_n}{dt} = r + V_s^2\frac{\partial V_n}{\partial t}$ (d) $\frac{dV_n}{dt} = \frac{r}{V_s^2} + \frac{\partial V_n}{\partial t}$

Sol: (b)

91. Which one of the following is the equation for extension of whole length of a uniformly tapering rectangular bars where b_1 and b_2 are the limits of widths ($b_2 > b_1$), length L, thickness t and the bar is subjected to an axial force P and elastic module E ?

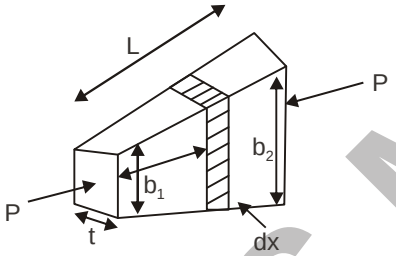
(a) $\Delta = \dfrac{PL}{(b_2 - b_1)tE}\log_e \dfrac{b_2}{b_1}$

(b) $\Delta = \dfrac{PL}{(b_2 - b_1)tE}\log_{10} \dfrac{b_1}{b_2}$

(c) $\Delta = \dfrac{PL}{(b_1 - b_2)tE}\log_{10} \dfrac{b_2}{b_1}$

(d) $\Delta = \dfrac{PLt}{(b_2 - b_1)E}\log_e \dfrac{b_2}{b_1}$

Sol: (a)



$$d\delta = \frac{P\,dx}{t\left(\frac{b_2 - b_1}{L} \times x + b_1\right)E}$$

$$\delta = \int_0^L \frac{p\,dx}{t\left(\frac{b_2 - b_1}{L} \times x + b_1\right)}$$

$$\Rightarrow \quad \delta = \frac{P}{tE}\left[\frac{ln\left(\frac{b_2 - b_1}{L} \times x + b_1\right)}{\left(\frac{b_2 - b_1}{L}\right)}\right]_0^L$$

$$\Rightarrow \quad \delta = \frac{PL}{(b_2 - b_1)tE} \times \left[ln(b_2) - ln(b_1)\right]$$

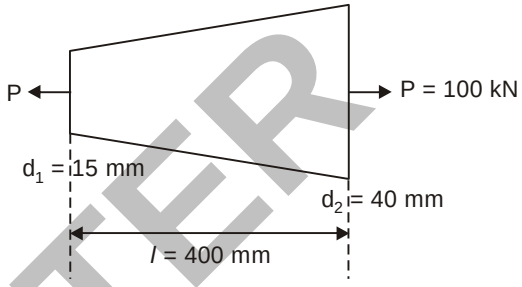
$$\delta = \frac{PL}{(b_2 - b_1)tE}\log_e\left(\frac{b_2}{b_1}\right)$$

92. A conical bar tapers uniformly from a diameter of 15 mm to a diameter of 40 mm in a length of 400 mm. What is the elongation of the bar under an axial tensile force of 100 kN ? (Take E = 2×10^5 N/mm^2)

(a) 0.242 mm (b) 0.121 mm

(c) 0.424 mm (d) 0.212 mm

Sol: (c)



$$\Delta = \frac{P\ell}{\frac{\pi}{4}d_1 d_2 E}$$

$$= \frac{100 \times 10^3 N \times 400\ mm}{\frac{\pi}{4}(15)(40)mm^2 \cdot 2 \times 10^5 \frac{N}{mm^2}}$$

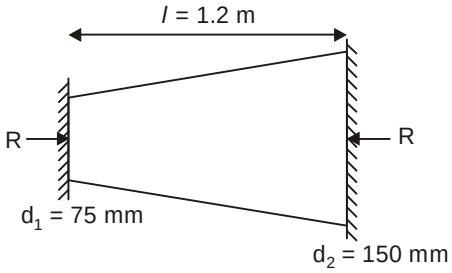
$$= 0.424\ mm$$

93. A circular section tapering bar is rigidly fixed at both the ends. The diameter changes from 75 mm at one end to 150 mm at the other end, in a length of 1.2 m. What is the maximum stress in the bar if the temperature is raised by 32°C ? (Take E = 2×10^5 N/mm^2 and $\alpha = 12 \times 10^{-6}$ per 1°C)

(a) 123.6 N/mm^2 (b) 143.6 N/mm^2

(c) 163.6 N/mm^2 (d) 153.6 N/mm^2

Sol: (d)



Change in length to temperature + change in length due to load = 0

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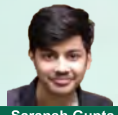

