TEST ID: 507

ACE Engineering Academy

Head Office : Sree Sindhi Guru Sangat Sabha Association, # 4-1-1236/1/A, King Koti, Abids, Hyderabad – 500001.

Ph: 040-23234418, 040-23234419, 040-23234420, 040 - 24750437

Hyderabad | Delhi | Bhopal | Pune | Bhubaneswar | Lucknow | Patna | Bengaluru | Chennai | Vijayawada | Vizag | Tirupati | Kukatpally | Kolkata | Ahmedabad

ESE- 2019 (Prelims) - Offline Test Series Test- 13

CIVIL ENGINEERING

SUBJECT: SOLID MECHANICS, DESIGN OF CONCRETE AND MASONRY STRUCTURES AND CONSTRUCTION PRACTICE, PLANNING AND MANAGEMENT

01. Ans: (c)

Sol: Area of cross section = 200 × 600

= 120000 mm^2

Moment of inertia = 200 × 600^3/12

= 3600 × 10^6 mm^4

Stress in concrete at level of steel

$$= \frac{P}{A} + \frac{Pe \times e}{\ell}$$

$$= \frac{1200 \times 1000}{120000} + \frac{1200 \times 1000 \times 90 \times 90}{3600 \times 10^6}$$

= 12.7 MPa

Loss of stress due to creep = $\varepsilon_{cc}\, f_c\, Es$

= 40 × 10^{-6} × 12.7 × 2 × 10^5 = 101.6 MPa

02. Ans: (b)

Sol: In Hoyer system tension is applied by hydraulic jack

Freysinet system, Magnel system, Gifford Udall system based on wedge action

Lee Mc-call system is based on nut and bolt type of anchorage

In chemical prestressing, special type of cements i.e. expanding cements are used. The expansion of cement is restrained by high tensile steel, resulting in compressive stress in concrete and tensile stress in wires.

03. Ans: (c)

Sol: $\delta_{con} = \dfrac{PL^3}{48EI}$

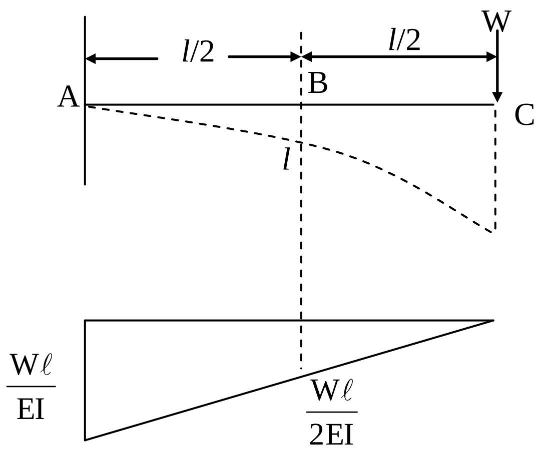
$$\delta_{udl} = \frac{5WL^4}{384EI} = \frac{5PL^3}{384EI}(P = WL)$$

$$\therefore \% \text{ Decrease in } \delta = \frac{\left(\frac{1}{48} - \frac{5}{384}\right)}{\left(\frac{1}{48}\right)} = 37.5\%$$

04. Ans: (b)

05. Ans: (d)

Sol:



$$\theta_B - \theta_A = \frac{1}{2}\left(\frac{\ell}{2}\right)\left(\frac{W\ell}{EI} + \frac{W\ell}{2EI}\right)$$

$$= \frac{3W\ell^2}{8EI}$$

∵ 'A' is fixed end

$\theta_A = 0$

$$\therefore \quad \theta_B = \frac{3W\ell^2}{8EI}$$

06. Ans: (b)

Sol:

- Response spectra shown the maximum response of a Single degree freedom oscillators subjected to specified earthquake ground motion (i.e. same damping) for different time periods/frequencies.
- Response can be displacement or velocity or acceleration. Hence The response spectra can be plotted with any of the three parameters (acceleration, velocity and displacement) as ordinate and time period as abscissa
- It depends on the soil condition, damping in the system , time period of the system, focal depth, richter magnitude etc.

07. Ans: (a)

Sol: Shear stress, $\tau = \frac{VA\bar{y}}{Ib}$

$$A\bar{y} = \left(\frac{bh}{2}\right)\left(\frac{h}{4}\right) = \frac{bh^2}{8}$$

$$\therefore \quad \tau = \frac{V.\left(\frac{bh^2}{8}\right)}{\left(\frac{bh^3}{12}\right)\times b} = \frac{3}{2}\left(\frac{V}{bh}\right)$$

$$\tau_{max} = \frac{3}{2}\times\frac{2000}{50\times 200}$$

$$= 30 \text{ kgf/cm}^2$$

08. Ans: (b)

Sol:

$$\bar{x} = \frac{\Sigma A_i \bar{x}_i}{\Sigma A_i} = \frac{140\times10\times70 + 60\times10\times30 + 60\times10\times110 + 50\times10\times55 + 50\times10\times85}{140\times10 + 60\times10\times2 + 50\times10\times2}$$

$$= \frac{98000 + 66000 + 18000 + 27500 + 42500}{1400 + 1200 + 1000}$$

$$= \frac{252000}{3600} = 70$$

$$\bar{y} = \frac{\sum A_i y_i}{\sum A_i} = \frac{140\times10\times5 + 60\times10\times15\times2 + 50\times10\times45\times2}{140\times10 + 60\times10\times2 + 50\times10\times2}$$

$$= \frac{7000 + 18000 + 45000}{1400 + 1200 + 1000}$$

$$= \frac{70,000}{3600}$$

= 19.44

Alternatively, since the section is symmetric about an axis parallel to y-axis and at 70 from y-axis $\bar{x} = 70$

From the option $\because \bar{y} \neq 35$; Sol:70, 19.4

09. Ans: (c)

Sol: Initial cost (P) = 1,50,000

Salvage value (SV) = 25000

Life period (n) = 10 years

$$D = \frac{P - SV}{n} = \frac{150000 - 25000}{10}$$

= 12500

BV_3 = P –4D

= 1,50,000 – 3(4 × 12500)

