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ESE- 2018 (Prelims) - Offline Test Series Test-5

CIVIL ENGINEERING

SUBJECT: DESIGN OF CONCRETE AND MASONRY STRUCTURES + BUILDING MATERIALS SOLUTIONS

01. Ans: (c)

Sol: (T) Pulling force = $\sigma_{st}.\frac{\pi}{4}.\phi^2$

Resisting force = $\tau_{bd}.\pi.\phi.L_d$

Equating R.F and P.F

$$\sigma_{st}.\frac{\pi}{4}.\phi^2 = \tau_{bd}.\pi.\phi L_d$$

$$T = \tau_{bd}\pi\phi L_d$$

Bond stress at failure

$$\tau_{bd} = \frac{T}{\pi.\phi.L_d} = \frac{55\times10^3}{\pi\times20\times300}$$

$$= 2.91\text{ N/mm}^2$$

Allowable bond stress

$$\tau_{bd} = \frac{2.91}{\text{Factor of safety}} = \frac{2.91}{4}$$

$$= 0.72\text{ N/mm}^2$$

02. Ans: (c)

Sol: $\left(\frac{3}{8}\right)A_{st_x} = 198$

$$A_{st_x} = 198\times\frac{4}{3}\times2$$

$$= 528\text{ mm}^2$$

03. Ans: (a)

Sol: (1) $x_u = \frac{0.87f_yA_{st}}{0.36f_{ck}b}$ (2) z= d-0.42x_u

04. Ans: (b)

Sol: M = 0.87 f_y A_{st} (d– 0.42 x_u)

In under reinforced concrete as moment of resistance decrease because of less reinforcement. Moment of resistance should be more (as it decreasing by area of steel) by increasing the depth that's why they are deeper.

05. Ans: (d)

Sol: (a) Minimum tension reinforcement as per IS456-2000

$$\frac{A_s}{bd} = \frac{0.85}{f_y}$$

(b) Maximum tension reinforcement 4% of gross area

06. Ans: (b)

Sol: Time period (T_a) = 0.1 N

Here, N = No. of storey

$T_a = 0.1 \times 10 = 1$ sec

07. Ans: (d)

Sol: In both balanced and over reinforced section, concrete will fail first in compression is called primary compression.

08. Ans: (d) **09. Ans: (a)** **10. Ans: (d)**

11. Ans: (b) **12. Ans: (a)**

13. Ans: (a)

Sol: $\pi/4 \times (12)^2 \rightarrow 144$ mm c/c

$\pi/4 \times (10)^2 \rightarrow x$

New spacing of 10 mm dia bars

$$x = \frac{144 \times 10^2}{12^2} = 100 \text{ mm c/c}$$

14. Ans: (b)

Sol: Deflection $= \frac{\text{Span}}{500} = \frac{4000}{500} = 8 > 7$

So, fails in deflection

Lateral stability:

25b = 25 × 150 = 3750 mm

$100\frac{b^2}{d} = 100 \times \frac{150^2}{d} = 4500$ mm

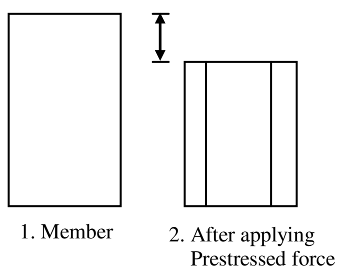
Lesser of two i.e. 3750 mm

So, beam fails in deflection also

Among the following options (b) is suitable

15. Ans: (a)

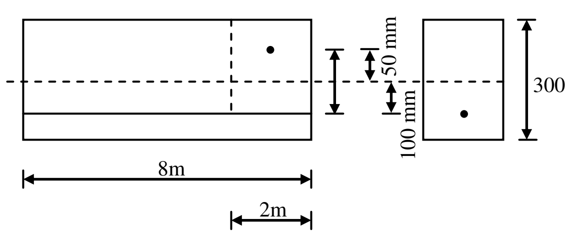
Sol:



16. Ans: (d)

17. Ans: (b)

Sol:



BM due to live load $= \frac{3w\ell^2}{32}$

$= \frac{3 \times 7 \times 8 \times 8}{32}$ = 42 kN-m

$e = \frac{M}{P} = \frac{42\,\text{kN.m}}{280\,\text{kN}} = 150\,\text{mm}$

(e – c) = 150 – 100 = 50 mm from CG

18. Ans: (c)

19. Ans: (b)

Sol: In LSM, spacing of reinforcement controls primarily cracking

Unequal top and bottom reinforcement in a RCC section leads to creep deflection

20. Ans: (a)

Sol: When bent up bars are provided, their contribution towards shear resistance shall not be taken more than half of total shear reinforcement. [IS456, clause 40.4]

21. Ans: (b) 22. Ans: (a)

23. Ans: (b)

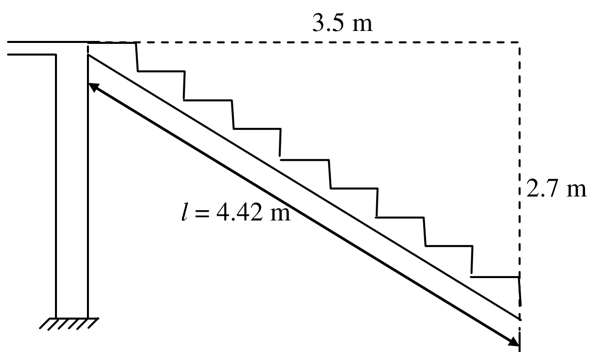
Sol: Design base shear (V_B) = A_h × w

= 0.10 × 6000

= 600 kN

24. Ans: (b)

Sol:



$$\text{No. of Risers} = \frac{2.7}{R} = \frac{2.7}{0.18} = 15 \text{ No's}$$

No. of tread = R – 1 = 15 – 1 = 14 No's.

Going length of staircase = 14 × 250

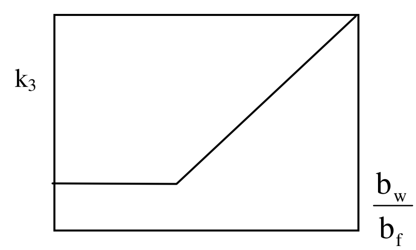
= 3.5 meters

25. Ans: (d)

26. Ans: (b)

27. Ans: (a)

Sol:



$$\uparrow \frac{b_w}{b_f} : \uparrow k_3 : \uparrow p : \text{Deflection} \downarrow$$

$$\downarrow \frac{1}{d} : k_1\, k_2\, k_3(p) \uparrow$$

$$\text{i.e } p \;\alpha \frac{1}{d}$$

28. Ans: (c)

Sol: Modulus of elasticity of concrete (E_c)

$$= 5000\sqrt{f_{ck}}$$

$$\therefore \quad E_c \propto \sqrt{f_{ck}}$$

Flexural strength of concrete,

$$f_{cr} = 0.7\sqrt{f_{ck}}$$

$$f_{cr} \propto \sqrt{f_{ck}}$$

29. Ans: (b)

Sol: As per limit state of collapse and IS 456-2000 depth of neutral axis for balanced section is

$x_u = kd$ (d = effective depth)

Value of 'k' for Fe250 is 0.53

for Fe415 is 0.48

for Fe500 is 0.46

∴ With increase in the grade of steel, depth of neutral axis decreases.

As per limit state of collapse for spans less than 10 m

$$\frac{\text{span}}{\text{effective depth}} = 20$$

(for simply supported)

Also modification factors are considered for tension and compression reinforcement.

30. Ans: (d)

31. Ans: (a)

Sol: For an isolated L beam, effective width of flange as per cl. 23.1.2 of IS 456 is minimum of

(a) $$b_f = \left(\frac{0.5\ell_o}{\left(\frac{\ell_o}{b}\right)+4}\right) + b_w$$

(b) Actual width of flange = 600 mm

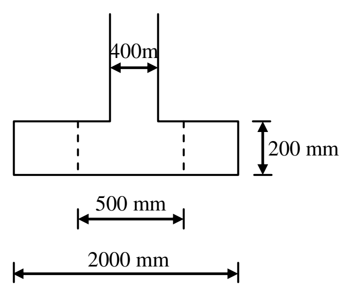
$$b_f = \left(\frac{0.5 \times 6000}{\left(\frac{6000}{600}+4\right)}\right) + 400$$

$$= 614.28 \text{ mm}$$

∴ Effective width of flange = 614.28 mm

32. Ans: (a)

Sol:



Critical case for design is bearing failure of soil. So, just before failure, pressure exerted by soil on footing = 400 kN/m^2

Punching shear should be checked at a distance $\frac{d}{2}$ from face of column $= \frac{200}{2} = 100$ mm

Punching force

$$= \frac{400}{1000}(2000^2 - 600^2)\text{N}$$

$$= 1.456 \times 10^6 \text{ N}$$

$$\text{Shear stress } = \frac{1.456\times10^6}{4\times600\times200}$$

$$= 3.03 \text{ N/mm}^2 \simeq 3\text{N/mm}^2$$

33. Ans: (b)

Sol: When the beam is subjected to torsional moment (T_u) and bending moment (M_u),the effective bending moment as per cl 41.4.2 of IS 456-2000 is

$$M_e = M_u + M_t$$

$$M_t = T_u\left(\frac{1+D/b}{1.7}\right)$$

$$M_t = 170\left(\frac{1+\frac{600}{300}}{1.7}\right)$$

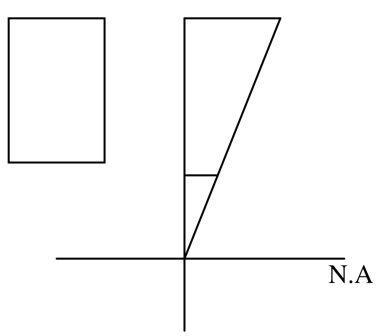
$$= 300 \text{ kN-m}$$

$\therefore$ Effective BM = 300 + 400 = 700 kN-m

34. Ans: (c)

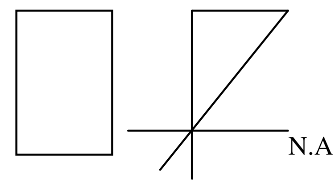
Sol:

From B to C



Entire column is compression N.A is out of the section

From A to B



Only some part of the column is in tension N.A is in inside the section

35. Ans: (b)

Sol: For beams with depth of web >750 mm, side reinforcement not less than 0.1% of web area is provided on both the sides of the web.

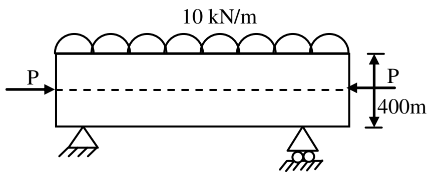
For a simply supported beam with UDL, sagging bending moment acts on the beam i.e. tension is at bottom of beam. so, main tension reinforcement is provided at bottom.

For a cantilever with UDL, hogging bending moment acts on the beam i.e. tension is at top of beam. so, main reinforcement is provided at top of the beam.

For a fixed beam, hogging bending moment occurs at support and sagging BM occurs at mid span. So, main reinforcement is provided at bottom at mid span and at top at ends.

36. Ans: (d)

Sol:



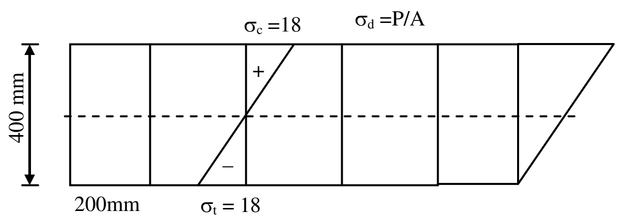
DL of beam = assuming unit weight of concrete is 25 kN/m^3

$$= 25 \times 0.4 \times 0.2 = 2 \text{ kN/m}$$

LL on beam = 10 kN/m

total = 12 kN/m

$$\text{Max BM} = \frac{w\ell^2}{8} = \frac{12 \times 4^2}{8} = 24 \text{ kN-m}$$



Max tensile stress at bottom

$$= \frac{M}{Z} = \frac{24 \times 10^6}{\frac{200 \times 400^2}{6}} = 4.5 \text{ MPa}$$

For no tension at bottom $\Rightarrow \frac{P}{A} = 4.5$

$\Rightarrow$ P = 4.5 × 200 × 400 N = 360 kN

37. Ans: (c)

Sol: Maximum longitudinal reinforcement for column is 6% of its cross-sectional as per CL.2.6.5.31 of IS456. and lateral reinforcement is provided to avoid buckling.