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$$\Rightarrow \quad \ell\alpha\Delta T = \frac{R\ell}{\frac{\pi}{4}d_1d_2E} = 0$$

$$R = (\alpha \cdot \Delta T)\cdot\frac{\pi}{4}d_1d_2E$$

$$\sigma_{max} = \frac{R}{\frac{\pi d_1^2}{4}} = \frac{(\alpha\cdot\Delta T)\cdot E\, d_2}{d_1}$$

$$= 2 \times 10^5 \times 12 \times 10^{-6} \times 32 \times 2$$

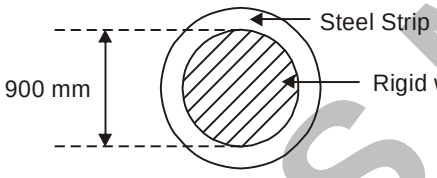
$$= 153.6 \text{ N/mm}^2$$

94. A thin type of steel is to be shrunk on to a rigid wheel of 900 mm diameter. What is the internal diameter of the tyre if the hoop stress is limited to 120 N/mm^2 ? (For the tyre take α 12 × 10^{-6} per °C and E = 2 × 10^5 N//mm^2)

(a) 899.46 mm (b) 819.46 mm

(c) 900.54 mm (d) 800.54 mm

Sol: (a)



$$\sigma_H = 120 \text{ MPa}$$

$$\in_h = \frac{\sigma_H}{E}$$

$\Delta \rightarrow$ Assuming D as internal dia. of steel strip.

$$D_f = D(1+\in_h) = 900 \text{ mm}$$

$$= D\left(1+\frac{120}{2\times10^5}\right)$$

$$= 900 \Rightarrow D = 899.46 \text{ mm}$$

95. Consider the following statements regarding the effective stress and effective strain:

1. $\bar{\sigma}$ and $\bar{\varepsilon}$ will reduce to σ_x and ε_x in an x-direction tension test.
2. The incremental work per volume done in deforming a material plastically is $d\omega = \bar{\varepsilon}\, d\bar{\sigma}$.
3. It is usually assumed that the $\bar{\sigma}$ vs $\bar{\varepsilon}$ curve describes the strain hardening for loading under a constant stress ratio α, regardless of α^*.

Which of the above statements is/are correct ?

(a) 2 and 3 (b) 3 only

(c) 1 and 3 (d) 2 only

Sol: (c)

The incremental work per unit volume done in deforming a material plasticity (dw)

$$dw = \bar{\sigma}\cdot d\bar{\varepsilon}$$

Complementary work (dw) = $\bar{\varepsilon}\cdot d\bar{\sigma}$

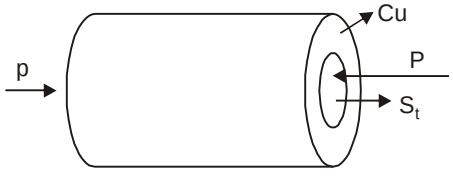
Hence, statement 2 is correct.

96. A solid cylinder of steel is placed inside a copper tube. The assembly is compressed between rigid plates by forces P. What is the value of increase in temperature so that all the load is carried by the copper tube ? (Let the parameters with suffix c represent copper and suffix s represent steel)

(a) $t = \frac{4P}{A_sE_s(\alpha_c-\alpha_s)}$ (b) $t = \frac{2P}{A_cE_c(\alpha_s-\alpha_c)}$

(c) $t = \frac{P(\alpha_c-\alpha_s)}{A_cE_c}$ (d) $t = \frac{P}{A_cE_c(\alpha_c-\alpha_s)}$

Sol: (d)



As all the load is carried by Cu.

Hence, $\Delta_{st} = l\alpha_{St}\Delta T = \Delta_C$

$$\Delta_C = \Delta_{temp} - \Delta_{load}$$

$$\Delta_C = l\alpha_C\Delta T - \frac{P\times l}{A_CE_C} = l\alpha_S\Delta T$$

$$\Rightarrow \quad p = (\alpha_C - \alpha_S)\Delta T \times A_C E_C$$

$$\Rightarrow \quad \Delta T = \frac{P}{(\alpha_C - \alpha_S)A_C E_C}$$

97. Match the following lists:

List–I (Materials)	List–II (Modulus of elasticity)
P. Aluminium alloys	1. 190
Q. Cast iron	2. 190 – 210
R. Copper	3. 70 – 79
S. Steel	4. 110 – 120
T. Wrought iron	5. 83. – 170

Select the correct answer using the code given below:

	P	Q	R	S	T
(a)	2	3	4	5	1
(b)	3	4	5	1	2
(c)	4	5	1	2	3
(d)	3	5	4	2	1

Sol: **(d)**

98. Which one of the following precipitations result from ocean air streams passing over land and being deflected upward by coastal mountains, thus cooling below saturation temperature and spilling moisture ?