= 1,50,000 – 50,000

= 1,00,000/-

10. Ans: (c)

Sol: Initially, the long column is fixed at one end and free at other end

$\therefore l_e = 2l$

$$\therefore P_c = \frac{\pi^2 EI}{\ell_e^2} = \frac{\pi^2 EI}{4\ell^2}$$

$$\therefore \frac{\pi^2 EI}{4\ell^2} = 100 \quad (\because P_c = 100 \text{ kN})$$

$$\therefore \frac{\pi^2 EI}{\ell^2} = 400$$

Now a hinge is provided half way up the column and at the top of the column

For section BC

$$\ell_e = \frac{\ell}{2}$$

$$\therefore P_c = \frac{\pi^2 EI}{\ell_e^2} = \frac{\pi^2 EI}{(\ell/2)^2} = \frac{4\pi^2 EI}{\ell^2}$$

= 4 × 400 = 1600 kN

For section AB

$$\ell_e = \left(\frac{\ell}{2}\right)/\sqrt{2} = \frac{\ell}{2\sqrt{2}}$$

$$\therefore P_C = \frac{\pi^2 EI}{\ell_e^2} = \frac{\pi^2 EI}{(\ell/2\sqrt{2})^2} = \frac{8\pi^2 EI}{\ell^2}$$

= 8 × 400 = 3200 kN

$\therefore$ Critical load for new configuration

= 1600 kN

11. Ans: (b)

Sol: Given $A_o = 1\ cm^2$, $\delta L = 5.65$ mm

$P = 20$ kN

$\therefore$ Guage length, $L_o = 5.65\sqrt{A_o}$

$= 5.65\sqrt{10^2}$

$\therefore L_o = 56.5$ mm

Nominal strain, $\varepsilon = \frac{\delta L}{L_o} = \frac{5.65}{56.5} = 0.1$

$\therefore$ True stress $= \frac{P}{A} = \frac{P}{A_o} \times \frac{A_o}{A} = \frac{P}{A_o}(1+\varepsilon)$

$= \frac{20 \times 10^3}{10^{-4}}(1+0.1) = 200 \times 10^6\ (1.1)$

$= 220 \times 10^6 = 220$ MPa

12. Ans: (a)

Sol: The fundamental time period of a RC building with infill walls is given by

$T = \frac{0.09h}{\sqrt{d}}\,\text{sec}$

H = height of the building in m

$= 3.2 \times 3 = 9.6$m

d = base dimension of the building at plinth level along the direction of lateral force in m

Earthquake force is along X direction ;

$d = 4 \times 4 = 16$m

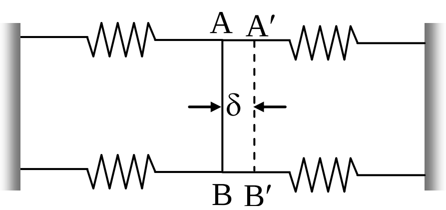
Hence time period, $T = \frac{0.09 \times 9.6}{\sqrt{16}}$

$= 0.216$ sec

13. Ans: (b)

14. Ans: (a)

Sol: In this configuration all the springs will share the load of 400 kN and will have equal deflection.



$400 = (100\,\delta + 100\,\delta + 100\,\delta + 100\,\delta) \times 10^{+3}$

$\Rightarrow \delta = 10^{-3}$ m = 1 mm

15. Ans: (a)

Sol: Torsion in the building may be due to Irregularities of mass, strength and stiffness. It also arises from eccentricity of the building layout i.e when the centre of mass does not coincide with centre of rigidity. The resultant lateral force acts through centre of mass. If there is torsion, the building rotates about centre of rigidity. Hence statement I is wrong.

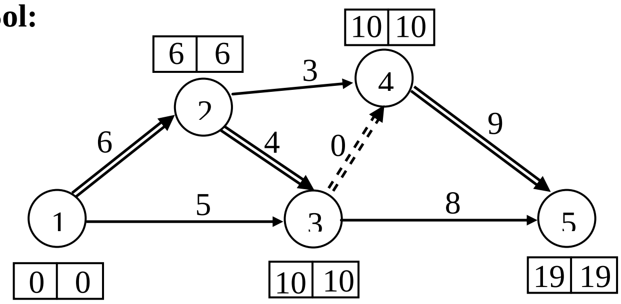
Symmetry in the building ensures that centre of mass coincides with centre of rigidity

Also, Twist in the building causes different portion on the same floor of the building to move by different amounts.

16. Ans: (d)

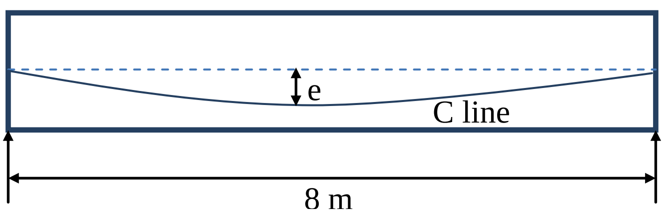
17. Ans: (c)

Sol:



18. Ans: (d)

Sol:



Eccentricity of tendons at centre,

e = 400/2 – 100 = 100 mm below centroid (location of C line)

Eccentricity at end section = 400/2 – 200

= 0 mm

Bending moment at midspan

$$= \frac{w\ell^2}{8} = \frac{6\times 8^2}{8} = 48 \text{ kNm}$$

Bending moment at end section=0

Shift of pressure line from C line at end section = M/P = 0

i.e P line is located at a distance of 200 mm from soffit i.e. at centroid at end section

Shift of pressure line from C line at midspan

= M/P = 48 × 1000/250 =192 mm

P line is located at 100 + 192 = 292 mm from soffit of the beam (i.e P line is located at a distance of 292 – 200 = 92 mm above centroid at midspan)

19. Ans: (b)

Sol: T = 1450 – 3 w

Where,

$$w = \frac{2\pi N}{60} = \frac{2\times\pi\times 1400}{60} = \frac{440}{3} \text{ rad/sec}$$

$$\therefore T = 1450 - 3 \times \frac{440}{3}$$

T = 1010 N-m

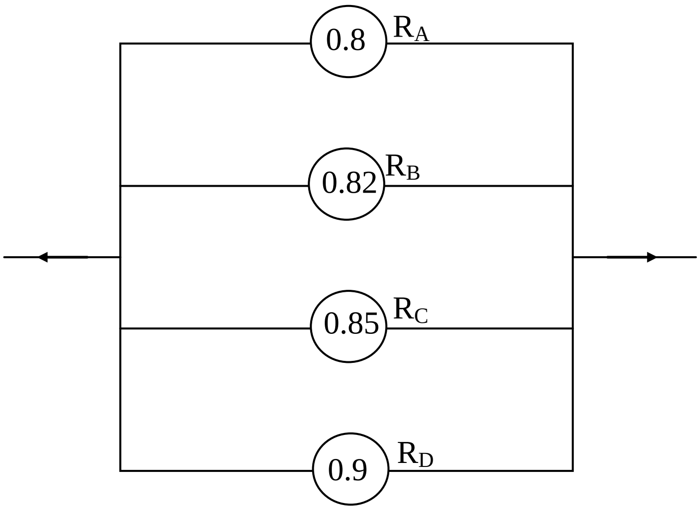
Power of the engine (P) = $\frac{2\pi NT}{60}(\text{watt})$

$$= \frac{2\times\pi\times 1400\times 1010}{60000}(\text{kW})$$

$$= \frac{2\times\frac{22}{7}\times 1400\times 1010}{60000} = 148.13 \text{ kW}$$

