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UPPSC 2020

Assistant Engineer
Prelims Exam
Civil Engineering
Paper-I
Answer Key (SET-B)

Exam Date - 13th December **Time - 09:00 AM - 11:30 AM**

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SET - B

1. 'अंदर-अंदर कड़ाही में गुड़ पगना' – इस मुहावरे का सही अर्थ है

(a) ज्ञान होना

(b) गुप्त मंत्रणा होना

(c) स्वसीमित होना

(d) किसी काम न आना

Ans. **(b)**

2. 'निवृत्ति' शब्द का विलोम है

(a) सद्वृत्ति (b) सुवृत्ति

(c) प्रवृत्ति (d) कुवृत्ति

Ans. **(c)**

3. निम्नलिखित में से शुद्ध वर्तनी का शब्द है

(a) उज्ज्वल (b) उज्जवल

(c) उजवल (d) उज्वल

Ans. **(a)**

4. इनमें से 'अनघ' का विलोम शब्द है

(a) निरघ (b) अघी

(c) कृती (d) सनघ

Ans. **(b)**

5. निम्नलिखित में से शुद्ध वर्तनी का शब्द है

(a) अनाधिकार (b) रचइता

(c) सहस्र (d) संग्रहीत

Ans. **(c)**

6. निम्नलिखित में से 'शारदा' का पर्यायवाची शब्द है

(a) कमला (b) कौमुदी

(c) वारुणी (d) गिरा

Ans. **(d)**

7. 'बुद्धिहीन' शब्द व्याकरण की दृष्टि से इनमें से किस संवर्ग में है?

(a) संज्ञा (b) सर्वनाम

(c) विशेषण (d) क्रिया

Ans. **(c)**

8. इनमें से 'पक्षी' शब्द का पर्यायवाची नहीं है

(a) पिशुन (b) विहंग

(c) शकुनि (d) द्विज

Ans. **(a)**

9. समास-योजना की दृष्टि से इनमें से एक अशुद्ध युग्म है

(a) सतसई – द्विगु समास

(b) तुलसीकृत – तत्पुरुष समास

(c) मंदोदरी – बहुव्रीहि समास

(d) मरणासन्न – अव्वयीभाव समास

Ans. **(d)**

10. 'मृत्यु के इच्छुक'-इस वाक्यांश के लिए एक शब्द है

(a) मुमुक्षा (b) मुमूर्षू

(c) मुमूर्षा (d) मुमुक्षु

Ans. **(b)**

11. इनमें से एक वाक्य शुद्ध है, वह है

(a) मेरा प्राण संकट में है।

(b) सोमवार को रेलवे के कई कर्मचारी गिरफ़्तार हुए।

(c) अपराधी को मृत्युदंड की सजा दी गयी है।

(d) महादेवी वर्मा छायावाद की प्रसिद्ध कवयित्री हैं।

Ans. (d)

12. नीचे दिये गये वाक्यांश और उसके लिए प्रयुक्त होने वाले एक शब्द का एक युग्म गलत है, वह है

(a) उत्तराधिकार में प्राप्त सम्पत्ति–धरोहर

(b) जिसे प्रमाण द्वारा सिद्ध न किया जा सके–अप्रमेय

(c) सीमा का अनुचित रूप से किया गया उल्लघंन–अतिक्रमण

(d) पूरब और उत्तर (दिशा) के बीच का कोना–ईशान

Ans. (a)

13. अलग होने के अर्थ में 'से' कारक–चिन्ह का प्रयोग होता है

(a) अपादान कारक में

(b) करण कारक में

(c) करण कारक तथा अपादान दोनों मे

(d) सम्बन्ध कारक में

Ans. (a)

14. 'चीनांशुक' शब्द का अर्थ है

(a) तंतु (b) रेणु

(c) रेशम (d) चीनी मिट्टी

Ans. (c)

15. इनमें से दन्त्य ध्वनियाँ हैं

(a) च, छ, ज, झ (b) प, फ, ब, भ

(c) त, थ, द, ध (d) ट, ठ, ड, ढ

Ans. (c)

16. निम्नलिखित में से 'महीसुर' शब्द का अर्थ है

(a) पृथ्वी का रक्षक (b) महिषासुर

(c) राक्षस (d) ब्राह्मण

Ans. (a)

17. निम्नलिखित में से एक शब्द में से उपसर्ग का प्रयोग नहीं हुआ है, वह शब्द है

(a) सहज (b) अनुभव

(c) संचार (d) नयन

Ans. (a)

18. निम्नलिखित में से तद्भव शब्द है

(a) वानर (b) तेल

(c) पीत (d) घोटक

Ans. (b)

19. इनमें से व्यंजन सन्धि आधारित शब्द है

(a) अन्वेषण (b) उद्धार

(c) लघूर्मि (d) पुरोहित

Ans. (b)

20. निम्नलिखित में से तत्सम शब्द है

(a) विवाह (b) ईख

(c) खीर (d) गिद्ध

Ans. (a)

21. 'पवन' शब्द का सन्धि–विच्छेद है

(a) पौ+अन (b) पो+अन

(c) प+अवन (d) प+वन

Ans. (b)

22. अनेकार्थक शब्द 'सारंग' का निम्नलिखित में से एक अर्थ नहीं है

(a) भौंरा (b) कामदेव

(c) तलवार (d) ज्योतिषी

Ans. **(d)**

23. 'चौराहा' शब्द में समाप्त है

(a) तत्पुरुष (b) बहुव्रीहि

(c) अव्ययीभाव (d) द्विगु

Ans. **(d)**

24. 'ने+अन' = 'नयन' में सन्धि है

(a) यण सन्धि (b) गुण सन्धि

(c) अयादि सन्धि (d) वृद्धि सन्धि

Ans. **(c)**

25. इनमें से शुद्ध वर्तनी का रूप है

(a) निरझरणी (b) निरझरिणी

(c) निर्झरिणी (d) निर्झरणी

Ans. **(c)**

26. Match List-I and List-II, and select the correct answer using the codes in given below list.

List-I	List-II
i. Preliminary estimate	1. Probable variation for quantity rate and amount for each items.
ii. Revised estimate	2. Material deviation of a structural nature
iii. Supplementary estimate	3. Complete estimate
iv. Quantity estimate	4. Approximate cost of the project.

Codes :

	(i)	(ii)	(iii)	(iv)
(a)	4	1	2	3
(b)	4	2	1	3
(c)	3	1	2	4
(d)	3	2	1	4

Ans. **(a)**

27. The total number of grades of ordinary concrete stipulated in IS : 456-2000 are

(a) 10 (b) 8

(c) 3 (d) 6

Ans. **(c)**

Sol. As per IS:456-2000 Table no.2, ordinary concrete are stipulated in 3 grades.

28. Two shafts of same length and material are joined in series. If the ratio of their diameters is 2, then the ratio of their angles of twist will be :

(a) 2 (b) 4

(c) 8 (d) 16

Ans. **(d)**

Sol.

$$\text{Angle of twist } (\phi) = \frac{T.l}{G.J.}$$

For same length and material

$$\phi \propto \frac{1}{J}$$

$$\frac{\phi_1}{\phi_2} = \frac{J_2}{J_1} = \left(\frac{d_2}{d_1}\right)^4$$

$$\Rightarrow \quad \frac{\phi_1}{\phi_2} = 2^4 = 16$$

29. The mortar used for masonry construction are classified based on strength in IS : 2950 and IS : 1905 according to their designations L_1, L_2, H_1, H_2, M_1 and M_2. The correct sequence of increasing order of their strength is

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(a) L_1, L_2, H_1, H_2, M_1 and M_2
(b) L_2, L_1, M_2, M_1, H_2 and H_1
(c) L_1, L_2, M_1, M_2, H_1 and H_2
(d) M_1, M_2, L_1, L_2, H_1 and H_2

Ans. **(b)**

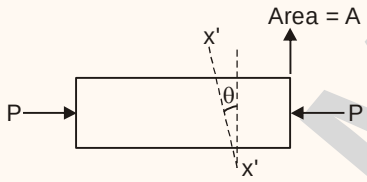
Sol. As per IS:1905-1987, the correct answer should be (b).

30. A prismatic bar in compression has a cross-sectional area A = 1200 mm^2 and carries a load P = 90 kN. Normal and shear stresses acting on a plane cut through the bar at $\theta = 25°$, are respectively

(a) 61.6 MPa and 28.7 MPa
(b) 49.5 MPa and 23.8 MPa
(c) 78.2 MPa and 20.7 MPa
(d) 73.4 MPa and 29.2 MPa

Ans. **(a)**

Sol. For uniaxial compression



$$\sigma_{x'x'} = \frac{P}{A}\cos^2\theta$$

$$\sigma_{x'} = \frac{90\times10^3}{1200}\times\cos^2(25°) = 61.6\,MPa$$

$$\tau_{x'} = \left(\frac{P}{2A}\right)\sin2\theta$$

$$\tau_{x'} = \frac{90\times10^3}{1200\times2}\times\sin(2\times25°)$$

$$= 28.7\ MPa$$

31. The minimum width of tread without nosing for staircase of residential building shall be

(a) 150 mm (b) 190 mm
(c) 200 mm (d) 300 mm

Ans. **(d)**

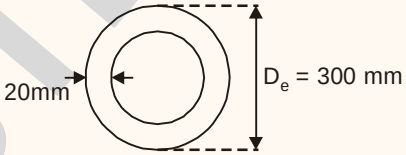
Sol. The minimum width of tread without noising shall be 300 mm. However, for one or two family dwelling, it may be reduced to not less than 250 mm.

32. A cast iron column of external diameter of 300 mm is 20 mm thick. Find safe compressive load on column with factor of safety of 5, if the crushing strength of material is 550 N/mm^2

(a) 1925.21 kN (b) 1935.21 kN
(c) 1945.21 kN (d) 1955.21 kN

Ans. **(b)**

Sol.



$$D_i = 300 - 2\times20$$

$$= 260\ mm$$

$$P_{safe} = \frac{P_C}{FOS} = \frac{f_c\times A}{FOS}$$

$$P_{safe} = \frac{550\times\frac{\pi}{4}(300^2 - 260^2)}{5}$$

$$P_{safe} = 1935.21\ kN$$

33. The water-cement ratio for ferrocement mix should be

(a) Less than 0.35
(b) Between 0.35 to 0.40
(c) Between 0.40 to 0.50
(d) Greater than 0.60

Ans. **(c)**

Sol. The range of water cement ratio for ferro cement mix is 0.35 to 0.5. For watertightness the water cement ratio is restricted to 0.4.