(a) Convective precipitation
(b) Frontal precipitation
(c) Orographic precipitation
(d) Cyclonic precipitation

Sol: **(c)**

99. Which one of the following terms refers to the time between the end of the net rainfall and the end of the direct runoff hydrograph ?

(a) Recession time (b) Time-to-peak
(c) Lag time (d) Concentration time

Sol: **(d)**

100. Match the following lists:

List–I (Soil and vegetation)	List–II (Infiltration rate) (mm/hr)
P. Forested loam	1. 10 – 70
Q. Loam pasture	2 0 – 4
R. Sand	3 3 – 15
S. Bare clay	4. 100 – 200

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	1	2	4
(c)	4	1	3	2
(d)	4	1	2	3

Sol: **(c)**

101. Match the following lists:

List-I (Type of surface)	List-II (Value of coefficient of runoff)
P. Wooded areas	1. 0.70 - 0.95
Q. Gravel roads and walks	2. 0.15 - 0.30
R. Macadamized Roads	3. 0.01 - 0.20
S. Watertight roof surfaces	4. 0.25 – 0.60

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	3	2	4	1
(c)	3	1	2	4
(d)	4	1	2	3

Sol: **(b)**

102. Consider the following statements regarding ground water:

1. Ground water is exhaustible and is evenly available.
2. Natural replenishment of the ground water resource is a very fast process.
3. Ground water is generally better than surface water in respect of biological characteristics.

Which of the above statements is/are correct?

(a) 1 and 3 only (b) 2 and 3 only

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

Sol: **(c)**

103. Match the following lists:

List-I (Material)	List-II (Specific yield %)
P. Clay	1. 5 - 15
Q. Sand and gravel	2. 15 - 25
R. Sandstone	3. 0.5 - 5
S. Limestone	4. 1 – 10

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	1	4
(b)	1	2	4	3
(c)	3	1	2	4
(d)	4	2	1	3

Sol: **(c)**

104. A fully penetrating artesian well is pumped at a rate Q = 1500 m^3/day from an aquifer whose storage coefficient and transmissivity are 4×10^{-4} and 0.145 m^2/min, respectively. Considering $\omega(u) = 8.62$, what is the drawdowns at a distance 3 m from the production well after one hour of pumping?

(a) 8.62 m (b) 14.53 m

(c) 4.93 m (d) 2.38 m

Sol: **(c)**

$$s = \frac{Q}{4\pi T}\ln\left(\frac{2.25Tt}{r^2 s}\right)$$

$$= \frac{1500 m^3/day}{4\times 3.14\times\left(\frac{0.145 m^2}{\frac{1}{1440} day}\right)}\ln\left(\frac{\frac{2.25\times 0.145}{1}\times\frac{1}{24}}{\frac{1}{1440}}\right)$$

$$= \frac{1}{3^2\times 4\times 10^{-4}}$$

= 0.572 ln (5437.5) = 4.92 m

105. Water attached to soil particles through loose chemical bonds is termed as

(a) Capillary water (b) Gravity water

(c) Hygroscopic water (d) Field capacity

Sol: **(c)**

106. Consider the following statements regarding flow measurement through pipes:

1. The reduction in constriction diameter causes velocity to increase.
2. High velocities in constriction cause low pressure in the system.
3. The reduction in constriction diameter enables lesser accuracy in its measurement.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3

(c) 2 only (d) 1 and 3

Sol: **(a)**

107. Consider the following statements regarding ultrasonic flowmeters:

1. There are no moving parts.
2. They cannot measure flow quantities in reverse flow.

3. There is no direct contact with the fluid, there is no danger of corrosion or clogging.

Which of the above statements is/are correct?

(a) 1 and 2 only (b) 1 and 3 only

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

Sol: **(a)**

108. When the average flow is steady, which one of the following causes significant fluctuations in velocity, temperature and pressure?

(a) Streamlines in turbulent flow

(b) Molecular diffusion in turbulent flow

(c) Eddy motion in turbulent flow

(d) Orderly flow in turbulent flow

Sol: **(c)**

109. Consider the following statements regarding uniform flow in channel:

1. The depth of flow and wetted area are constant at every section along the channel reach.
2. The velocity of flow and discharge are varying along the channel reach.
3. The total energy line, water surface and the channel bottom are all parallel.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 and 3

(c) 3 only (d) 1 and 3

Sol: **(d)**

110. If Q = discharge into the channel, a = cross sectional area at the entrance, and D_n is depth at the channel entrance, what is the equation for depth of the reservoir (D_r) when the flow in the channel is subcritical?