20. Ans: (d)

Sol:



Reliability of whole system (R)

$= 1 - (1 - R_A)(1 - R_B)(1 - R_C)(1 - R_D)$

$= 1 - (1 - 0.8)(1 - 0.82)(1 - 0.85)(1 - 0.9)$

$= 1 - (0.2)(0.18)(0.15)(0.1)$

$= 1 - 0.0054$

$= 0.9995$

21. Ans: (b)

Sol: Spalling stresses are produced behind the loaded area of anchor blocks resulting in breaking of concrete. Hence spalling reinforcement is placed behind anchorage zone. Bursting reinforcement resists lateral tensile forces

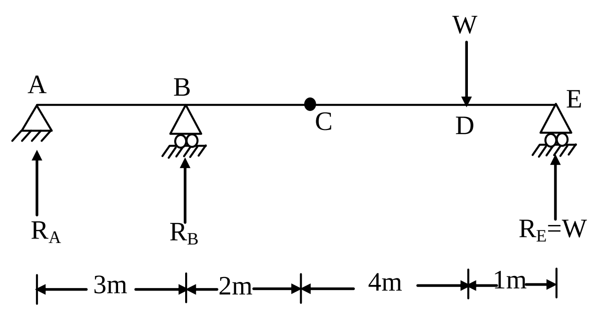
22. Ans: (a)

Sol: The bond length is the minimum length over which, the stress in the tendon can increase from the effective prestress to the ultimate prestress at the critical location.

The development length is the minimum length over which the stress in tendon can increase from zero to the ultimate prestress.

23. Ans: (a)

Sol: Consider whole beam



$\Sigma M_c = 0$

$R_E = \frac{4}{5}W$

Now considering moment about A

$\Sigma M_A = 0$

$3 \times R_B + \frac{4}{5} W \times 10 = W \times 9$

$R_B = \frac{W}{3}$


ACE
SUMMER
SHORT TERM BATCHES
GATE+PSUs - 2020
Admissions Open From 14th NOV 2018
HYDERABAD
29th April | 06th May | 11th May
18th May | 26th May | 02nd June 2019
DELHI
11th May | 23rd May 2019
EARLY BIRD OFFER :
Register on or Before 31st December 2018 : 5000/- Off | Register on or Before 31st March 2019 : 3000/- Off
Start Early.. Gain Surely...
SHORT TERM BATCHES

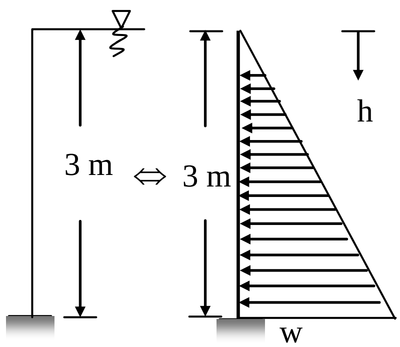

ACE
TEST YOUR PREP
IN A REAL TEST ENVIRONMENT
Pre GATE - 2019
Date of Exam : 20th January 2019
Last Date to Apply : 31st December 2018
Highlights :
* Get real-time experience of GATE-2019 test pattern and environment.
* Virtual calculator will be enabled.
* Post exam learning analytics and All India Rank will be provided.
* Post GATE guidance sessions by experts.

24. Ans: (c)

Sol: The above problem can be equated to a cantilever beam with uniformly varying load as shown in the figure, where w = ρ g H × width

$\therefore$ w = 1000 × 10 × 3 × 1 m

= 30 kN/m



$\therefore$ If 'h' is depth of water from the top then

intensity of load at h = $\frac{w \times h}{3}$

$\therefore$ Shear force at h = $\int_o^h \frac{wh}{3} dh = \frac{wh^2}{6}$

$\therefore$ Bending moment at h = $\int_o^h \frac{wh^2}{6} = \frac{wh^3}{18}$

At 1 m from the bottom h = 2 m

$\therefore\ SF_{h=2m} = \frac{30 \times 2^2}{6} = 20kN$

$BM_{h=2m} = \frac{30 \times 2^3}{18} = 13.33$ kN-m

25. Ans: (c)

Sol: Shear force at support B is equal to the reaction at B

$$R_B = \frac{W_1\ell}{2} + \frac{(W_2 - W_1)\ell}{2} \times \frac{2}{3}$$

$$= \frac{3W_1 + 2W_2 - 2W_1}{6}\ell = \frac{(W_1 + 2W_2)\ell}{6}$$

$$= \frac{W_1\ell}{6} + \frac{W_2\ell}{3}$$

26. Ans: (c)

Sol: Slenderness ratio of the wall is the minimum of

- effective length/effective thickness

  = 4/0.25 = 16

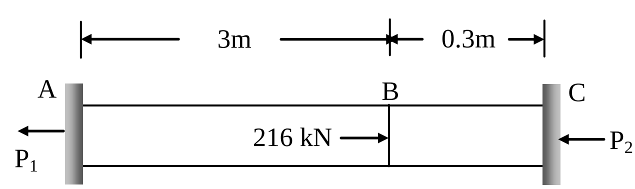
- effective height/effective thickness

  = 3/0.25 = 12

Slenderness ratio = 12

27. Ans: (c)

Sol: From equilibrium conditions



$P_1 + P_2 = 216$ kN $\rightarrow$ (1)

From compatibility

$\Delta L_{AB} = \Delta L_{BC}$

$$\frac{P_1(3)}{AE} = \frac{P_2(0.3)}{AE}$$

$P_1 = 0.1\ P_2 \qquad \rightarrow (2)$

From equation (1) and (2)