34. A simply supported beam of length 6 m carries a point load at the centre of the beam such that the maximum bending moment there is

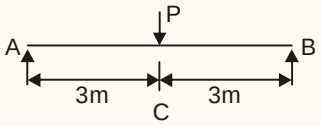
12 kN-m, if 'EI' is the flexural rigidity of the beam, the deflection at the centre is

(a) $\frac{9}{EI}$ (b) $\frac{18}{EI}$

(c) $\frac{36}{EI}$ (d) $\frac{45}{EI}$

Ans. **(c)**

Sol.



$$M_{max} = \frac{P.L.}{4} = 12\,kNm$$

$$\Rightarrow \quad P = \frac{4\times 12}{6} = 8\,kN$$

$$\delta_C = \frac{PL^3}{48EI} = \frac{8\times 6^3}{48EI}$$

$$\delta_C = \frac{36}{EI}$$

35. The minimum depth of the reinforced bond provided as strengthing arrangement in masonry building is

(a) 75 mm (b) 60 mm

(c) 50 mm (d) 40 mm

Ans. **(a)**

Sol. As per IS 4326: 1993, Cl 8.4.5.

The band shall be made of reinforced concrete of grade not leaner than M15 or reinforced brick-work in cement mortar not leaner than 1:3. The bands shall be of the full width of the wall, not less than 75 mm in depth and reinforced with steel.

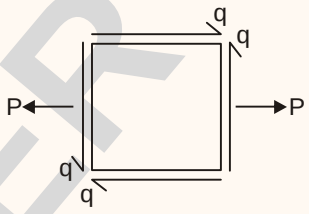
36. When a body is subjected to a direct tensile stress (p) in one plane accompanied by a simple shear stress (q), the maximum normal stress is

(a) $\frac{p}{2}+\frac{1}{2}\sqrt{p^2+4q^2}$ (b) $\frac{p}{2}-\frac{1}{2}\sqrt{p^2+4q^2}$

(c) $\frac{p}{2}+\frac{1}{2}\sqrt{p^2-4q^2}$ (d) $\frac{p}{2}-\frac{1}{2}\sqrt{p^2-4q^2}$

Ans. **(a)**

Sol.



$$\sigma_{major} = \frac{P}{2}+\sqrt{\left(\frac{P}{2}\right)^2+q^2}$$

$$\sigma_{major} = \frac{P}{2}+\frac{1}{2}\sqrt{P^2+4q^2}$$

37. Technical term 'Eaves' is defined as

(a) The apex line of the sloping roof

(b) The lower edge of the inclined roof surface

(c) Sloped triangular surface formed at the end of a roof

(d) The ridge formed by the intersection of two sloping surfaces

Ans. **(b)**

38. A ductile structure is defined as one for which the plastic deformation before fracture

(a) is smaller than the elastic deformation

(b) vanishes

(c) is equal to the elastic deformation

(d) is much larger than elastic deformation

Ans. **(d)**

Sol. For ductile structure, plastic deformations are much larger than elastic deformations.

39. The method suitable for measuring the workability of dry concrete mix having very low workability is

(a) Slump test
(b) Compaction factor test
(c) Vee-bee consistometer test
(d) Vicat test

Ans. **(c)**

Sol. The measuring of workability from very low to very high is vee-bee consistometer, compaction factor test, slump test, flow table test sequently.

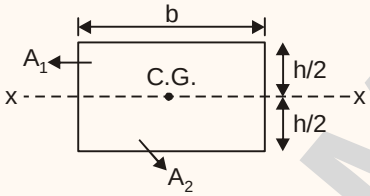
40. The first moment of area of a rectangular section of width 'b' and depth 'h' about centre of gravity is

(a) $\frac{b \cdot h^2}{2}$ (b) $\frac{b \cdot h^2}{4}$

(c) zero (d) $b \cdot h^2$

Ans. **(c)**

Sol.



First moment of area $= A_1\bar{y}_1 + A_2\bar{y}_2$

$$= \left(b \times \frac{h}{2}\right) \times \frac{h}{4} + \left(b \times \frac{h}{2}\right) \times \left(-\frac{h}{4}\right) = 0$$

Note : For any given area first moment of area about centroid will always be zero.

41. According to National Building Code 2016, the slope of a ramp in the building shall NOT exceed

(a) 1 in 12 (b) 1 in 10

(c) 1 in 8 (d) 1 in 6

Ans. **(a)**

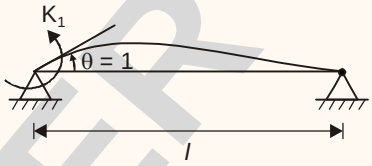
42. The ratio of the stiffness of the beam at the near end when the far end is hinged, to the stiffness of the beam at the near end when the far end is fixed

(a) $\frac{4}{3}$ (b) $\frac{3}{4}$

(c) 1 (d) $\frac{1}{2}$

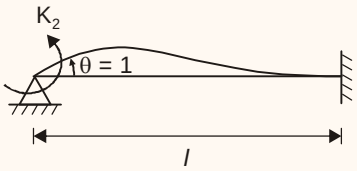
Ans. **(b)**

Sol. (i) Stiffness of beam at near end when far end is hinged.



$$K_1 = \frac{3EI}{l}$$

(ii) Stiffness of beam at near end when far end is fixed.



$$K_2 = \frac{4EI}{l}$$

Ratio of K_1 and K_2, i.e., $\boxed{\frac{K_1}{K_2} = \frac{3}{4}}$

43. A property fetch a net annual income of Rs 80,000/- after deducting all outgoings. Rate of interest is 6% per annum. What is capitalized value of the property?

(a) Rs. 13,33,600/- (b) Rs 9,60,000/-

(c) Rs 16,63,500/- (d) Rs 9,33,900/-

Ans. **(a)**

Sol. Year's purchase $= \frac{100}{6} = 16.67$

Capitalized value of the property

= net income × year purchase

= 80000 × 16.67

= 1333600

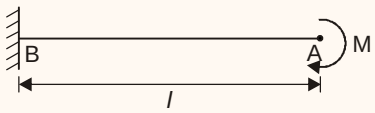
44. The deflection at the free end of a cantilever beam subjected to a couple 'M' at the free end and having a uniform flexural rigidity 'EI' throughout its length 'L' is equal to

(a) $\frac{ML^2}{2EI}$ (b) $\frac{ML^2}{3EI}$

(c) $\frac{ML^2}{6EI}$ (d) $\frac{ML^2}{8EI}$

Ans. **(a)**

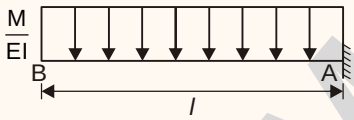
Sol.



Assumption: EI = constant

Deflection at A, $\boxed{\Delta_A = \frac{Ml^2}{2EI}}$

Using conjugate beam method



Conjugate beam of free end cantilever.

Deflection at A in real beam = Bending Moment at A in conjugate beam

$$\Delta_A = M_A = -\left(\frac{Ml}{EI}\right)\times\left(\frac{l}{2}\right) = -\frac{Ml^2}{2EI}$$

$$\boxed{\Delta_A = \frac{Ml^2}{2EI}\downarrow}$$

45. Match List-I and List-II, and select the correct answer using the codes given below the lists.

List-I

(i) Index plan

(ii) Key plan

(iii) Service plan

(iv) Layout plan

List-II

1. Details of plumbing service, water supply and sewage disposal system.
2. Relative position of all the different units.
3. General layout of a new town showing the position of roads, market, hospital, parks etc.
4. Details of the particular building.

Codes:

	i	ii	iii	iv
(a)	4	3	2	1
(b)	3	4	1	2
(c)	3	1	2	4
(d)	4	1	2	3

Ans. **(b)**

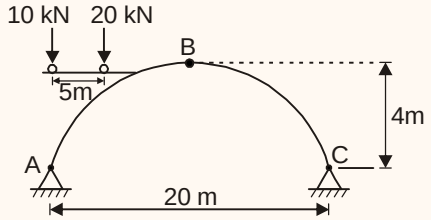
46. A three hinged arch ABC has a span of 20 m and central rise of 4 m. The arch has hinges at the end and at the centre. A train of two point loads of 20 kN and 10 kN, 5 m apart crosses this arch from left to right with 20 kN load leading. The maximum thrust induced at the support is

(a) 25 kN (b) 32.81 kN

(c) 28.13 kN (d) 31.25 kN

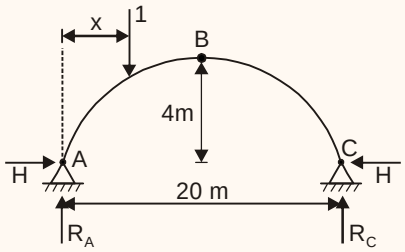
Ans. **(d)**

Sol. Three hinged arch ABC



ILD for horizontal thrust

(i) When unit load is on left side of B.



$\sum M_A = 0$

$R_c \times 20 - x = 0$

$R_c = \frac{x}{20}$

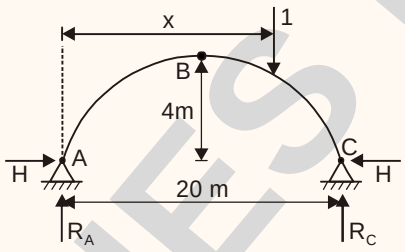
$\sum M_B = 0$, right of B.

$-R_c \times 10 + H \times 4 = 0$

$H = R_c\left(\frac{10}{4}\right)$

$H = \frac{x}{20} \times \frac{10}{4} = \frac{x}{8} \qquad 0 \le x \le 10\,m$

(ii) When unit load is on right side of B.