(a) $D_r = D_n - \frac{Q}{2ga^2}$ (b) $D_r = D_n - \frac{Q^2}{2ga^2}$

(c) $D_r = D_n + \frac{Q}{2ga^2}$ (d) $D_r = D_n + \frac{Q^2}{2ga^2}$

Sol: **(c)**

111. Which one of the following heads is defined as "the head against which a centrifugal pump has to work"?

(a) Suction head (b) Delivery head

(c) Static head (d) Manometric head

Sol: **(d)**

A centrifugal pump has to work against manometric head.

112. Consider the following statements regarding positive-displacement pumps:

1. Positive-displacement pump is better able to handle shear sensitive liquids.
2. A well-sealed positive-displacement pump can create a significant vacuum pressure at its inlet, even when dry.
3. The rotor(s) of a positive displacement pump run at higher speeds than the rotor (impeller) of a dynamic pump at similar loads.

Which of the above statements is/are correct?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: **(a)**

The rotor of a positive displacement pump runs at lower speed than the rotor of a centrifugal pump (roto dynamic pump) at similar loads.

113. Consider the following statements regarding draft tube of Francis turbine:

1. It permits a suction head to be established at the runner exit.
2. It makes possible to install the turbine above the tail race level without loss of head.

3. It converts a large proportion of velocity energy rejected from the runner into useful pressure energy.

Which of the above statements is/are correct?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: **(d)**

114. Consider the following statements regarding Kaplan turbine:

1. The runner blades of Kaplan turbine runner are warped.
2. The blade angle is being greater at the hub than at the outer tip.
3. The peripheral velocity of the blades is being directly proportional to radius.

Which of the above statements is/are correct?

(a) 1 and 3 only (b) 2 and 3 only

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

Sol: **(a)**

The runner blades of a Kaplan turbine are warped or twisted. The blade angle is greater at the outer tip than at the hub.

115. Match the following lists:

List-I (Specific speed (rpm))	List-II (Type of turbine)
P. 8.5 to 30	1. Francis turbine
Q. 50 to 340	2. Kaplan turbine
R. 255 to 860	3. Pelton wheel turbine with single jet

Select the correct answer using the code given below:

	P	Q	R
(a)	2	3	1
(b)	3	1	2
(c)	2	1	3
(d)	1	2	3

Sol: **(b)**

P $\rightarrow$ 3; Q $\rightarrow$ 1; R $\rightarrow$ 2

116. Consider the following statements regarding the difference between true strains and engineering strains:

1. True strains for equivalent amounts of deformation in tension and compression are equal including for sign.
2. True strains are additive. For a deformation consisting of several steps the overall strain is the sum of the strains in each step.
3. The volume change is related to the sum of the three normal strains. For constant volume, $\varepsilon_x + \varepsilon_y + \varepsilon_z = 0$.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 1 and 3

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

Sol: **(c)**

The strain $(\in_t) = ln(1+\in)$

For tension

$$\in_{true,\,t} = ln(1+\in)$$

For compression

$$\in_{true,\,c} = ln(1-\in)$$

$$(\in_{true})_{tension} \neq (\in_{true})_{comp}$$

Hence, statement 1 is incorrect.

Statement 2 and 3 are correct.

117. Consider the following statements regarding the properties of materials:

1. A material in plastic state is temporarily deformed by the application of load and it has tendency to recover.
2. Ductility is the characteristic of a material to be drawn out longitudinally to a reduced section under the action of tensile force.

3. Malleability is a property of a material which permits the materials to be partially extended in all directions without rupture.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 only

(c) 3 only (d) 1 and 3

Sol: (b)

1. Plastic deformation are nonrecoverable
2. Ductility is the characteristics of a material to be drawn about in wires longitudinally (i.e. reduced X-section) under action of tensile force.
3. Malleability is a property of material which permits the material to be spreaded in transverse directions on the application of compressive load.

118. Which one of the following statements is correct regarding the Mohr's circle of a plane Tensor?

(a) σ is positive in tension and is plotted to the right of the origin. Compression is negative to the left.

(b) τ is plotted negatively if it rotates the stress block clockwise.

(c) Angles θ from one axis to another around the origin are in different direction

(d) Any orthogonal set of axes are 90° to one another on Mohr's circle.

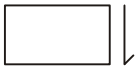
Sol: (a)

For axial stresses ;

Tension $\rightarrow$ +ve

Compression $\rightarrow$ –ve

For shear :



$\Rightarrow$ clockwise rotation $\rightarrow$ +ve

$\Rightarrow$ Anti clockwise rotation $\rightarrow$ –ve

- By adopting correct sign convention, sense of rotation in mohr circle will be same as of actual planes.
- Any orthogonal set of axes in actual stress element are at 180° to one another on Mohr's circle.

119. Consider the following regarding the general situations in linear elasticity:

1. The stress field is a function of only the boundary conditions, geometric shape and loading which are constant.
2. The stress field is a function of material properties like volume and deviatric stiffness as well.
3. The loads are time independent.