$P_1 + 10P_1 = 216$

$$P_1 = \frac{216}{11} = 19.64\,\text{kN}$$

$P_2 = 196.36$ kN

$$\sigma_1 = \frac{P_1}{\frac{\pi}{4}(0.05)^2} = \frac{19.64}{1.9625\times10^{-3}} = 10\text{ MPa}$$

$$\sigma_2 = \frac{P_2}{\frac{\pi}{4}(0.05)^2} = 100\,\text{MPa}$$

28. Ans: (d)

Sol: Riser R = 150 mm

Tread T = 300 mm

$\sqrt{R^2 + T^2} = \sqrt{150^2 + 300^2} = 335.41$ mm

Thickness of waist slab = 100 mm

Self weight of slab = 25 × 0.1 × 0.335

= 0.837 kN/m

Self weight of steps

= 25 × (0.5 × 0.15 × 0.3)

= 0.562 kN/m

Total weight = 0.837 + 0.562

= 1.399 kN/m

29. Ans: (b)

Sol: $W\left(h + \frac{\sigma_{max} L}{E}\right) = \frac{\sigma_{max}^2}{2E} \times AL$

$$h = \frac{20^2}{2\times25000} \times \frac{\pi}{4} \times \frac{300^2\times6000}{5000} - \frac{20\times6000}{25000}$$

h = 673.8 mm

30. Ans: (c)

Sol: Depth of water in tank = 5.3 – 0.3 = 5 m

Considering the bottom 1m height, pressure intensity corresponding to the centre of bottom 1m height of the wall

= p = 10(5 – 0.5) = 45 kN/m^2

Maximum hoop tension

= p D/2 = 45 × 12/2 = 270 kN

31. Ans: (c)

32. Ans: (a)

Sol: $\sigma_x = 70$ MPa, $\sigma_y = \tau_{xy} = 0$, $\theta = 60°$

$$\sigma_\theta = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$= \frac{70}{2} + \frac{70}{2}\cos 120° = 17.5\ \text{MPa}$$

$$\tau_\theta = \frac{\sigma_x - \sigma_y}{2}\sin 2\theta - \tau_{xy}\cos 2\theta$$

$$= \frac{70}{2}\sin 120° = 30.31\text{MPa}$$

33. Ans: (a)

Sol: The counterforts should be designed to resist the lateral (horizontal) force transmitted by the stem to it and is designed as a vertical cantilever fixed at its base. Since the stem acts integrally with the counterfort, the effective section resisting moment is a flanged section with flange under compression. Hence the counterforts are designed as T beams with the depth of the section varying linearly from top (free edge) to bottom (fixed edge).

34. Ans: (d)

Sol: $P = \frac{2\pi N T_{mean}}{60\times1000}$ kW

$$T_{mean} = \frac{100\times60\times1000}{2\pi\times900}$$

$T_{mean} = 10^4/(3\pi)$

Maximum torque, $T = 1.2\frac{10^4}{3\pi}$

$$= \frac{4\times10^3}{\pi} = 2210 \text{ N-m}$$

Substituting T_{max}

$$T_{max} = \frac{\tau J}{r} = \frac{\tau\frac{\pi R^4}{2}}{R}$$

$$R = \sqrt[3]{\frac{2T_{max}}{\pi\tau}} = \sqrt[3]{\frac{2\times4\times10^3}{\pi\times100\times10^6\times\pi}}$$

$R \simeq 20.14$ mm (Assuming $\pi^2 \simeq 10$, we get $R\simeq20$)

35. Ans: (c)

Sol: Thickness of the footing is based on shear, flexure, bond length and bearing stress criteria.

Providing smaller bars ensures the bond length required is less and also due to the smaller spacings the crack widths are also reduced.

Generally, shear considerations dominate in the design of the footing and the thickness of the footing is based on shear criteria. Hence shear reinforcement is generally avoided in footings.

Pedestals are provided in the footings to

- Transfer the load more uniformly to the footing
- Improved resistance to shear stresses and design moment
- Reduce the development length requirements.

Hence providing pedestals increases the depth of the footing and helps in achieving the development length criteria.

Pedestals are very short compression members and may be designed as columns while checking bearing and minimum reinforcement criteria.

36. Ans: (b)

Sol: For economic moment

Maximum Hogging moment = Maximum sagging moment.

37. Ans: (c)

Sol: Secant modulus: slope of the line any pint of stress strain curve to origin.

Tangent modulus: Slope of the tangent at any point of stress stain curve.

Initial Tangent modulus: Slope of stress stain curve at origin.

38. Ans: (b)

39. Ans: (a)

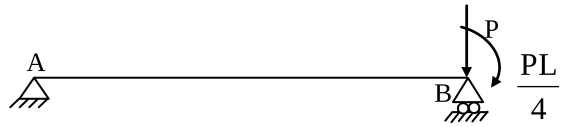
Sol: Torsion reinforcement to be provided at restraint corners

= 3/4 (reinforcement required at midspan)

= (3 × 400)/4 = 300 sqmm

40. Ans: (c)

Sol:



$$\text{Slope at } B = \theta_B = \frac{ML}{3EI} = \frac{\left(\frac{PL}{4}\right)L}{3EI} = \frac{PL^2}{12EI}$$

If there is no load on over hang then

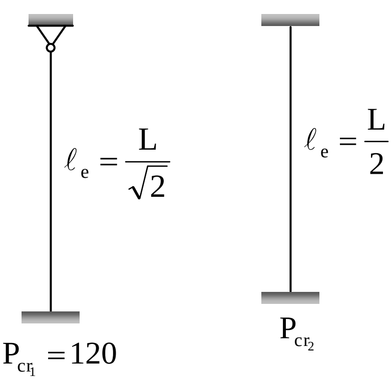
$$\text{deflection} = \frac{P\left(\frac{L}{4}\right)^3}{3EI}$$

$\therefore$ Deflection under load

$$= \frac{PL^2}{12EI} \times \frac{L}{4} + \frac{PL^3}{192EI} = \frac{5}{192}\frac{PL^3}{EI}$$

41. Ans: (c)

Sol:



$$P_{cr} \alpha \frac{1}{(\ell_e)^2}$$

$$\therefore \frac{P_{cr_1}}{P_{cr_2}} = \left(\frac{\ell_{e2}}{\ell_{e1}}\right)^2 \Rightarrow P_{cr_2} = 120\left(\frac{\frac{L}{\sqrt{2}}}{\frac{L}{2}}\right)^2$$

$$= 120\left(\sqrt{2}\right)^2$$

$$P_{cr_2} = 240\,kN$$

42. Ans: (c)

Sol: Durability of the concrete can be increased by reducing permeability which can be achieved by