$\sum M_C = 0$

$R_A \times 20 - (20 - x) \times 1 = 0$

$R_A = \frac{20 - x}{20}$

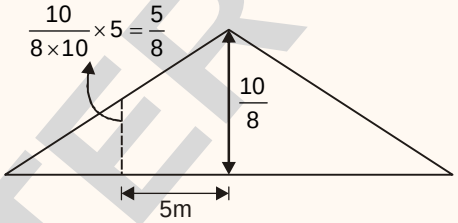
$\sum M_B = 0$, left of B.

$R_A \times 10 - H \times 4 = 0$

$H = R_A\left(\frac{10}{4}\right)$

$H = \left(\frac{20 - x}{20}\right)\left(\frac{10}{4}\right)$

$H = \frac{20 - x}{8} \qquad 10\,m \le x \le 20\,m$



ILD for H

Maximum thrust induced, when 20 kN is at crown i.e. B.

$H = 20 \times \left(\frac{10}{8}\right) + 10 \times \left(\frac{5}{8}\right)$

$\boxed{H = 31.25\,kN}$

47. Base of a paint is

(a) Linseed oil

(b) Poppy oil

(c) Sulphates of zinc and manganese

(d) White lead

Ans. **(d)**

Sol. The base of paint is white lead, red lead, zinc white, titanium white, iron oxide, aluminium powder etc.

48. Influence line for redundant structures can be obtained by

(a) Castigliano's theorem

(b) Unit load theorem

(c) Muller-Breslau principle

(d) Maxwell Betti's reciprocal theorem

Ans. **(c)**

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Sol. Influence line diagram can be obtained by Muller-Breslau principle for both determinate and indeterminate or redundant structure.

49. Part of brick which has half-header face and half-stretcher face is known as

(a) Bevelled closer (b) King closer

(c) Queen closer (d) Bat

Ans. **(b)**

50. A single bay portal frame of height 'h' fixed at the base is subjected to a horizontal displacement 'Δ' at the top. The base moment developed is proportional to

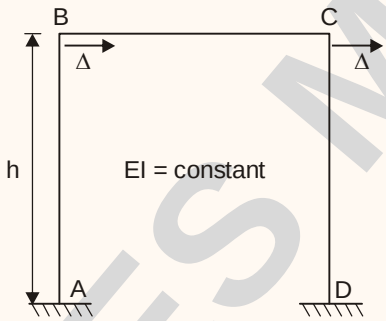
All members are prismatic.

(a) $\frac{1}{h}$ (b) $\frac{1}{h^2}$

(c) $\frac{1}{h^3}$ (d) None of these

Ans. **(b)**

Sol. **Single bay portal frame**



Base moment i.e. M_A and M_D developed is proportional to $\frac{1}{h^2}$.

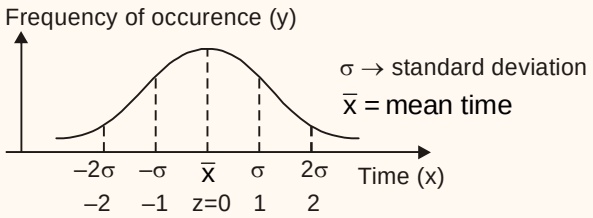
51. In a 'PERT' analysis, if the probability factor is negative, the chances of completing the project in time is

(a) Less than 50% (b) Fifty-fifty %

(c) More than 50% (d) Zero

Ans. **(a)**

Sol.



Probability factor, $Z = \frac{x - \bar{x}}{\sigma}$

For z = 0, P(z) = 50%

For z < 0, P(z) < 50%

For z > 0, P(z) > 50%

52. Which is the unit matrix or identity matrix in the following?

(a) $\begin{bmatrix} 1.0 & 0.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \\ 1.0 & 0.0 & 1.0 \end{bmatrix}$

(b) $\begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 1.0 & 0.0 & 0.0 \\ 1.0 & 0.0 & 1.0 \end{bmatrix}$

(c) $\begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix}$

(d) $\begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 1.0 \end{bmatrix}$

Ans. **(d)**

53. The limit state of serviceability includes

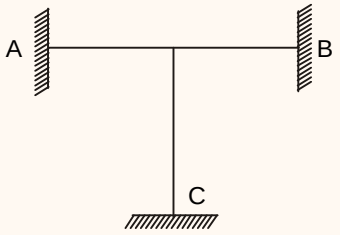
1. Deflection
2. Repairable damage or crack due to fatigue
3. Vibration
4. Fire

(a) Only 1 and 3 (b) Only 1 and 4

(c) Only 1, 3 and 4 (d) 1, 2, 3 and 4

Ans. **(d)**

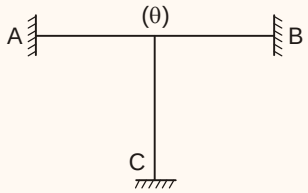
54. Neglecting axial changes in lengths, determine the kinematic indeterminacy of the following frame 'ABC'.



(a) 3 (b) 2
(c) 1 (d) 9

Ans. **(c)**

Sol.



Degree of kinematic indeterminacy of frame ABC by assuming inextensibility of member, $D_k = 1$.

55. In steel structures, the thickness of the base plate in a column base is determined from the

(a) Flexural strength of plate
(b) Shear strength of plate
(c) Bearing strength of concrete pedestal
(d) Punching criteria

Ans. **(a)**

56. For a linear elastic structural system, minimization of potential energy yields

(a) Compatibility condition
(b) Constitutive relationship
(c) Equilibrium equations
(d) Strain displacement relations

Ans. **(a)**

57. Match List-I and List-II and selet correct answer using the codes given below the list.

List-I

(i) Building lease
(ii) Occupational lease
(iii) Sub-lease
(iv) Life lease

List-II

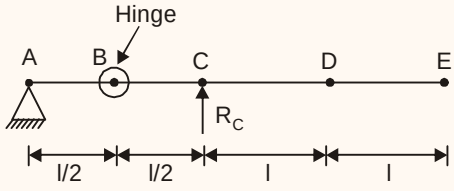
1. The lease holder does not have right to spend money on construction
2. The lease holder can erect a building
3. Duration of lease is given until death
4. The lease holder may render lease hold property

Codes:

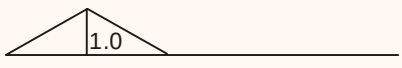
	i	ii	iii	iv
(a)	1	2	4	3
(b)	2	1	4	3
(c)	3	1	2	4
(d)	3	2	1	4

Ans. **(a)**

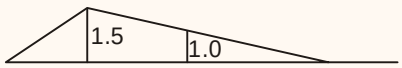
58. The influence line for support reaction R_c for the beam shown in figure will be as



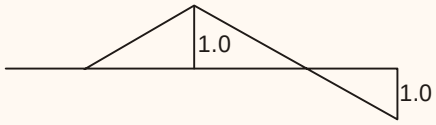
(a)



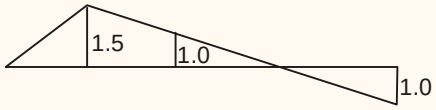
(b)



(c)



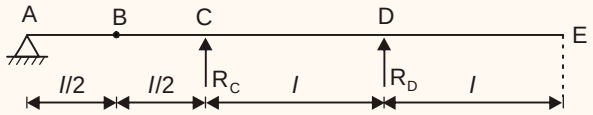
(d)



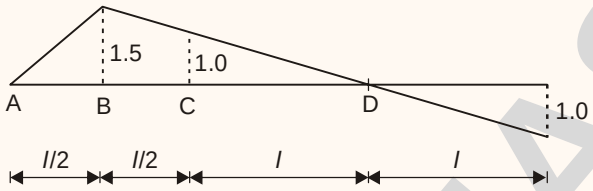
Ans. **(d)**

Sol. **Note:** Given structure is unstable.

Assumption: (i) Assume support at D.

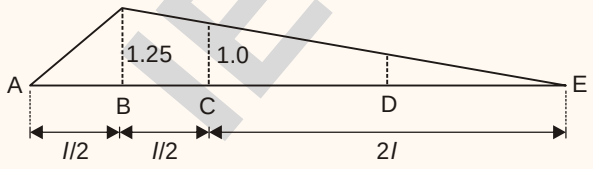


ILD for R_c, using Muller-Breslau principle



(ii) Assume support at E.

ILD for R_c, using Muller-Breslau principle.



$$\frac{y_B}{\frac{5}{2}l} = \frac{1}{2l}$$

$$y_B = \frac{5}{4} = 1.25$$

$$\boxed{y_B = 1.25}$$

Option (d) is satisfying our assumption of case (i).

Hence, option (d) is correct answer.

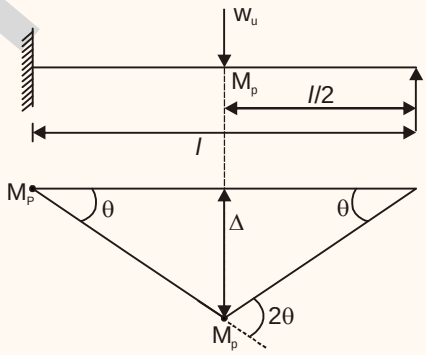
59. A propped cantilever beam of span 'L' is carrying a vertical concentrated load acting at mid span. The plastic moment of the section is M_P. The magnitude of collapse load will be

(a) 8 M_P/L (b) 6 M_P/L

(c) 4 M_P/L (d) 2 M_P/L

Ans. **(b)**

Sol.



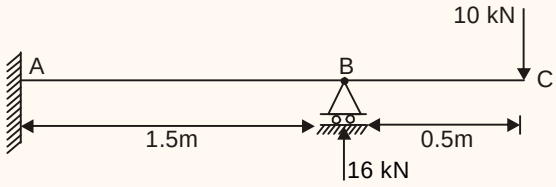
External workdone = Internal workdone

$$w_u \times \Delta = M_p\theta + M_p(\theta + \theta)$$

$$w_u \times \frac{L}{2}\theta = 3M_p\theta$$

$$\boxed{w_u = \frac{6M_p}{L}}$$

60. A horizontal beam is shown below. The distance of the point of contraflexure from the end 'A' is

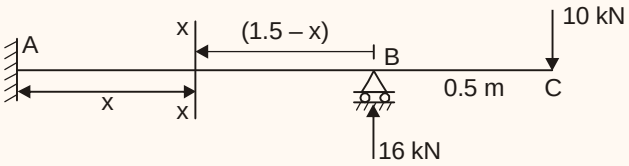


(a) 0.333 m (b) 0.666 m

(c) 1.50 m (d) 0.50 m

Ans. **(b)**

Sol.