Which of the above statements is/are correct?

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

(c) 1 and 2 only (d) 2 and 3 only

Sol: (b)

120. Consider the following statements regarding two dimensional stress formulations:

1. In a plane stresses are identical for any given geometry, loading.
2. The in-plane stresses are different for plane strain or plane stress.
3. Linear viscoelastic stress fields are different for constant load and change with time.

Which of the above statements is/are correct?

(a) 1 only (b) 1 and 2

(c) 3 only (d) 2 and 3

Sol: (d)

121. Match the following lists:

List-I (Components)	List-II (Working)
P. Trusses	1. Carry compressive force

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Q.	Cables	2.	Located at the crown and supports elevations
R.	Arches	3.	Support their loads in tension
S.	Three-hinged arches	4.	Prevent collapse

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	3	1	2
(b)	3	2	4	1
(c)	4	1	2	3
(d)	2	3	4	1

Sol: **(a)**

122. Which one of the following is the condition for maximum shear in a cantilever?

(a) It occurs when a series of concentrated loads are not placed at the farthest point away from the fixed support.

(b) It occurs when a series of distributed loads are placed at the farthest point away from the fixed support

(c) It occurs when a series of concentrated loads are placed at the nearest point away from the fixed support

(d) It occurs when a series of concentrated loads are placed at the farthest point away from the fixed support.

Sol: **(*)**

123. Match the following lists:

	List-I (Type of commerical building/institution)		List-II (Water demand in litres per day)
P.	Restaurants	1.	45 per capita
Q.	Nurses homes and medical quarters	2.	70 per seat
R.	Cinemas, concert halls and theatre	3.	135 per capita
S.	Factories	4.	15 per seat

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	1	2	3
(b)	2	1	4	3
(c)	4	3	2	1
(d)	2	3	4	1

Sol: **(d)**

124. Consider the following statements regarding quality difference of ground water and surface water:

1. The Turbidity of ground water is high, whereas surface water is little.
2. Total dissolved solids of ground water is lower than surface water.
3. Concentration of inorganic compounds or ions of ground water is higher than surface water.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 only

(c) 3 only (d) 1 and 3

Sol: **(c)**

125. If P is population of town/city, Q is total quantity of water required during one year for a town/city; what is the formula for maximum daily per capita demand for a town/city/

(a) $1.8\times\frac{Q}{P\times 365}$ (b) $1.8\times\frac{Q}{P\times 24}$

(c) $1.5\times\frac{Q}{P\times 365}$ (d) $1.5\times\frac{Q}{P\times 24}$

Sol: **(a)**

126. If P_n = population at the end of n decade, P_0 = present population, P_{av} = average arithmetic increase in the population (decade), P_1 = Average incremental increase in population, n = Number of decades; what is the mathematical representation of Incremental Increase method?

(a) $P_n = P_l \times n + (P_{av} + P_o)$

(b) $P_n = P_l + (P_{av} + P_o) \times n$

(c) $P_n = P_o + (P_{av} + P_l) \times n$

(d) $P_n = P_o \times n + (P_{av} + P_l)$

Sol: **(c)**

127. The impurities in water which are extremely small size particles and cannot be removed by settling and filtration are known as

(a) Suspended impurities

(b) Colloidal impurities

(c) Dissolved impurities

(d) Picked up impurities

Sol: **(c)**

128. What is the function of flocculator in the typical water treatment scheme for surface water?

(a) To rapid dispersion of chemical coagulant(s) to encourage destabilization of colloids

(b) To permit the settlement of chemical 'flocs' along with colloidal particles

(c) To provide for gentle mixing of the destabilized colloids to promote agglomeration of colloids into large easily settleable flocs

(d) To remove the flocs and colloids which escape from the settlement in the secondary sedimentation tank

Sol: **(c)**

129. What is the function of rapid mixing in the typical water treatment flow scheme for ground water with high hardness?

(a) To drive out the objectionable dissolved gas such as H_2S and CO_2

(b) To permit the settlement of chemical precipitates under gravity

(c) To reform the calcium and magnesium bicarbonates to prevent settlement of $CaCO_3$ under $Mg(OH)_2$ precipitates in the distribution lines

(d) To disperse the lime and soda ash to form chemical precipitates

Sol: **(d)**

130. If Q is the water requirement in L/min and P is population in thousands, what is Buston's formula to determine fire demand?