- Providing adequate drainage
- Using low water cement ratio
- Using well graded, dense aggregates
- Using high grade of cement
- Using appropriate admixtures
- Maximum compaction
- Effective curing etc

43. Ans: (b)

Sol: For no tension condition

$$\frac{P}{A}-\frac{M.y}{I}\geq 0$$

$$\frac{P}{A}-\frac{P\,e\,y}{I}\geq 0$$

$$\text{or } e\leq\frac{I}{yA}$$

For bending about x-x axis

$$I=\frac{BD^3}{12}-\frac{bd^3}{12}$$

$$y=\frac{D}{2}$$

A = BD –bd

$$\therefore\ e_y\geq\frac{BD^3-bd^3}{6D(BD-bd)}$$

44. Ans: (a)

Sol: For balanced section

$0.36\ f_{ck}\ bx_{u,\ max} = 0.87f_y\ A_{st}$

For Fe 415 steel balanced depth of neutral axis = $x_{u,\ max}$ = 0.48d

$0.36\ f_{ck}\ b \times 0.48d = 0.87f_y\ A_{st}$

$$\frac{A_{st}}{bd}\times 100=\frac{0.36\times 0.48f_{ck}}{0.87f_y}\times 100$$

$$\frac{0.36\times 0.48\times 25}{0.87\times 415}\times 100 = 1.19\%$$

45. Ans: (c)

Sol: $$\tau_{max}=\frac{\sigma_1-\sigma_2}{2}$$

$$=\frac{-120-(-30)}{2}=-45\,\text{MPa}$$

$$\tau_{max}=\frac{\sigma_{yt}}{2}$$

$\therefore\ \sigma_{yt} = -45 \times 2 = \pm 90$ MPa

46. Ans: (a)

Sol: Critical depth of neutral axis for Fe 500 steel

= 0.46d = 0.46 × 500 = 230 mm

Actual depth of neutral axis:

$0.36\ f_{ck}\ bx_u = 0.87f_y\ A_{st}$

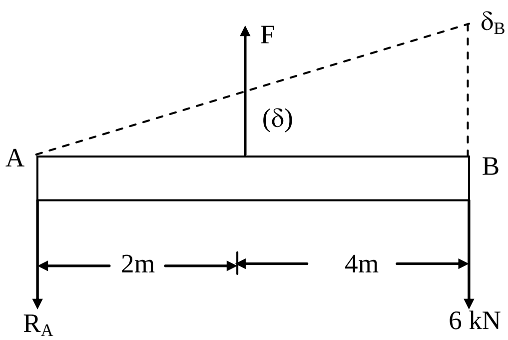
$0.36 \times 25 \times 300 \times x_{act} = 0.87 \times 500 \times 2000$

x_{actual} = 322.22 mm > critical depth

Hence the beam is over reinforced. The failure will be compression i.e. crushing of concrete.

47. Ans: (c)

Sol: The free body diagram of bar is



F is the force in the spring

Taking moment about A

$F \times 2 = 6\times6$

$F = 18$ kN

Deflection at spring, $\delta = \frac{18}{2} = 9\,\text{mm}$

$\therefore$ Deflection at B , $\frac{\delta_B}{6} = \frac{\delta}{2}$

$\Rightarrow \delta_B = 3\delta = 3\times9 = 27\text{mm}$

48. Ans: (c)

Sol: $\phi_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}$

ϕ_{xy} = shear strain in x-y plane

$\phi_{xy} = \left(7\times10^{-3}\right) + \left(-2\times10^{-3}\right)$

$= 5\times10^{-3}$

$\tau_{xy} = G \times \phi_{xy}$

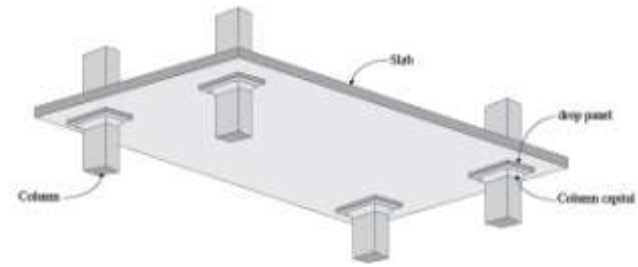
$= 100 \text{ GPa} \times 5\times 10^{-3}$

$= 100 \times 10^{3} \times 5\times 10^{-3}$

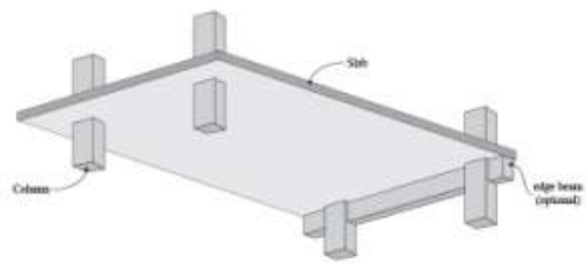
$= 500$ MPa

49. Ans: (c)

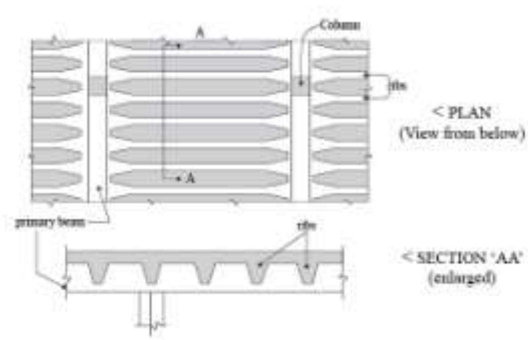
Sol: **Flat slab:** It is a type of slab supported directly on columns by means of stiffening arrangements like drop panels etc



Flat plate: It is type of slab supported directly on columns without any stiffening arrangements



Ribbed slab: It is a special type of grid floor, slab – beam system in which the slab is very thin, beams are very slender and are closely spaced.