Point of contraflexure is the location where bending moment changes sign.

Let, section x-x is the location of point of contraflexure.

$\Rightarrow BM_{@x\text{-}x} = 0$

$\Rightarrow 16(1.5 - x) = 10 \times (1.5 - x + 0.5)$

$\Rightarrow 24 - 16x = 20 - 10x$

$\Rightarrow x = \left(\frac{4}{6}\right) = 0.6667$ m

61. Rivets under combined stresses must be subjected to a limit as

where, τ_v and σ_t = The actual shear and tensile stresses in the rivets, respectively.

τ_{vf} and σ_{tf} = Allowable shear and tensile stresses in the rivets, respectively.

(a) $\frac{\tau_v}{\tau_{vf}} + \frac{\sigma_t}{\sigma_{tf}} \le 2.0$ (b) $\frac{\tau_v}{\tau_{vf}} + \frac{\sigma_t}{\sigma_{tf}} \le 1.5$

(c) $\frac{\tau_v}{\tau_{vf}} + \frac{\sigma_t}{\sigma_{tf}} \le 1.0$ (d) $\frac{\tau_v}{\tau_{vf}} + \frac{\sigma_t}{\sigma_{tf}} \le 1.4$

Ans. **(d)**

62. Excavation was being carried out for a foundation on plastic clay with a unit weight of 22.5 kN/m^3. Failure occured when a depth of 8.10 m was reached. What is the value of cohesion if $\phi = 0°$?

(a) 11.4 kN/m^2 (b) 22.8 kN/m^2

(c) 45.56 kN/m^2 (d) None of these

Ans. **(c)**

Sol. Given $\gamma = 22.5$ kN/m^3

$H = 8.1$ m

$\phi = 0°$

We know depth of tension crack $H = \frac{4C}{\gamma\sqrt{K_a}}$

$K_a = \frac{1-\sin\phi}{1+\sin\phi} = 1$

$H = \frac{4C}{\gamma}$

$C = \frac{H\gamma}{4} = \frac{8.1 \times 22.5}{4}$

$= 45.56$ kN/m^2

63. Match List-I and List-II and select correct answer using the codes given below the list.

List-I

(i) Dead load

(ii) Imposed load

(iii) Wind load

(iv) Snow load

List-II

1. IS : 875 - 2015 (Part -4)
2. IS : 875 - 2015 (Part -3)
3. IS : 875 - 2015 (Part - 2)
4. IS : 875 - 2015 (Part -1)

Codes:

	(i)	(ii)	(iii)	(iv)
(a)	4	3	2	1
(b)	4	3	1	2
(c)	3	4	2	1
(d)	3	4	1	2

Ans. **(a)**

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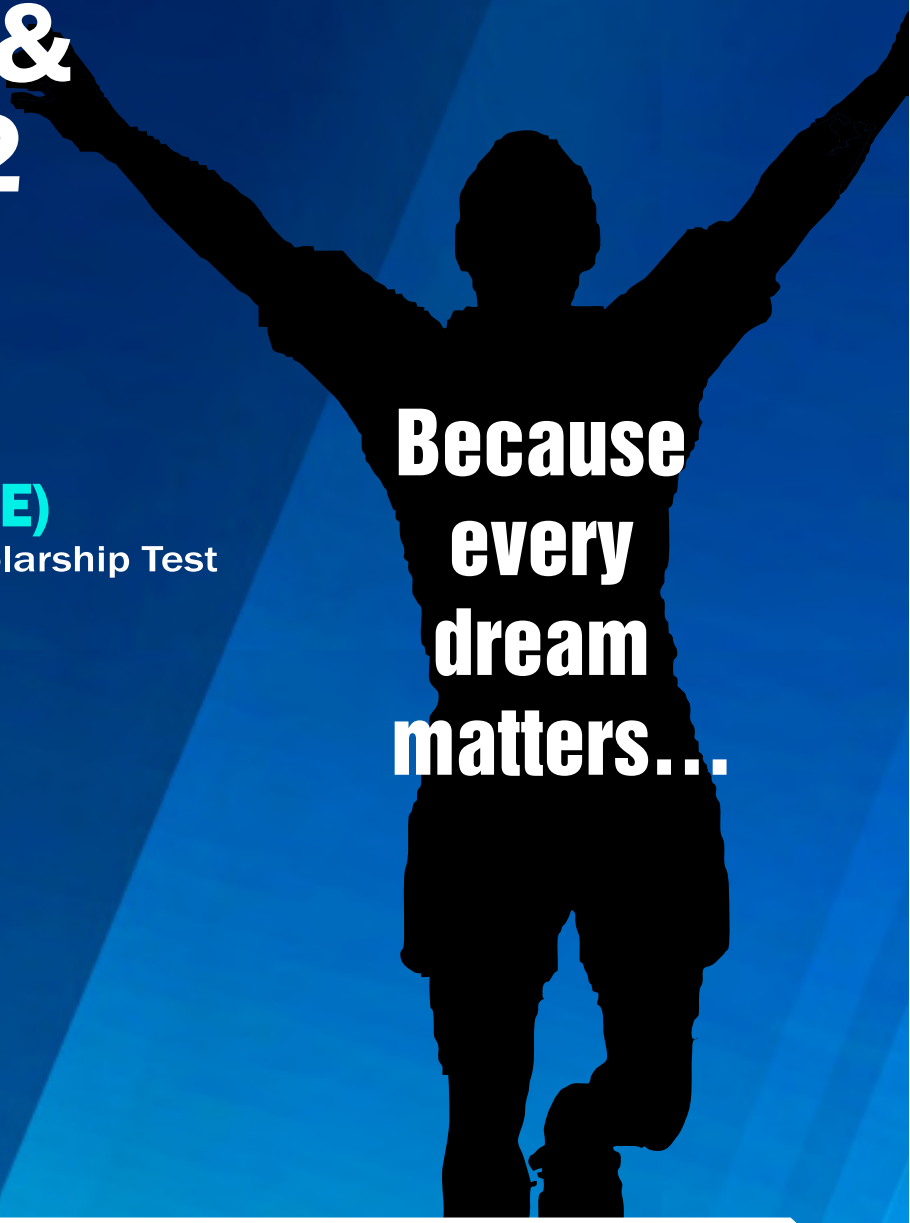

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64. The poisson's ratio for soil smaple 1 and 2 are μ_1 and μ_2 respectively. If $\frac{\mu_1}{\mu_2}=1.5$ and $\frac{1-\mu_1}{1-\mu_2}=0.875$ then ratio of coeff. of earth pressure at rest for soil sample 1 (K_1) to coeff. of earth pressure at rest for soil sample 2 (K_2), $\frac{K_1}{K_2}$ will be

(a) 1.3125 (b) 1.7143
(c) 1.9687 (d) 1.8213

Ans. **(b)**

Sol.
$$\frac{\mu_1}{\mu_2} = 1.5 \Rightarrow \mu_1 = 1.5\mu_2$$
$$\frac{1-\mu_1}{1-\mu_2} = 0.875$$
$$1-1.5\mu_2 = 0.875 - 0.875\ \mu_2$$
$$\mu_2 = 0.2$$
$$\mu_1 = 1.5\mu_2 = 0.3$$

We know earth pressure at rest $K_0 = \frac{\mu}{1-\mu}$

$$\frac{K_1}{K_2} = \frac{\mu_1}{\mu_2}\left(\frac{1-\mu_2}{1-\mu_1}\right)$$
$$= 1.5\times\left(\frac{1-0.2}{1-0.3}\right)$$
$$= 1.7143$$

65. In the design of steel structure, for the purpose of designing any member, the load generated due to secondary effects include

1. Due to contraction or expansion from the temperature
2. Due to differential settlement of structure
3. Due to accidental loads
4. Due to eccentric connections

(a) Only 1 and 3 (b) Only 1, 2 and 3
(c) Only 1, 2 and 4 (d) 1, 2, 3 and 4

Ans. **(c)**

Sol. The load generated due to secondary effect includes :

(a) Due to contraction or expansion resulting from temperature change.
(b) Due to differential settlements.
(c) Due to eccentric connections.
(d) Rigidity of joints differing from design assumption.

66. For sand of uniform spherical particles, the void ratio in the loosest and densest state, are respectively,

(a) 0.91, 0.35 (b) 0.35, 0.91
(c) 0.65, 0.09 (d) 0.09, 0.65

Ans. **(a)**

Sol. For sand of uniform spherical particles

e_{max} = 0.91 (loosest state)
e_{min} = 0.35 (densest state)

67. Prying forces are

(a) Forces due to the friction between connected parts
(b) Bending forces on the bolts because of the joints
(c) Shearing forces on the bolts because of joints
(d) Tensile forces due to the flexibility of connected parts

Ans. **(d)**

68. The constant of proportionality between seepage velocity and hydraulic gradient is called

(a) Seepage coefficient
(b) Coefficient of transmissiblity
(c) Coefficient of percolation
(d) Modified coefficient of permeability

Ans. **(c)**

Sol. $V_s = K_p i$

Where V_s = Seepage velocity

K_p = Coefficient of percolation

i = Hydraulic gradient

69. In a steel plate with bolted connection the rupture of the net section is a mode of failure under

(a) Tension (b) Compression

(c) Flexure (d) Shear

Ans. **(a)**

70. A 300 mm square bearing plate settles by 21 mm in a plate load test on a cohesive soil, when the intensity of loading is 0.2 N/m^2. The settlement of a prototype shallow footing 1 m square (1 m × 1m) under the same intensity of loading (considering both plate and footing are placed at same depth) is

(a) 15 mm (b) 70 mm

(c) 50 mm (d) 167 mm

Ans. **(b)**

Sol. $B_p = 300 \text{ mm} = 0.3 \text{ m}$

$S_p = 21 \text{ mm}$

$B_f = 1 \text{ m}$

$S_f = ?$

Settlement of foundation from the settlement of plate

$$\frac{S_f}{S_p} = \left(\frac{B_f}{B_p}\right)$$

where S_f = Settlement of foundation of width B_f(m)