(a) $Q = 5663\sqrt{P}$

(b) $Q = 3182\sqrt{P}$

(c) $Q = 4637(1 - 0.01\sqrt{P})$

(d) $Q = 100\sqrt{P}$

Sol: **(a)**

131. What is meant by soffit?

(a) The system of pipes which conveys discharges in separate pipes to the drainage system

(b) A pipe or conduit which is owned by a local authority for conveyance of the sewage

(c) The highest point of the interior of a sewer pipe at any cross section

(d) The horizontal pipe lay below the floor level or below basement to receive the discharge of soil or waste water

Sol: **(c)**

132. What is the logical extension of the pit privy?

(a) Septic tank and tile field

(b) Composting toilet

(c) Seepage pits

(d) Plastic pipe with holes

Sol: **(b)**

133. Consider the following statements regarding a good building/house drainage system:

1. The pipes should be of non-absorbent materials.
2. The system should have traps at all necessary points.
3. The branch drains should be as long as possible.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: **(a)**

A plumbing system should be designed keeping into consideration the following general principles:

- For better maintenance and easy repairs, the house sewer pipes should preferably be laid by the side of the building rather than in walls or underground. But in modern days in small houses, they are generally embedded in walls; and in large buildings, kept outside and accommodated in shafts, to avoid their bad appearance.
- Drains should be laid straight between the manholes (inspection chambers). All sharp bends and junctions, which tend to become dead-ends for collection of sewage solids, should be avoided except through manholes.
- The house sewer should be connected to the public sewer, keeping the outfall level of the house sewer sufficiently higher than the water level of the public sewer to avoid back flow and inefficient building drainage.
- The plumbing system should contain enough number of traps, at suitable points for its efficient functioning or to avoid evolution of foul smells.
- The layout of house plumbing system should, as far as possible, be such as to permit easy cleaning in case of blockage, or repair in case of leakage, or additions if additional sanitary fittings are provided on a future date.
- High quality sewer pipes should be used in the system.
- Possibilities of formation of air-locks, siphonage, undue deposits, etc. should be properly studied, and remedies should be accommodated in the design to avoid them.
- It should be made of some non-absorbent material.

134. What is a drawback of aerobically digested sludges

(a) Odour reduction

(b) Enhanced putrescible

(c) Degreaded of organic acids

(d) Difficulty in dewatering

Sol: **(d)**

135. What needs to be maintained to avoid the odour problem in tannery effluent treatment?

(a) Low pH

(b) pH between 7 - 8

(c) pH between 9.5 - 10

(d) High pH

Sol: **(b)**

136. The water remaining in the soil after the removal of gravitational water is called

(a) Capillary water (b) Gravity water

(c) Hygroscopic water (d) Field capacity

Sol: **(d)**

After removal of gravitational waters, the remaining water is represented by water content field capacity (f_c), which consist of both capillary water and hygroscopic water.

137. The field capacity and permanent wilting point for a given 0.8m root zone soil are 35 and 10 pe cent, respectively. At a given time, the soil moisture in the given soil is 20 percent when a farmer irrigates the soil with 250 mm depth of water. Assuming bulk specific gravity of the soil as 1.6, what is the amount of water wasted from the consideration of irrigation?

(a) 23.2% (b) 58%

(c) 5.8% (d) 19.2%

Sol: **(a)**

$$R = D = 0.8 \text{ m}, f_c = 35\%$$

$$\phi = 10\%$$

Existing m/c (w) = 20%

Supplied depth of water (d) = 250 mm

$$G_{s,\,bulk} = 1.6$$

As we know

$$\gamma_{dry} = \frac{\gamma_{bulk}}{1+w}$$

$$\gamma_{dry} = \frac{G_{s,\,bulk}\times\gamma_w}{1+w} = \frac{1.6\gamma_w}{1+0.2}$$

$$\gamma_{dry} = \frac{4}{3}\gamma_w$$

$$d_{stored} = \frac{\gamma_d}{\gamma_w}\times D\times(f_c - m_0)$$

$$d_{stored} = \frac{4/3\gamma_w}{\gamma_w}\times 0.8\times(0.35-0.2)$$

$$d_{stored} = 0.16 \text{ m} = 160 \text{ mm}$$

$$d_{wasted} = d_{supplied} - d_{stored}$$

$$d_{wasted} = 250 - 160 = 90 \text{ mm}$$

$$\%\text{ loss} = \frac{90}{250}\times 100 = 36\%$$

As there is no option having 36% loss, so just to select one of the option, one can assume

$$\gamma_{bulk} = \gamma_{dry}$$

Now,

$$d_{stored} = \frac{\gamma_d}{\gamma_w}\times D\times(f_c - m_0)$$

$$d_s = 1.6 \times 0.8\ (0.35 - 0.20)$$

$$d_s = 0.192 \text{ m} = 192 \text{ mm}$$

$$\%\text{losses} = \frac{d_a - d_s}{d_m}\times DO = \frac{250-192}{250}\times 100$$

= 23.2% i.e., option (a)