50. Ans: (c)

Sol: P = 20 kW N = 200 rpm

$$T = \frac{P}{W} = \frac{20\times10^3}{\left(\frac{2\pi\times200}{60}\right)} = 954.92\,\text{Nm}$$

$$\tau = \frac{16T}{\pi d^3}$$

$$\tau = \frac{\text{Ultimate shear stress}}{(\text{FOS})}$$

$$\frac{360\times10^6}{8} = \frac{16\times954.92}{\pi\times d^3}$$

d = 47.63 mm

51. Ans: (d)

Sol: $$\sigma_\theta = \frac{\sigma_x+\sigma_y}{2} + \frac{\sigma_x+\sigma_y}{2}\cos2\theta + \tau_{xy}\sin2\theta$$

$$\tau_\theta = \frac{\sigma_x-\sigma_y}{2}\sin2\theta - \tau_{xy}\cos2\theta$$

For mm′ plane $\sigma_\theta = \sigma\cos2\theta$

$\tau_\theta = \sigma\sin2\theta$

$\therefore \sigma_R = \sigma$

For nn′ plane $\sigma_\theta = \sigma\cos[2(90+\theta)]$

$= -\sigma\cos2\theta$

$\tau_\theta = \sigma\sin[2(90+\theta)]$

$= -\sigma\sin2\theta$

$\therefore \sigma_R = \sigma$

52. Ans: (c)

Sol: Shear capacity due to concrete

$= V_{uc} = 0.5\times200\times400$

$= 40000$ N = 40 kN

Shear capacity due to stirrups V_{us}

$$V_{us} = \frac{0.87 f_y A_{sv} d}{s}$$

$$= \frac{0.87\times250\times\left(2\times\frac{\pi}{4}\times10^2\right)\times400}{200}$$

= 68329.64 N

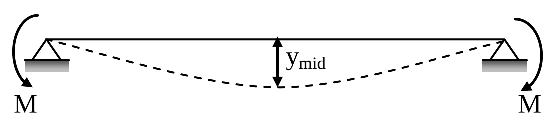
= 68.33 kN

Shear capacity of the section = 68.33 + 40

= 113.426 kN

53. Ans: (c)

Sol: This is a case of pure bending



$M = 100\times10^3\times200 = 2\times10^4$ kN mm

$$(y_{max})_{\text{at mid point}} = \frac{ML^2}{8EI}$$

$$= \frac{2\times10^4\times1500^2}{8\times30\times10^8} = \frac{75}{40}$$

= 1.875 mm

54. Ans: (b)

Sol: Under pure axial conditions the ultimate load carrying capacity of the column is

$$P_{uo} = 0.447 f_{ck}(A_g - A_{sc}) + f_{sc}A_{sc} \ldots\ldots(1)$$

Where $f_{sc} = 0.87\ f_y$ for Fe 250

Under minimum eccentricity conditions the ultimate load carrying capacity of the column is approximately 10% less than the above case i.e

$$P_{uo} = 0.9(0.44 f_{ck}(A_g - A_{sc}) + 0.87 f_y A_{sc})$$

$$P_{uo} = 0.4 f_{ck}(A_g - A_{sc}) + 0.67 f_y A_{sc} \ldots\ldots(2)$$

Hence the ratio is always 0.9 and calculation is not required.

Note:

$f_{sc} = 0.79\ f_y$ for Fe 415

$f_{sc} = 0.746 f_y$ for Fe 500

To be on conservative side , eq 2 is the generalised equation for all grades of steel.

55. Ans: (a)

Sol: $R_A + R_B = 2W$

$\sum M_A = 0$

$$R_B \times a = W\left(\frac{L}{2}\right) + W(L)$$

$$R_B = \frac{3WL}{2a}$$

$$R_A = 2W - \frac{3WL}{2a}$$

For maximum bending moment for the beam to be as small as possible.

$$W(L-a) = \left(2W - \frac{3WL}{2a}\right)\left(\frac{L}{2}\right)$$

$4aL + 4a^2 = 4aL + 3L^2$

$$a = \frac{\sqrt{3}}{2}L$$

56. Ans: (d)

Sol: Bond in the reinforced concrete refers to the adhesion between steel and surrounding concrete. Hence bond is responsible for transfer of axial force from reinforcing bar to surrounding concrete. This ensures strain compatibility and composite action of steel and concrete. The assumption plane section remains plane before and after bending is satisfied because of this.

Further, the axial stress in steel bars (tensile or compressive) is varied from point to point sue to bond resistance. This accommodates the variation in bending moment along the length. If bond is not present stress would be same at all the points as a string.

Bond resistance can be increased by increasing cover around the bars, using deformed bars, using higher grade of concrete et..

57. Ans: (c)

Sol: According to Maxwell's Reciprocal Theorem

$$W_A \times y_{AB} = W_B \times y_{BA}$$

$$8\text{ kN} \times 2\text{ mm} = 4\text{ kN} \times y$$

$$y = 4\text{ mm}$$

58. Ans: (c)

Sol: Lap splicing is the overlapping of the bars over a certain length in order to transfer the axial force from terminating bar to connecting bar. It is permitted for bars less than 36 mm in diameter. For bars > 36 mm, welded splices are recommended.

59. Ans: (c)

Sol: General equation of ε_θ

$$\varepsilon_\theta = \left(\frac{\varepsilon_x + \varepsilon_y}{2}\right) + \left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)\cos 2\theta + \frac{\gamma_{xy}}{2}\sin 2\theta$$

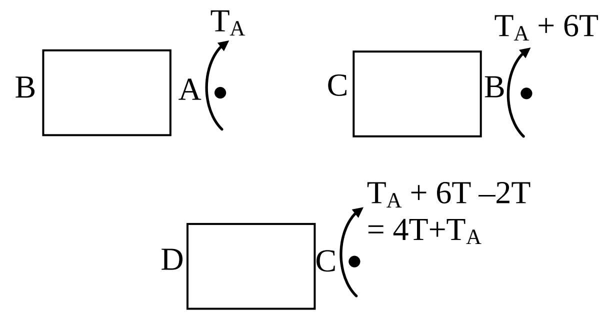
$$\varepsilon_{60^\circ} = \left(\frac{\varepsilon_x + \varepsilon_y}{2}\right) + \left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)\left(\frac{-1}{2}\right) + \frac{\gamma_{xy}}{2}\left(\frac{\sqrt{3}}{2}\right)$$

$$= \frac{\varepsilon_x}{4} + \frac{3\varepsilon_y}{4} + \frac{\sqrt{3}}{2}\left(\frac{\gamma_{xy}}{2}\right)$$

$$= \frac{1}{4}\left(\varepsilon_x + 3\varepsilon_y + \sqrt{3}\gamma_{xy}\right)$$

60. Ans: (d)

Sol:



Now,

$$\theta_{AD} = \theta_{AB} + \theta_{BC} + \theta_{CD}$$

$$0 = \frac{T_A\left(\frac{L}{2}\right)}{GJ} + \frac{(T_A + 6T)L}{GJ} + \frac{(T_A + 4T)\left(\frac{L}{2}\right)}{GJ}$$

$$0 = \frac{2T_A + 8TL}{GJ}$$

$$\Rightarrow T_A = -4T$$

Now,

$$\theta_{CD} = \frac{(T_A + 4T)\left(\frac{L}{2}\right)}{GJ}$$

$$\theta_C - \cancel{\theta_D}^{\,0} = \frac{(T_A + 4T)L}{2GJ}$$

$$\theta_C = 0$$

61. Ans: (c)

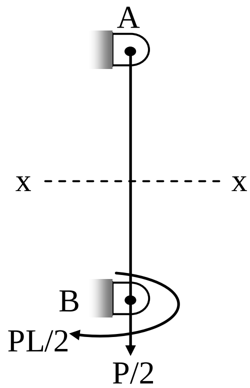
Sol: `Deflection at C,

$$\Delta_C = \frac{\partial U}{\partial P} = \frac{\partial U_{AB}}{\partial P} + \frac{\partial U_{BC}}{\partial P}$$

$$= \frac{1}{EI}\int M_{x_{AB}} \frac{\partial M_{x_{AB}}}{\partial P}dx + \frac{1}{EI}\int M_{x_{BC}} \frac{\partial M_{x_{BC}}}{\partial P}dx$$

$$M_{x_{BC}} = \frac{-P}{2}x$$

$$\frac{\partial M_{x_{BC}}}{\partial P} = \frac{-x}{2}$$



$\Sigma F_H = 0$

$R_A + R_B = 0$

$\Sigma M_A = 0$

$$R_B \times L - \frac{PL}{2} = 0$$

$$R_B = \frac{P}{2}$$

$$R_A = \frac{-P}{2}$$

$$M_{x_{AB}} = R_A x = \frac{-P}{2}x$$

$$\frac{\partial M_{x_{AB}}}{\partial P} = -\frac{x}{2}$$

$$\Delta_C = \frac{1}{EI}\int_o^L\left(\frac{-P}{2}x\right)\left(\frac{-x}{2}\right)dx + \frac{1}{EI}\int_o^L\left(\frac{-Px}{2}\right)\left(\frac{-x}{2}\right)dx$$

$$= \frac{2}{EI}\int_o^L \frac{Px^2}{4}dx$$

$$= \frac{P}{2EI}\times\int_o^L x^2 dx = \frac{P}{2EI}\left[\frac{x^3}{3}\right]_o^L = \frac{PL^3}{6EI}$$

62. Ans: (d)

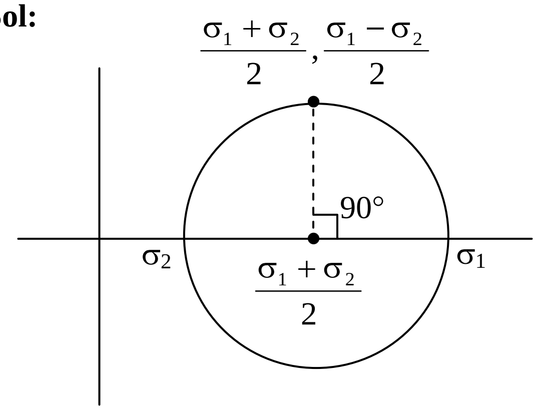
Sol:

- When principal stress on two perpendicular plane becomes equal then Mohr's circle will be a point circle i.e., touches only at one point. So statement (1) is incorrect.

  Mohr's circle is always symmetrical about normal stress axis. So statement (3) is incorrect

63. Ans: (b)

Sol:



If $\theta = 45°$, in mohr circle angle will be 90°

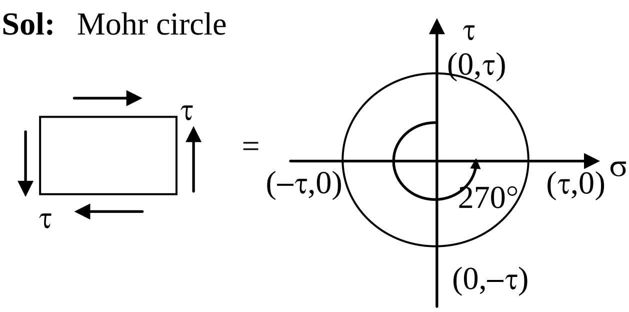
Normal stress on AB = $\frac{\sigma_1 + \sigma_2}{2}$

Shear stress on AB $= \frac{\sigma_1 - \sigma_2}{2}$

$\therefore$ Resultant stress = $\sqrt{\left(\frac{\sigma_1+\sigma_2}{2}\right)^2 + \left(\frac{\sigma_1+\sigma_2}{2}\right)^2}$

64. Ans: (c)

Sol: Mohr circle



Plane inclined @135° ≡ 270°in Mohr circle

∴ Stress induced are $(\tau,0)$

$\therefore \sigma_n = +\tau$

$\tau_{tangential} = 0$

65. Ans: (d)

Sol: If Z is more ⇒ more economical

$Z_{square} > Z_{circle}$

Square is more economical than circle.So, statement(2) is incorrect.

66. Ans: (a)

Sol: Stress concept: Ordinary concrete when subjected only to compressive stresses behaves as perfectly elastic material since there are no tensile cracks. But when it is subjected to flexural stress, due to the presence of tension, it no longer remains elastic.

In prestressed concrete, concrete is initially subjected to compression and later to flexural stresses. The tensile stresses caused due to external load are balanced by compressive stresses and the final stress in the extreme fibre is compressive. Hence there are no tension cracks in concrete and it is thus transformed from brittle material to ductile material.

67. Ans: (a)

Sol: As per code minimum thickness of 150 mm is provided for footing s in general (and 300 mm in pile caps). This is done so that the footing has sufficient rigidity and provides the calculated bearing pressures. This requirement is based on the dispersion of internal pressure in the footing.

68. Ans: (d)

Sol: When the applied moment is less than cracking moment, the section remains uncracked and the second moment of area corresponds to gross transformed section

When the applied moment exceeds cracking moment, the section gets cracked and concrete in the tension zone is neglected theoretically . Hence second moment of area corresponds to cracked transformed section.