S_p = Settlement of plate of width B_p(m)

$$\frac{S_f}{21} = \left[\frac{1}{0.3}\right] = 70 \text{ mm}$$

71. The flange splice in plate girders is preferably placed near about

(a) Mid span section

(b) Quarter span section

(c) End section

(d) Any section

Ans. **(b)**

72. In a drained triaxial compression test conducted on dry sand, failure occurred when the deviator stress was 218 kN/m^2 at a confining pressure of 61 kN/m^2. The effective angle of shearing resistance and the inclination of failure plane to major principal plane will be

(a) 34°, 62° (b) 34°, 28°

(c) 40°, 25° (d) 40°, 65°

Ans. **(d)**

Sol. $C' = 0$

$\bar{\sigma}_d = 218 \text{ kN/m}^2$

$\sigma_c = 61 \text{ kN/m}^2$

$\bar{\sigma}_3 = \bar{\sigma}_c = 61 \text{ kN/m}^2$

$\bar{\sigma}_1 = \bar{\sigma}_c + \bar{\sigma}_d$

$= 61 + 218$

$= 279 \text{ kN/m}^2$

$$\bar{\sigma}_1 = \bar{\sigma}_3 \tan^2\left(45 + \frac{\phi}{2}\right) + 2C' \tan\left(+45 + \frac{\phi'}{2}\right)$$

$$279 = 61\tan^2\left(45 + \frac{\phi'}{2}\right)$$

$$45 + \frac{\phi'}{2} = 64.94$$

$$\phi' = 39.88° \simeq 40°$$

α = inclination of failure plane to major principal plane

$$= 45 + \frac{\phi'}{2}$$

$$= 45 + \frac{40}{2}$$

$$= 65°$$

73. A steel section is subjected to a combination of shear and bending actions. The applied shear force is 'V' and shear capacity of the section is 'V_s' for such sections, high shear force (as per IS : 800 - 2007) is defined as

(a) $V > 0.6\ V_s$ (b) $V > 0.7\ V_s$

(c) $V > 0.8\ V_s$ (d) $V > 0.9\ V_s$

Ans. **(a)**

Sol. As per IS:800-2007, $V > 0.6V_d \rightarrow$ case of high shear force.

74. A pile 450 mm in diameter and 15 m long is driven into a soft clay. The undrained strength of soil varies linearly with depth such that Su = $0.22\sigma_z$. Determine the allowable pile load capacity using total stress analysis. The factor of safety required is 2 and γ_{sat} = 17 kN/m^3. Ground watyer is at surface.

(a) 286.1 kN (b) 252.0 kN

(c) 95.4 kN (d) 84.0 kN

Ans. **(a)**

Sol. Pile load capacity using total stress analysis

d = 0.45 m, L = 15m, γ_{sat} = 17 kN/m^3,

FoS = 2.

$C_u = 0.22\,\sigma_z = 0.22 \times 17 \times z = 3.74\ z$

$$A_b = \frac{\pi}{4} \times 0.45^2 = 0.159\ m^2$$

$$A_s = \pi \times 0.45 \times 15 = 21.205\ m^2$$

$$Q_b = cN_cA_b = 9C_uA_b$$

$$= 9 \times 3.74 \times 15 \times 0.159$$

$$= 80.28\ kN$$

$Q_s = \alpha C_{ua} A_s$ (α = 0.95 for soft clay)

C_{ua} = Average undrained strength

$$= \frac{3.74 \times 15}{2} = 28.05\ kN/m^2$$

$Q_s = 0.95 \times 28.05 \times 21.205$

$= 565.06$ kN

$Q_u = Q_b + Q_s$

$= 80.28 + 565.06$

$= 645.34$ kN

$$Q_{safe} = \frac{Q_u}{FoS} = \frac{645.34}{2} = 322.67\ kN$$

Option (a) will be correct.

75. Torsion resisting capacity of a given RC section

(a) Decrease with decrease in stirrup spacing

(b) Decrease with increasing the number of longitudinal bars

(c) Does not depend upon stirrup and longitudinal steel

(d) Increase with the increase in stirrup and longitudinal steel

Ans. **(d)**

Sol. Torsion capacity of reinforced concrete section increases with increase in stirrup and longitudinal steel.

76. What will be the natural frequency of a machine foundation which has a base area of 2.20 m × 2.20 m and a weight of 155 kN including the weight of the machine? Take the value of the coefficient of elastic uniform compression as 4.4×10^4 kN/m^3.

(a) $29/\pi$ (b) $58/\pi$

(c) $116/\pi$ (d) None of these

Ans. **(b)**

Sol. As we know,

$$\omega_n = \sqrt{\frac{C_u A}{M}}$$

$$M = \frac{155}{9.81} = 15.8 \frac{kN}{m} sec^2$$

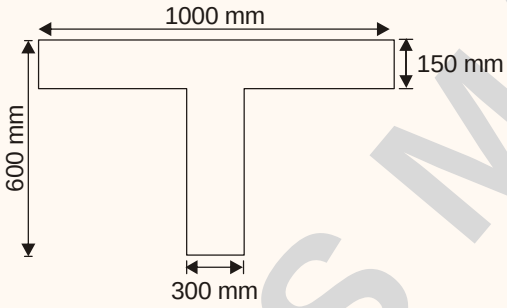
$$\omega_n = \sqrt{\frac{4.4 \times 10^4 \times 2.2^2}{15.8}}$$

$$\omega_n = 116.096 \text{ rad/sec}$$

$$\text{Frequency, } f = \frac{\omega_n}{2\pi} = \frac{116.096}{2\pi}$$

$$\boxed{f = \frac{58.048}{\pi} Hz}$$

77. An isolated T-beam is used as walkway. The beam is simply supported with an effective span of 6 m. The effective width of the flange for the cross-section shown in figure is

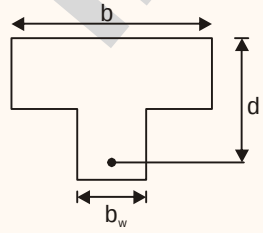


(a) 900 mm (b) 1000 mm

(c) 1259 mm (d) 2200 mm

Ans. **(a)**

Sol. Effective width of flange in isolated t-beam



$$b_f = b_w + \frac{\ell_0}{\frac{\ell_0}{b} + 4} \le b$$

Given $b_w = 300$ mm

$\ell_0 = 6$ m $= 6000$ mm

$b = 1000$ mm

$$b_f = 300 + \frac{6000}{\frac{6000}{1000} + 4} = 900$$

$b_f = 900$ mm < 1000 mm

78. As per Rankine analysis, the minimum depth of foundation (D_{min}) will be

where, q = intensity of loading

γ = unit wt. of over burden

ϕ = angle of internal friction of soil

(a) $\frac{q}{\gamma}\left[\frac{1-\sin\phi}{1+\sin\phi}\right]^2$ (b) $\frac{q}{\gamma}\left[\frac{1-\sin\phi}{1+\sin\phi}\right]$

(c) $\frac{q}{\gamma}\left[\frac{1+\sin\phi}{1-\sin\phi}\right]$ (d) $\frac{q}{\gamma}\left[\frac{1+\sin\phi}{1-\sin\phi}\right]^2$

Ans. **(a)**

Sol. As per Rankine analysis

$$D_{min} = \frac{q}{\gamma}\left[\frac{1-\sin\phi}{1+\sin\phi}\right]^2$$

79. Factored shear force of 140 kN is applied on a beam having breadth 250 mm. The beam is also subjected to factored torsional moment of 20 kN-m. The equivalent shear force on the beam is

(a) 298 kN (b) 348 kN

(c) 268 kN (d) 300 kN

Ans. **(c)**

Sol. Factored shear force, $V_u = 140$ kN

Factored torsional moment, $T_u = 20$ kN-m

Breadth, $b = 250$ mm

Equivalent shear force, $V_{eq} = V_u + 1.6 \frac{T_u}{b}$

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$$V_{eq} = 140 + 1.6 \times \frac{20 \times 1000}{250}$$

$$\boxed{V_{eq} = 268\,kN}$$

80. The net ultimate bearing capacity of a purely cohesive soil

(a) Depends on both, width and depth of footing

(b) Depends on only width of footing

(c) Depends on only depth of footing

(d) Is independent of both, depth and width of footing

Ans. **(d)**

Sol. Net ultimate bearing capacity of a purely cohesive soil $q_{nu} = CN_C$

It is independent of both, depth and width of footing.

81. A reinforced concrete wall carrying vertical loads, is generally designed as per recommendations given for columns. The ratio of minimum reinforcement in the vertical and horizontal direction is

(a) 2 : 1 (b) 1 : 1

(c) 5 : 3 (d) 3 : 5

Ans. **(d)**

Sol. As per Cl 32.5 of IS 456 : 2000

(a) the minimum ratio of vertical reinforcement to gross concrete area shall be

(i) 0.0012 for deformed bars not larger than 16 mm in diameter.

(ii) 0.0015 for other type of bars

(b) the minimum ratio of horizontal reinforcement to gross concrete area shall be

(i) 0.0020 for deformed bars not larger than 16 mm in diameter.

(ii) 0.0025 for other types of bars

$\therefore$ Ratio of minimum vertical reinforcement to minimum horizontal reinforcement

$$= \frac{0.0012}{0.0020} \text{ or } \frac{0.0015}{0.0025} = \frac{3}{5}$$

82. The test conducted on foundation soil gives SPT value; $N \leq 5$ and density index, $I_D < 20$, the foundation will fail in

(a) General shear (b) Local shear

(c) Punching shear (d) Sinking shear

Ans. **(b)**

Sol. 1. Stress-strain test $(C - \phi$ soil)

General shear failure at low strain, say < 5%, while for local shear failure, stress strain curve continues to rise at strain of 10 to 20%.

2. Angle of shear resistance

For $\phi > 36°$, general shear failure

$\phi < 28°$, local shear failure

3. Penetration test

$N \geq 30$, general shear failure

$N \leq 5$, local shear failure

4. Plate load test

Shape of load settlement curve decides whether it is general shear failure or local shear failure.