138. Match the following lists:

List-I (Soil texture)	List-II (Field capacity (%))
P. Sand	1. 5 - 10
Q. Loam	2. 27 - 35
R. Silty clay	3. 18 - 25
S. Clay	4. 32 - 40

Select the correct answer using the code given below:

	P	Q	R	S
(a)	4	3	2	1
(b)	1	3	2	4
(c)	3	1	2	4
(d)	4	2	1	3

Sol: **(b)**

As clay content increases, waters holding capacity of soil increases. Hence we can choose option having f_c in the same order. i.e., order of f_c →

Sand < Loam < Silty clay < Clay

139. If V is the wind velocity and F is the fetch, for F < 32 Km, what is the formula for wave height (h_w) in gravity dams?

(a) $h_w = 1.032\sqrt{VF} + 0.76 + 0.27F^{\frac{1}{4}}$

(b) $h_w = 0.032\sqrt{VF} - 0.76 - 0.27F^{\frac{1}{4}}$

(c) $h_w = 1.032\sqrt{VF} - 0.76 + 0.27F^{\frac{1}{4}}$

(d) $h_w = 0.032\sqrt{VF} + 0.76 - 0.27F^{\frac{1}{4}}$

Sol: (d)

For F < 32 km

$$h_w = 0.032\sqrt{VF} + 0.763 - 0.271F^{1/4}$$

For, F > 32 km

$$h_w = 0.32\sqrt{VF}$$

140. If c_1 = a dimensionless pressure co-efficient, α_h = horizontal acceleration factor, ρ = mass density of water, g = acceleration due to gravity, h = depth of the reservoir; what is the formula for the variation of horizontal hydrodynamic earthquake pressure with depth (P_e) in gravity dams?

(a) $P_e = C_1\alpha_h\frac{g}{h}$ (b) $P_e = \frac{C_1\alpha_h}{gh}$

(c) $P_e = C_1\alpha_h gh$ (d) $P_e = C_1 g(h + \alpha_h)$

Sol: (c)

According to Von-Karman

$$\rho_e = 0.555 \times \alpha_H \gamma_w H^2$$

ρ_e = Hydrodynamic pressure force

Hence, option (c) is most appropriate.

141. Consider the following statements regarding the distribution shear stress assumptions:

1. For all values of y, q is uniform across the width of the cross-section, irrespective of its shape.
2. 'F = (dM/dx)' is derived from the assumption that bending stress varies non-linearly across the section and is not zero at the centroid.
3. The material is homogenous and isotropic and the value of E is the same for tension as well as compression.

Which of the above statements is/are correct?

(a) 1 and 2 only (b) 2 and 3 only

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

Sol: (c)

142. Which one of the following statements is NOT a property of the curves?

(a) Both the systems of the curves cross each other at 45°.

(b) Each system crosses the N.A at 45°.

(c) At any point of a curve the tangent and normal give the directions of the two principal stresses.

(d) The intensity of stress along each curve is the greatest when it is parallel to the length of the beam and diminishes along the curve to zero, where it cuts a face of beam at right angles.

Sol: (b)

Curves of principal stress

- Curves or envelopes of principal stresses may be obtained by finding the direction of principal stresses at various points in several cross-sections of the beam, and joining up the directions fo the principal stresses. Such curves are shown below on a longitudinals section of a beam.
- The curves are such that the tangent and normal at any point give the directions of the two principal stresses at the point.
- As shown, there are two systems of curves, one normal to the other.

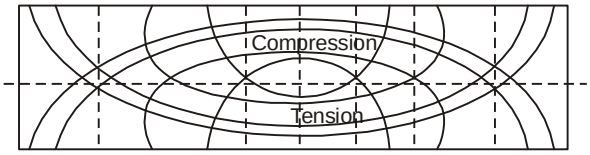


Fig. Curves of principal stresses

Properties of the curves

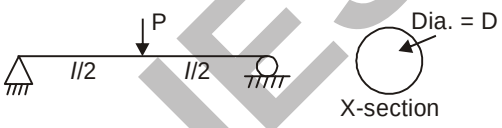
1. Both the systems of the curve cross each other at right angles.
2. Each system crosses the N.A. at 45°
3. At any point of a curve, the tangent and normal give the directions of the two principal stresses.
4. The intensity of stress along each curve is the greatest when it is parallel to the length of the beam and diminishes along the curve to zero, where it cuts a face of beam at right angles.

143. A rod of circular section is subjected to a shearing force on a plane perpendicular to its axis. What is the maximum shearing stress in terms of shearing force and rod diameter, if the rod is used as beam with free ends and a central concentrated load, express the free length in terms of diameter for which the maximum shearing stress, due to shearing force is half the maximum direct stress?