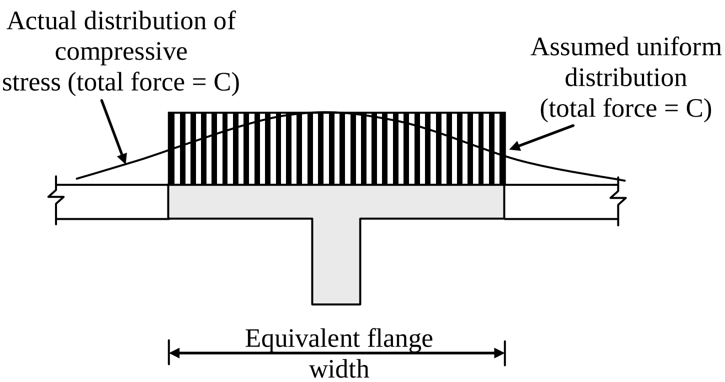
As the second moment of area (I) of gross transformed section is more than cracked transformed section, flexural rigidity (EI) for uncracked section is more than cracked section.

(**Note:** In practise, it was observed that concrete between the cracks resists tension and this causes and increase in the stiffness over the "cracked section stiffness". This is called tension stiffening effect.

Flexural rigidity is the slope of moment (M) –curvature(1/R) relation.

69. Ans: (c)

Sol: In wide flanges 'f', 'T' or 'L' beam, flexural compressive stress is not uniform. It is maximum at the web and decreases at the points away from the web. According to theory of flexure, distribution of stress must be uniform. Hence a hypothetical term called effective width is used whose width is less than actual width such that the compressive stress of uniform magnitude in effective width equals to the peak stress in original wide flange.



70. Ans: (b)

Sol: In Earthquake resistant design, it is preferred to have continuous and monolithic structures as the earthquake resistance depends on the capacity to absorb excessive energy input, mainly by plastic deformation of the members. Hence continuous members being redundant ensures the formation of more plastic hinges and more paths are available for load re-distribution, thus increasing the energy absorption.

71. Ans: (a)

Sol: For same rpm

$P \propto T$

For same material $T \propto Z_p$

$\because$ C/S area is same

$$\frac{\pi}{4}D_s^2 = \frac{\pi}{4}\left(D_h^2 - d_h^2\right)$$

$$\Rightarrow D_s^2 = D_h^2 - d_h^2$$

$$\therefore \frac{Z_p^s}{Z_p^h} = \frac{\frac{\pi}{16}D_s^3}{\frac{\pi}{16}D_h^3\left[1-\left(\frac{d_h}{D_h}\right)^4\right]} = \frac{D_h\sqrt{D_h^2 - d_h^2}}{D_h^2 + d_h^2}$$

$$= \frac{\sqrt{1-\left(\frac{d_h}{D_h}\right)^2}}{1+\left(\frac{d_h}{D_h}\right)^2}$$

$\because \frac{d_h}{D_h}$ varies from 0 to 1

$\frac{Z_p^s}{Z_p^h}$ varies from 1 to 0

$$\therefore \frac{Z_P^S}{Z_P^h} < 1 \Rightarrow Z_p^s < Z_p^h$$

$$\therefore T^s < T^h$$

$\therefore P^s < P^h$

$\therefore$ Statement I is true and statement II is the correct reason for statement I

72. Ans: (d)

Sol: For a material to have same lateral strains at energy point in a particular component, it has to be both homogeneous and isotropic.

$\therefore$ Statement (1) is false

As homogenous materials have elastic properties same at every point but only in one direction, statement (2) is true.

73. Ans: (c)

Sol: W = intensity of load; V = shear force;

M = bending moment

$$W = \frac{dV}{dx} = \frac{d^2M}{dx^2}, V = \frac{dM}{dx}$$

$\because V = \frac{dM}{dx}$, shear force curve will always be one degree lower than bending moment curve.

$V = \frac{dM}{dx} \Rightarrow$ Shear force is rate of change of Bending moment

$\therefore$ Statement (1) is true and statement (2) is false

74. Ans: (b)

75. Ans: (d)

Sol: Location of plane with maximum shear stress θ_s

Location of plane with principal stress θ_p

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

$$\tan 2\theta_s = \frac{-(\sigma_x - \sigma_y)}{2\tau_{xy}}$$

$\therefore \tan 2\theta_p \times \tan 2\theta_s = -1$

$\Rightarrow 2\theta_s = 2\theta_p + 90° \Rightarrow \theta_s = \theta_p + 45°$

$\therefore$ Statement (1) is false

On maximum shear stress plane normal stress is $\sigma_{\theta_s} = \frac{\sigma_x + \sigma_y}{2}$

$\therefore$ Statement (2) is true


ACE ENGINEERING ACADEMY
Since 1995
ACE
Engineering Academy
Leading Institute for ESE/GATE/PSUs
23
Years of Excellence
CONGRATULATIONS TO OUR
ESE - 2018 TOP RANKERS
AIR 1 SHASHANK E&T
AIR 1 CHIRAG JHA EE
AIR 1 VINAY PRAKASH CE
AIR 1 AMAN JAIN ME
AIR 2 CHERUKURI SAIDEEP E&T
AIR 2 SHADAB AHAMAD EE
AIR 2 PUNIT SINGH CE
AIR 2 CHIRAG SINGLA ME
AIR 3 RAMESH KAMULLA E&T
AIR 3 SRIJAN VARMA EE
AIR 3 PRAVEEN KUMAR CE
AIR 3 MAYUR PATIL ME
AIR 4 JAPJIT SINGH E&T
AIR 4 ANKIT GARG EE
AIR 4 AMIT KUMAR ME
AIR 5 NARENDRA KUMAR E&T
AIR 5 KARTHIK KOTTURU EE
AIR 5 RISHABH DUTT CE
AIR 5 VITTHAL PANDEY ME
AIR 6 KUMUD JINDAL E&T
AIR 6 RATIPALLI NAGESWAR EE
AIR 7 KARTIKEYA DUTTA E&T
AIR 7 TEKCHAND DESHWAL EE
AIR 7 ROHIT KUMAR CE
AIR 8 SURYASH GAUTAM E&T
AIR 8 RAVI TEJA MANNE EE
AIR 8 VIJAYA NANDAN CE
AIR 8 ROHIT BANSAL ME
AIR 9 SHANAVAS CP E&T
AIR 9 SOUVIK DEB ROY EE
AIR 9 ROOPESH MITTAL CE
AIR 10 PRATHAMESH E&T
AIR 10 MILAN KRISHNA EE
AIR 10 SRICHAND POONIYA CE
TOTAL SELECTIONS in Top 10 34
E&T TOP 10 10
EE TOP 10 10
CE TOP 10 8
ME TOP 10 6
and many more...
www.aceenggacademy.com