5. Density index

$I_D > 70$, general shear failure

$I_D < 20$, local shear failure

83. As per IS : 456 - 2000, the range of standard concrete is

(a) M_{25} - M_{55} (b) M_{20} - M_{55}

(c) M_{25} - M_{50} (d) None of these

Ans. **(a)**

Sol. As per IS:456-2000 table no.2, the correct answer should be (a).

84. For any applied stress, zone of influence refers to isobar corresponding to

(a) 20% (b) 15%

(c) 10% (d) 5%

Ans. **(c)**

Sol. The zone within which the stresses have a significant effect on settlement of structure is known as pressure bulb. It is assumed that an isobar of 0.1q forms a pressure bulb.

85. As per IS : 1893 - 2016, the storey drift in any storey due to minimum specified, design lateral force, with partial load factor of 1, shall NOT exceed 'X' times the storey height. The value of 'X' is

(a) 0.2020 (b) 0.002

(c) 0.040 (d) 0.004

Ans. **(d)**

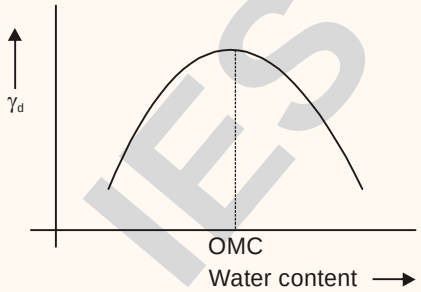
86. The optimum moisture content of a clay soil is 24% whom compaction test is conducted at 30% moisture content, its structure will be

(a) Flocculated (b) Single grained

(c) Honey comb (d) Dispersed

Ans. **(d)**

Sol.



Above OMC, clay will be having dispersed structure and below OMC, clay will be having flocculated structure. Water content = 30% > OMC.

87. The ring beam of a intze tank carries a hoop tension of 120 kN. The beam cross-section is 250 mm wide and 400 mm deep, and it is reinforced with 4 bars of 20 mm dia of Fe - 415 grade. The modular ratio of concrete is 10. The tensile stress (N/mm^2) in the concrete is

(a) 1.02 (b) 1.07

(c) 1.20 (d) 1.32

Ans. **(b)**

Sol. The tensile stress in concrete is given by

$$\sigma_t\,(\text{in concrete}) = \frac{P}{b\times d+(m-1)A_{st}}$$

P = 120 kN, b = 250 mm, d = 400 mm, m = 10

$$A_{st} = 4\times\frac{\pi}{4}\times 20^2 = \pi\times 400$$

$$A_{st} = 1256.56\ \text{mm}^2$$

Tensile stress in concrete

$$= \frac{120\times 10^3}{250\times 400+(10-1)\times 1256.56}$$

$$= 1.07\ \text{N/mm}^2$$

88. In a flow net drown below a sheet pile wall, the number of flow channels and head drops is 4 and 12 respectively. If the difference in the upstream and downstream water level is 3 m, what is the discharge per meter width of a sheet? K = 0.1 m/sec

(a) 1 m^3/s/m (b) 0.1 m^3/s/m

(c) 0.01 m^3/s/m (d) 0.001 m^3/s/m

Ans. **(b)**

Sol.

$N_f = 4$

$N_d = 12$

$H = 3$ m

$K = 0.1$ m/s

Discharge per meter width of sheet

$$q = k\frac{N_f}{N_d}H = 0.1\times\frac{4}{12}\times 3 = 0.1\ \text{m}^3/\text{s/m}$$

89. In the design of reinforced concrete beam, the requirement for bond is NOT getting

satisfied. The economical option to satisfy the requirement for bond is given by

(a) Bundling of bars

(b) Providing same diameter bars more in number

(c) Providing larger diameter bars less in number

(d) Providing smaller diameter bars more in number

Ans. **(d)**

Sol. Bond stress $(\tau_{bd}) = \dfrac{\text{Tensile force}}{\sigma_{st} n \pi \phi}$

τ_{bd} should be less then permissible value

$\tau_{bd} < (\tau_{bd})_{permissible}$

If $\tau_{bd} > (\tau_{bd})_{permissible}$

then best economical solution is to reduce the diameter of bar and increase its number.

90. Shrinkage limit of clay whose void ratio in dry state is 0.55 and Sp. gravity is 2.75, will be

(a) 20% (b) 5%

(c) 5.5% (d) 10.0%

Ans. **(a)**

Sol. $e = 0.55$

$G = 2.75$

At shrinkage limit $S = 1$

$eS = w_{SL} G$

$$w_{SL} = \frac{e}{G} = \frac{0.55}{2.75} = 0.2 \text{ or } 20\%$$

91. The flexural strength of M-30 concrete as per IS : 456 - 2000 is

(a) 3.83 MPa (b) 5.47 MPa

(c) 21.23 MPa (d) 30.00 MPa

Ans. **(a)**

Sol. For M30 concrete, $f_{ck} = 30$ N/mm^2

Flexural strength of concrete $= 0.7\sqrt{f_{ck}}$

$= 0.7\sqrt{30}$

$= 3.83$ MPa

92. The most useful geosynthetic physical property which is closely related to engineering performance is

(a) Thickness

(b) Mass per unit area

(c) Strength

(d) Stiffness

Ans. **(d)**

93. For a singly reinforced balanced section, Mu, lim = Ru, lim b.d^2; for M-20 grade concrete and Fe-415 steel, the value of Ru, lim will be

(a) 1.995 (b) 2.660

(c) 2.761 (d) 2.978

Ans. **(c)**

Sol. For a singly balanced section

$$M_u = R_{ulim} bd^2$$

$$R_{ulim} = 0.36 f_{cK} \left(1 - 0.42 \frac{x_{ulim}}{d}\right) \frac{x_{ulim}}{d}$$

$x_{ulim} = 0.48$ [For Fe415]

$$R_{ulim} = 0.36 \times 20 \times (1 - 0.42 \times 0.48) \times 0.48$$

$= 2.759$

94. For the clay with an OCR of greater than 4 in a CD test, the A-factor at failure will be

(a) Zero

(b) Positive (less than 1)

(c) Negative

(d) Positive (more than 1)

Ans. **(c)**

Sol. OCR = 4 $\rightarrow$ OC clay (OCR > 1)

For OC clays, A = f(OCR)

For heavily overconsolidated clay A < 0, typical value of A are –0.2 to –0.3

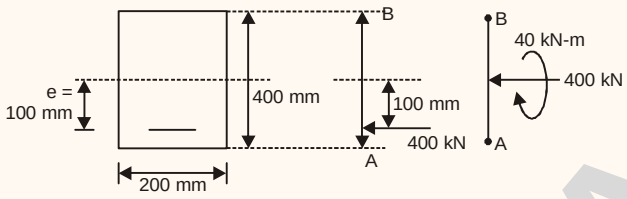
95. A concrete beam of rectangular cross-section of 200 mm × 400 mm is prestressed with a force of 400 kN at an eccentricity 100 mm. The maximum compressive stress in concrete is

(a) 2.5 N/mm^2 (b) 5.0 N/mm^2

(c) 7.5 N/mm^2 (d) 12.5 N/mm^2

Ans. **(d)**

Sol.



Maximum compressive stress will occur at bottom fibre i.e., at A

$$\sigma_A = \frac{P}{A} + \frac{6Pe}{bD^2}$$

$$\sigma_A = \frac{400\times10^3}{200\times400} + \frac{6\times400\times10^3\times100}{200\times400^2}$$

$$\sigma_A = 12.5 \text{ N/mm}^2$$

96. As per IS : 1892 - 1979; what should be the maximum thickness of cutting edge of sampling tube of 70 mm external diameter which is required for sampling in undistrubed stiff clay soil?

(a) 2.15 mm (b) 3.05 mm

(c) 3.95 mm (d) 6.10 mm

Ans. **(b)**

Sol. Area reatio, $A_r = \frac{D_o^2 - D_i^2}{D_i^2}$

D_o = Outer diameter of cutting edge

D_i = Inside diameter of cutting edge

For stiff formation $(A_r)_{max}$ = 20%

Soft sensitive clay $(A_r)_{max}$ = 10%

$$0.2 = \frac{70^2 - D_i^2}{D_i^2}$$

D_i = 63.9 mm

Maximum thickness of cutting edge

$$= \frac{D_o - D_i}{2}$$

$$= \frac{70 - 63.9}{2}$$

= 3.05 mm

97. The lateral ties in reinforced concrete rectangular column under axial tension are used to

(a) Avoid the buckling of the longitudinal steel under compression

(b) Provide adequate shear capacity

(c) Provide adequate confinement to concrete

(d) Reduce the axial deformation of the column

Ans. **(c)**

Sol. The lateral ties in reinforced concrete rectangular column under axial tension are used to provide adequate confinement to concrete because buckling is not possible.

98. What is the correct mathematical expression for the assumption 'consolidation' is occuring under small changes in effective stress made in arriving the differential equation for transient flow during one dimensional consolidation?

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All are standard notations.

(a) a_v = constant

(b) $\frac{1}{(1+e_o)}dx.dy.dz$ = constant

(c) γ_w = constant

(d) $h = \frac{u}{\gamma_w}$

Ans. **(a)**

Sol. For the occurence of consolidation under small changes in effective stress.

a_v will be constant.

99. Fire resistance of RCC member depends upon

1. Member size
2. Cover of steel reinforcement
3. Type of aggregate

(a) Only on 2 (b) Only on 1 and 2

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

Ans. **(d)**

Sol. As per IS 456: 2000 Clause 21.1

Fire resistance of concrete element depends upon details of member size, cover of steel reinforcement detailing and type of aggregate used in concrete.