(a) L = (3/2) D (b) L = (1/2) D

(c) L = (5/2) D (d) L = (2/3) D

Sol: (d)



$$V_{max} = \frac{P}{2},\ M_{max} = \frac{PL}{4}$$

$$\Rightarrow \tau_{max} = \frac{4}{3}\tau_{avg} = \frac{16}{3}\frac{V}{\pi D^2} = \frac{8}{3}\frac{P}{\pi D^2}$$

$$\sigma_{max} = \frac{32M_{max}}{\pi D^3} = \frac{32\times\left(\frac{PL}{4}\right)}{\pi D^3}$$

$$\Rightarrow \tau_{max} = \frac{1}{2}\sigma_{max}$$

$$\frac{8}{3}\frac{P}{\pi D^2} = \frac{1}{2}\left(\frac{8PL}{\pi D^3}\right)$$

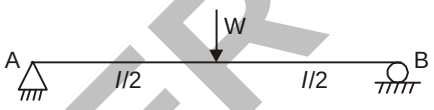
$$\Rightarrow L = \frac{2}{3}D$$

144. A beam 3m long, simply supported at its ends is carrying a point load W at its mid-span. If the slope at the ends of the beam does not exceed 1°, what is the deflection at the mid-span?

(a) 17.45 mm (b) 17.45 cm

(c) 19.45 mm (d) 19.45 cm

Sol: (a)



$$\theta_B = \frac{Wl^2}{16EI} = \frac{1^\circ\times\pi}{180} \quad ...(i)$$

$$\Rightarrow \delta_{max} = \frac{Wl^3}{48EI} = \frac{l}{3}\left(\frac{Wl^2}{16EI}\right)$$

From (i)

$$\delta_{max} = \frac{l}{3} * \frac{\pi}{180} = \frac{3000\times\pi}{3\times180}$$

$$\delta_{max} = 17.45 \text{ mm}$$

145. Consider the following statements regarding the end conditions and internal conditions of a conjugate beam:

1. A stable and statically determinate real beam will have a conjugate beam which is also stable and statically determinate.
2. An unstable real beam will have statically indeterminate conjugate beam. Hence if a conjugate beam is found to be statically in-determinate, it is concluded that the real beam is unstable and further analysis is not appropriate.
3. A statically indeterminate real beam will have stable conjugate beam. Hence its conjugate load must be such that it maintains equilibrium.

Which of the above statements is/are correct?

(a) 1 and 3 (b) 2 and 3

(c) 1 and 2 (d) 1 only

Sol: **(c)**

A statically indeterminate real beam will have unstable conjugate beam and it's conjugate load makes it in equilibrium.

Hence, statement 3 is incorrect.

146. Which one of the following is NOT an assumption of impact loading on a beam?

(a) The falling weight sticks to the beam and moves/vibrates with it

(b) No energy loss takes place

(c) The beam is linearly non elastic

(d) The deflected shape of the beam is the same under a dynamic load as under the static load

Sol: **(c)**

During analysis of impact load, we assume material to be linear elastic.

147. Which one of the following is NOT an effect of wind on a structure?

(a) The effect of wind on a structure depends upon the density and velocity of the air.

(b) It depends upon the angle of incidence of the wind.

(c) It depends upon the shape and stiffness of the structure

(d) It depends upon the smoothness of the structure surface.

Sol: **(d)**

Wind effect does not depend on smoothness of the structure surface.

Hence, the correct option is (d)

148. Match the following lists:

List-I (Basic structural elements)	List-II (Applications)
P. Tin rods	1. Carry tensile and compressive loads
Q. Beams	2. Members that resist axial compressive force
R. Columns	3. Bracing
S. Trusses	4. Reinforced concreter

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	2	1
(c)	4	1	2	3
(d)	1	2	3	4

Sol: **(b)**

The correct option is (b)

149. Consider the following statements, regarding the principle of super position:

1. The total displacement of the stress at a point in a structure subjected to several external loadings can be determined by adding together the displacements caused by each of the external loads acting together.
2. The material must behave in a non-linear elastic manner.
3. The geometry of the structure must not undergo significant change when the loads are applied.

Which of the above statements is/are correct?

(a) 1 and 2 (b) 2 only

(c) 3 only (d) 1 and 3

Sol: **(c)**

1. The total displacement of the stress at a point in a structure subjected to several loadings can be determined by adding together the displacements caused by each of the external loads acting separately.
2. The material should be linearly elastic. Hence statement 1 and 2 are incorrect and 3 is correct.

150. What is the condition for stability of truss with b number of bars, r number of external support reactions with j number of joints?

(a) $b + r = 2j$ (b) $b + r > 2j$

(c) $b + r < 2j$ (d) $b + r < j$

Sol: **(b)**