As per cl.26.5.1.1, maximum area of tension reinforcement for beam is 4% of its c/s area.

Lateral reinforcement is provided in beams to prevent the failure due to diagonal tension which causes shear cracks.

38. Ans: (d)

39. Ans: (b)

Sol: Boiling seasoning of timber is a quick process but, expensive.

Kiln seasoning is most preferred because rapid seasoning of timber on large scale reduces the strength of timber

40. Ans: (a)

Sol: $\frac{m}{v} = \rho$

$$\frac{50}{v} = 1440$$

$$\frac{50}{1440} = v$$

Volume of each bag = 0.0347 m^3

24 bags = 24 × 0.0347

= 0.8328m^3

= 832 liters

41. Ans: (d) **42. Ans: (c)** **43. Ans: (d)**

44. Ans: (b) **45. Ans: (c)**

46. Ans: (b)

Sol: The % void is 44% it means % of volume of solid is 56

Angular number = 67 – % of solid

= 67 – 56 = 11

47. Ans: (d) **48. Ans: (d)** **49. Ans: (b)**

50. Ans: (a)

51. Ans: (c)

Sol: $V_w = 0.65\ (35+27)$

$V_w = 52.55$ lit/m^3 of sand

52. Ans: (a)

Sol: At w/c ratio increases, the shrinkage of concrete increases

Shear slump and collapse slump in the slump test indicates segregation and bleeding of a concrete respectively.

53 Ans: (b)

Sol: For very high workability of concrete, flow table test is suggested.

54. Ans: (c)

55. Ans: (c)

Sol: Soft sand is ideal material for making mortar because very coarse sand does not adhere easily to the bricks during brick laying.

56. Ans: (b)

57. Ans: (b)

Sol: Gauge mortar ⇒ lime + cement + sand

58. Ans: (d) **59. Ans: (b)**

60. Ans: (b)

Sol:

- In charring preservative is not used
- The charred surface becomes black in appearance and hence it cannot be used for exterior work.
- Injecting preservative under pressure is most effective method.

61. Ans: (b)

62. Ans: (a)

Sol: The strength of brick masonry

$= 0.9\sqrt{10\times10} = 10 \times 0.9 = 9\ \text{N/mm}^2$

63. Ans: (a) **64. Ans: (c)** **65. Ans: (c)**

66. Ans: (c) **67. Ans: (a)** **68. Ans: (d)**

69. Ans: (b)

Sol: Max grade of steel is limited to Fe-415 to control the crack width of the section. The crack width of the section depends upon the grade of steel as well.

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70. Ans: (d)

Sol: As per IS456-2000, when nominal shear stress is less than design shear strength of concrete minimum shear reinforcement is provided such that

$$\frac{A_{sv}}{bS_v} \geq \frac{0.4}{0.87fy}$$

Design shear strength of concrete increases with increase in compressive strength for a constant percentage of longitudinal tension reinforcement.

71. Ans: (a)

Sol: Main assumption in design of RCC structure is tensile stresses are taken by steel and none by concrete.

i.e. concrete in tension zone is neglected i.e. tensile strength of concrete is ignored.

Note: For cracked section , tensile strength of concrete is considered.

For a 'T' beam, if neutral axis lies within the flange, it is equivalent to rectangular beam with width = width of flange since the area of concrete below neutral axis is ignored.

72. Ans: (d)

Sol: As per IS 456 cl.38.1, maximum strain in tension reinforcement in the section of failure shall not be less than $\frac{fy}{1.15E_s} + 0.002$ i.e. minimum value of strain for failure, maximum strain in concrete at outermost compression fibre in bending is 0.0035.

73. Ans: (d)

Sol: Development length is given by $L_d = \frac{\phi\sigma_{st}}{4\tau_{bd}}$

$$L_d \propto \sigma_{st}$$

∴ With increase in grade of steel, development length increases.

As per cl.26.2.1.1 permissible bond stress of HYSD based increased by 60% the value for mild steel bars.

74. Ans: (a) **75. Ans: (b)**