100. A 16-pile group has to be proportioned in a uniform pattern in a soft clay with equal spacing in both directions. Assuming any value of cohesion, taking $\alpha = 0.7$, neglecting the end bearing effect and assuming pile circular of diameter 'd', the optimum spacing (s) of piles in group will be

(a) 1.6 d (b) 2.6 d

(c) 3.3 d (d) 4 d

Ans. **(b)**

Sol. For individual pile

$$Q_u = Q_f = \alpha C A_s$$

$$= 0.7 C \times \pi \times d \times L$$

$$= 0.7\pi(CdL)$$

For group piles

$$Q_{ug} = \alpha C A_s \quad (\alpha = 1)$$

$$= 1 \times C \times (3s + d) \times 4L$$

$$= 4(3s + d)CL$$

$$Q_{ug} = nQ_u$$

$$4(3s + d)CL = 16 \times 0.7\pi\, CdL$$

$$3s + d = 4 \times 0.7\pi d$$

$$s = 2.6\, d$$

101. The principle used in finding the recoil velocity of a gun is

(a) Work-energy principle

(b) Energy conservation principle

(c) Conservation of linear momentum

(d) Newton's law of collision

Ans. **(c)**

Sol. If there is no external force acting on a system in some direction, then its linear momentum will be conserved in that direction. Using this principle recoil velocity of a gun can be found out.

102. What is the critical height of the slope of infinite extent having a slope angle = 25°, if it is made of clay having C = 30 kN/m^2, $\phi = 20°$, e= 0.65 and G_s = 2.7, when the slope is submerged?

(a) 22.25 m (b) 6.51 m

(c) 35.40 m (d) 40.23 m

Ans. **(c)**

Sol. $\beta = 25°$, $\phi = 20°$

e = 0.65, G_s = 2.7

C = 30 kN/m^2

Factor of safety for $C-\phi$ soil

In this case, $F = \dfrac{C+\gamma_{sub} z\cos^2\beta\tan\phi}{\gamma_{sub} z\cos\beta\sin\beta}$

$$\gamma_{sub} = \left(\frac{G-1}{1+e}\right)\gamma_w$$

$$= \left(\frac{2.7-1}{1+0.65}\right)\times 9.81$$

$$= 10.107 \text{ kN/m}^3$$

Let H_c be the critical height of slope for which

$$F = 1$$

$$C+\gamma_{sub}H_c\cos^2\beta\tan\phi = \gamma_{sub}H_c\frac{\sin 2\beta}{2}$$

$$30+10.107\times H_c\times\cos^2 25^\circ\tan 20^\circ$$

$$= 10.107\times H_c\times\frac{\sin(2\times 25)}{2}$$

$$H_c = 35.31 \text{ m}$$

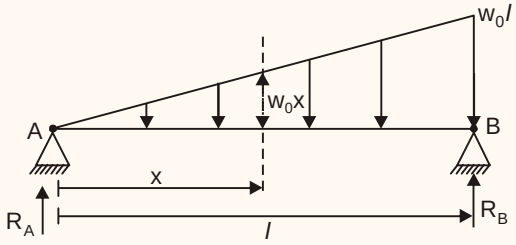
103. A simply supported beam of span 'ℓ' carries a uniformly variable load of intensity w_0x over its entire span. Maximum bending moment in the beam is

(a) $\dfrac{w_0\ell^3}{27}$ (b) $\dfrac{w_0\ell^3(\sqrt{3})}{27}$

(c) $\dfrac{w_0\ell^3(\sqrt{2})}{9}$ (d) $\dfrac{w_0\ell^3}{9}$

Ans. **(b)**

Sol.



$$\sum M_B = 0$$

$$R_A\times l-\left(\frac{w_0 l}{2}\right)\times l\times\frac{l}{3}=0$$

$$R_A = \frac{w_0 l^2}{6}$$

At max. Bending moment,

Shear force, $V = 0$

$$V(x) = R_A-\frac{w_0 x}{2}\times x = 0$$

$$\Rightarrow \frac{w_0 l^2}{6}=\frac{w_0 x^2}{2}$$

$$x = \frac{l}{\sqrt{3}}$$

Bending moment, $M\left(x=\dfrac{l}{\sqrt{3}}\right)$

$$= R_A\times x-\frac{1}{2}w_0 x\times x\times\frac{x}{3}$$

$$= \frac{w_0 l^2}{6}\times\left(\frac{l}{\sqrt{3}}\right)-\frac{w_0}{6}\left(\frac{l}{\sqrt{3}}\right)^3$$

$$= w_0 l^3\left(\frac{1}{6\sqrt{3}}-\frac{1}{6\times 3\times\sqrt{3}}\right)$$

$$= \frac{w_0 l^3}{6\sqrt{3}}\left(\frac{2}{3}\right)=\frac{w_0 l^3}{9\sqrt{3}}$$

$$= \frac{w_0 l^3\sqrt{3}}{27}$$

104. Due to rise in temperature, the viscosity and unit weight of a fluid percolating through a soil mass, are reduced to 80% and 90% respectively, if other factors remain unaltered, the coefficient of permeability

(a) Increases by 12.5%

(b) Decreases by 12.5%

(c) Increases by 28%

(d) Decreases by 28%

Ans. **(a)**

Sol. $\mu_2 = 0.8\mu_1$

$\gamma_2 = 0.9\gamma_1$

We know $K \propto \frac{\gamma}{\mu}$

$$\frac{K_2}{K_1} = \frac{\gamma_2}{\gamma_1}\left(\frac{\mu_1}{\mu_2}\right) = \frac{0.9}{0.8} = \frac{9}{8}$$

$$\frac{K_2 - K_1}{K_1} = \frac{9}{8} - 1 = \frac{1}{8}$$

$$\frac{K_2 - K_1}{K_1} \times 100 = \frac{1}{8} \times 100 = 12.5\% \text{ (Increased)}$$

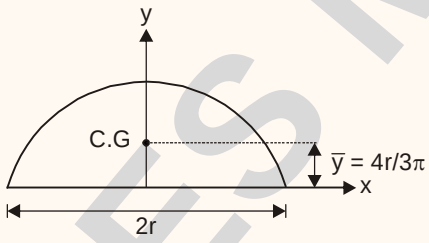
105. The centroid of semicircular area of radius 'r' is

(a) $\frac{3r}{4\pi}$ (b) $\frac{3r}{5\pi}$

(c) $\frac{4r}{3\pi}$ (d) $\frac{5r}{3\pi}$

Ans. **(c)**

Sol.



Centroid of semicircular area i.e. $\boxed{\bar{y} = \frac{4r}{3\pi}}$

106. The principal design criteria for foundations for reciprocating machinery are as follows:

1. The natural frequency should be atleast 40% away from the operating speed of the machine.
2. The amplitude of motion of the foundation should not exceed 0.2 mm.
3. The pressure on soil should be within the respective permissible values.
4. For preliminary design, the maximum pressure on soil due to static load alone may be taken as 0.4 times the corresponding safe bearing capacity.

(a) 1, 2, 3 and 4 are correct

(b) 1, 3 and 4 are correct

(c) 3 and 4 are correct

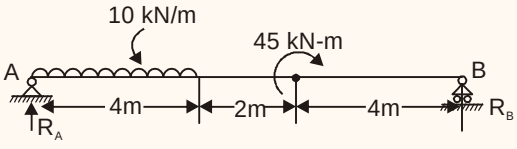
(d) 2, 3 and 4 correct

Ans. **(d)**

Sol. The principal design criteria for foundations for reciprocating machinery are as follows:

1. The natural frequency should be atleast 30% away from the operating speed of the machine.
2. The amplitude of motion of the foundation should not exceed 0.2 mm.
3. The pressure on soil should be within the respective permissible values.
4. For preliminary design, the maximum pressure on soil due to static load alone may be taken as 0.4 times the corresponding safe bearing capacity.

107. The vertical support reactions R_A and R_B for the given beam is



(a) R_A = 25 kN, R_B = 15 kN

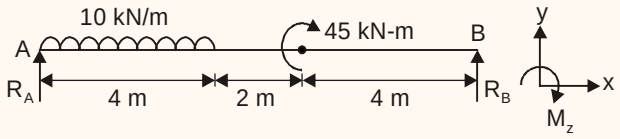
(b) R_A = 15 kN, R_B = 25 kN

(c) R_A = 12.5 kN, R_B = 27.5 kN

(d) R_A = 27.5 kN, R_B = 12.5 kN

Ans. **(d)**

Sol.



$$\sum M_{(A)} = 0$$

$$-R_B \times 10 + 45 + 10 \times 4 \times 2 = 0$$

$$R_B = \frac{125}{10} = 12.5\ \text{kN}$$

$$\boxed{R_B = 12.5\ \text{kN}}$$

$$\sum F_y = 0$$

$$R_A + R_B - 10 \times 4 = 0$$

$$R_A + 12.5 - 40 = 0$$

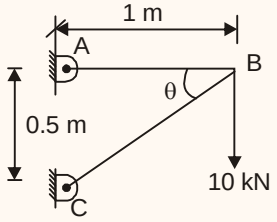
$$\boxed{R_A = 27.5\ \text{kN}}$$

108. The grip length for well foundation of railway bridges is taken as _____ of maximum scour depth, generally, while for road bridges _____ of maximum scour depth is considered adequate.

(a) 30% and 30% respectively
(b) 50% and 30% respectively
(c) 30% and 50% respectively
(d) 50% and 50% respectively

Ans. **(b)**

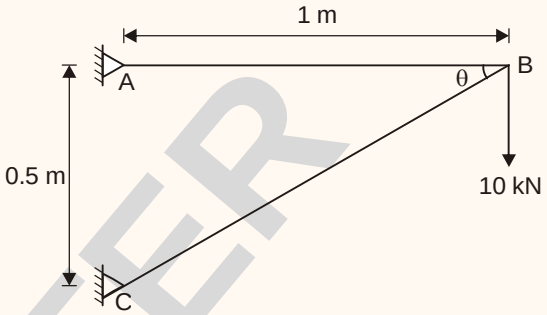
109. A two members truss ABC as shown in figure. The axial force (in kN) transmitted in member AB is



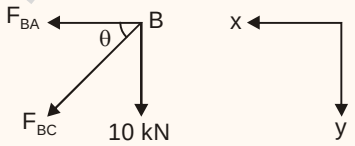
(a) 40 kN (b) 10 kN
(c) 20 kN (d) 30 kN

Ans. **(c)**

Sol. **Two member truss ABC**



Take joint B.



Axial force (in kN) for member AB,

$$\sum F_x = 0$$

$$F_{BC}\cos\theta + F_{BA} = 0 \quad \ldots(i)$$

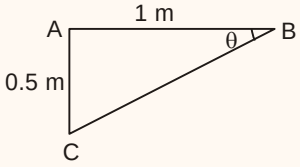
$$\sum F_y = 0$$

$$F_{BC}\sin\theta + 10 = 0 \quad \ldots(ii)$$

By solving (i) and (ii)

$$F_{BC} = -\frac{10}{\sin\theta}$$

$$F_{BA} = -\left(-\frac{10}{\sin\theta} \times \cos\theta\right) = 10\cot\theta$$



$$\cot\theta = \frac{1}{0.5}$$

$$F_{BA} = 10 \times \frac{1}{0.5} = 20\ kN$$

$$\boxed{F_{BA} = 20\ kN\ (Tensile)}$$

110. The total and effective vertical normal stresses at a depth of 5 m below the top level of water in a 7 m deep fresh water lake are respectively

(a) Zero and zero

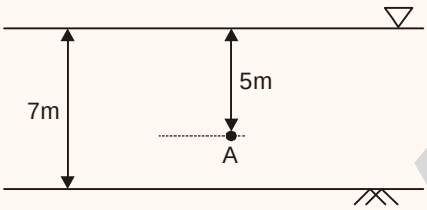
(b) 0.5 kg/cm^2 and 0.5 kg/cm^2

(c) 0.5 kg/cm^2 and zero

(d) 1.0 kg/cm^2 and 0.5 kg/cm^2

Ans. **(c)**

Sol.



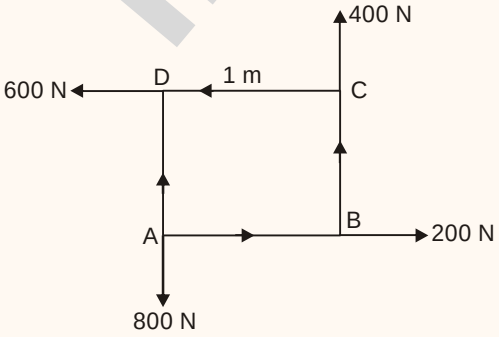
$$\sigma_A = 5\rho_w = 5 \times 1000\ kg/m^2$$

$$= 5000\ kg/m^2 = 0.5\ kg/cm^2$$

$$u_A = 5\rho_w = 0.5\ kg/cm^2$$

$$\bar{\sigma}_A = \sigma_A - \mu_A = 0$$

111. Four forces having magnitudes of 200 N, 400N, 600 N and 800 N, respectively acting along four sides (1 m each) of a square ABCD as shown in figure. Determine the magnitude and direction of the resultant force from 'A' along the ling 'AB'.



(a) $400\sqrt{3}$ N, 3.2m from A

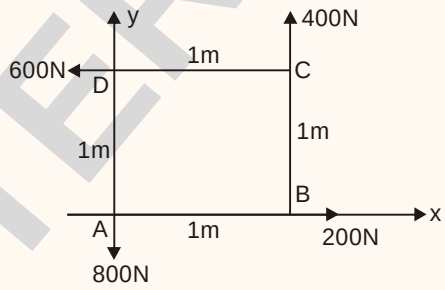
(b) $400\sqrt{2}$ N, 2.5 m from A

(c) $300\sqrt{2}$ N, 2 m from A

(d) $300\sqrt{3}$ N, 2.5 m from A

Ans. **(b)**

Sol.



Take A as origin for this system.

Coordinates of point A, B, C and D.

$800(-\hat{j})(0,0), 200\hat{i}(1,0), 400\hat{j}(1,1)$ and $600(\hat{i})(0,1)$ respectively.

Resultant $\vec{R} = R_x\hat{i} + R_y\hat{j}$

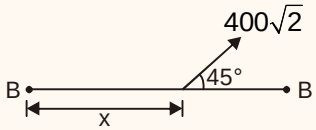
$$R_x = 200 + (-600) = -400\ N$$

$$R_y = -800 + 400 = -400\ N$$

$$\vec{R} = -400\ N\hat{i} - 400\ N\hat{j}$$

$$|\vec{R}| = \sqrt{400^2 + 400^2} = 400\sqrt{2}\ N$$

Let resultant is passing at distance x from A on line AB.



$\sum M_A$ = Moment about A due to resultant.

$$\Rightarrow -600 \times 1 - 400 \times 1 = -400\sqrt{2} \times \cos 45° \times x$$

$$\Rightarrow x = 2.5\ m$$

112. Group of the constituents of cement in decreasing order of their contribution to the strength of cement is

(a) C_3S, C_2S, C_3A and C_4AF

(b) C_2S, C_3S, C_3A and C_4AF

(c) C_2S, C_4AF, C_3A and C_3S

(d) C_3S, C_3A, C_2S and C_4AF

Ans. **(a)**

113. A bullet of mass 30 gm leaves the barrel of a gun with a velocity of 500 m/s. Suppose, the force lasted, for 0.0018 seconds, the average impulsive force is

(a) 533.33 N (b) 6333.33 N

(c) 7333.33 N (d) 8333.33 N

Ans. **(d)**

Sol.

$$F_{impuslive} = \frac{mv - mu}{t}$$

$$F_{impuslive} = \frac{30 \times 10^{-3} \times 500 - 0}{0.0018} = 8333.33N$$

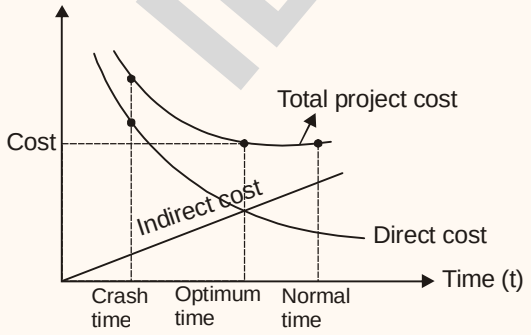
114. The time which results in the least possible construction cost of an activity is known as

(a) Normal time (b) Optimum time

(c) Crash time (d) Standard time

Ans. **(b)**

Sol.



The time at which construction cost for an activity shall be least at optimum time.

115. A particle undergoes a simple harmonic motion, the acceleration of the particle at a distance of 1.5 m from the centre of motion being 6 m/s^2, the time of oscillation in seconds is

(a) 2.00 (b) 4.00

(c) 3.14 (d) 6.28

Ans. **(c)**

Sol. For SHM :

$$|a_x| = |-w^2x|$$

$$\Rightarrow \quad w = \sqrt{\frac{6}{1.5}} = 2$$

$$T = \frac{2\pi}{w} = \pi = 3.14\,\text{sec}.$$

116. Which of the following constituent, present in excess quantity, changes the colour of the brick from red to yellow ?

(a) Alumina (b) Silica

(c) Lime stone (d) Iron Pyrite

Ans. **(c)**

117. The coefficient of friction is the ratio of

(a) Limiting friction force to the normal reaction

(b) Limiting friction force to the weight of body to be moved

(c) Sliding friction force to the normal reaction

(d) None of the above

Ans. **(a)**

Sol.

$$\text{Coefficient of friction} = \frac{\text{Limiting friction}}{\text{Normal reaction}}$$

118. Addition of fibres in concrete results in

(a) Modest increase in compressive strength

(b) Increase in ductility

(c) Enhanced toughness

(d) All of the above

Ans. **(d)**

119. The D'Alembert principle

(a) is a hypothetical principle

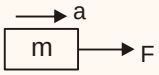
(b) provides no special advantage over Newton's law

(c) is based upon the existence of inertia force

(d) Allows a dynamical problem to be considered as a static problem

Ans. **(d)**

Sol.



$F = ma$ ...(i)

This equation may also be written as

$\boxed{F - ma = 0} \rightarrow D'$ Alembert principle ...(ii)

(i) Equation is equation of dynamics whereas

(ii) Equation is equation of statics.

120. A pozzolanic material must be composed mainly of

(a) Microscopic silica

(b) Microscopic and Amorphous silica

(c) Microscopic and Crystalline silica

(d) All of the above

Ans. **(b)**

121. Lame's equations are applicable for

(a) Thick cylinder

(b) Thin cylinder

(c) Thin spherical vessel

(d) Beams

Ans. **(a)**

122. Blow holes in concreting are result of

(a) Excess water-cement ratio

(b) Insufficient workability

(c) Improper design of shuttering

(d) None of the above

Ans. **(c)**

123. A cylindrical boiler 1.5 m diameter and made up of 10 mm thick plate is subjected to steam pressure of 2 N/mm^2. The hoop tension and longitudinal stresses will be

(a) 150 N/mm^2 and 75 N/mm^2

(b) 150 N/mm^2 and 150 N/mm^2

(c) 75 N/mm^2 and 75 N/mm^2

(d) 75 N/mm^2 and 150 N/mm^2

Ans. **(a)**

Sol. For cylindrical thin boiler,

$$\sigma_h = \frac{Pd}{2t} = \frac{2 \times 1.5 \times 1000}{2 \times 10}$$

$$= 150 N/mm^2$$

$$\sigma_l = \frac{Pd}{4t} = 75 N/mm^2$$

124. Probability distribution curve, fit well for PERT analysis, is

(a) Normal distribution curve

(b) Beta distribution curve

(c) Unimodal curve

(d) None of the above

Ans. **(b)**

125. In terms of bulk modulus (K) and modulus of rigidity (C), the Poisson's ratio can be expressed as

(a) $\frac{3K-4C}{6K+4C}$ (b) $\frac{3K+4C}{6K-4C}$

(c) $\frac{3K-2C}{6K+2C}$ (d) $\frac{3K+2C}{6K-2C}$

Ans. **(c)**

Sol.

$$E = 3K(1-2\mu)$$

and, $$E = 2G(1+\mu)$$

$$\Rightarrow 3K-6\mu K = 2G+2\mu G$$

$$\Rightarrow \mu(6K+2G) = 3K-2G$$

$$\Rightarrow \mu = \frac{3K-2G}{6K+2G}$$

where, $K \rightarrow$ Bulk modulus

$G \rightarrow$ Modulus of rigidity

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