TEST ID: 506

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

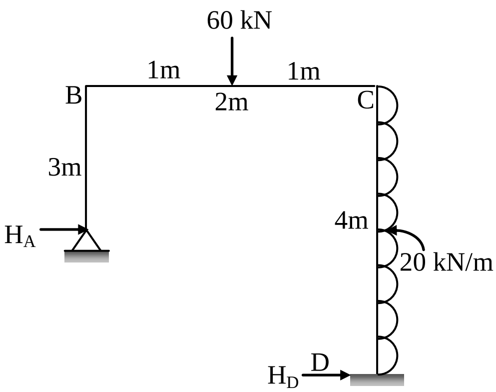
ESE- 2019 (Prelims) - Offline Test Series Test- 11

CIVIL ENGINEERING

SUBJECT: STRUCTURAL ANALYSIS & DESIGN OF STEEL STRUCTURE

01. Ans: (a)

Sol:



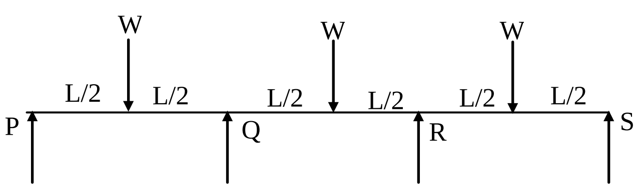
$\sum H = 0$

$H_A + H_D = 20 \times 4$

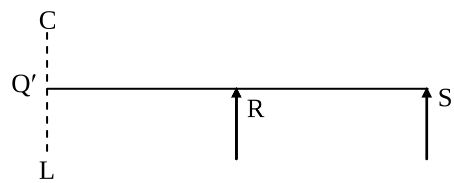
$H_A + H_D = 80$ kN

02. Ans: (b)

Sol:



Using short cut method of moment distribution.



Fixed ends moments:-

$$M_{FRQ} = +\frac{wL}{8}$$

$$M_{FRS} = -\frac{wL}{8}$$

$$M_{FSR} = +\frac{wL}{8}$$

Joint	Member	K	$\sum K$	$DF = \frac{K}{\Sigma K}$
R	RQ′	$\frac{1}{2} \times \frac{I}{L}$	$\frac{I}{2L} + \frac{3I}{4L}$	$\frac{\frac{I}{2L}}{\frac{5I}{4L}} = \frac{2}{5}$
	RS	$\frac{3}{4} \times \frac{I}{L}$	$\frac{5I}{4L}$	$\frac{3}{5}$

	Q′	R		S
		$\frac{2}{5}$	$\frac{3}{5}$	
FEM		$\frac{wL}{8}$	$\frac{-wL}{8}$	$\frac{wL}{8}$
Release at ‘s’ & carry over			$\frac{-wL}{16}$ ←	$\frac{-wL}{8}$
Initial moment Balance		$\frac{wL}{8}$ $\frac{wL}{40}$	$\frac{-3wL}{16}$ $\frac{3wL}{80}$	
Carry over	0			0
Final moments		$\frac{3wL}{20}$	$\frac{-3wL}{20}$	

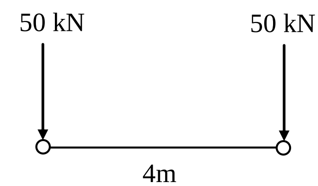
03. Ans: (c)

Sol: The most critical failure of web is due to shear yielding of web.

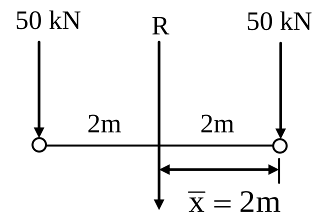
- For preventing web buckling due to bending compressive stress, horizontal stiffeners may be provided.
- For preventing web buckling due to shear stress, vertical stiffeners may be provided
- For preventing web buckling (or crippling) bearing stiffeners may be provided.

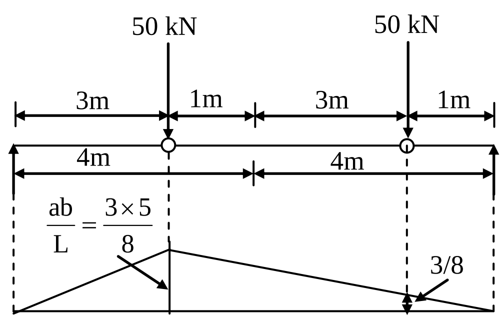
04. Ans: (c)

Sol:



$$\bar{x} = \frac{50\times0+50\times4}{50+50} = 2\,m$$





Absolute max Bending moment

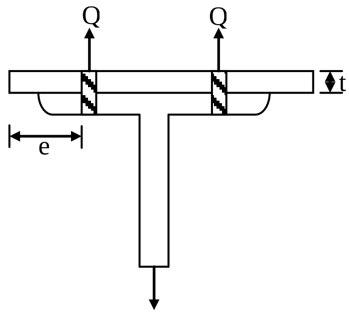
$$= 50\times\frac{15}{8}+50\times\frac{3}{8} = 112.5 \text{ kN-m}$$

05. Ans: (d)

Sol: The connections where bolts are required to transfer load by direct tension, an additional force is developed in bolts due to thin jointed plates.

Prying forces is negligible if plates to be jointed are thick and stiff.

Prying force



$$\dot{Q} = \frac{\ell_v}{2\ell_e}\left[T_e - \frac{\beta\eta f_0 b_e t^4}{27\ell_e \ell_v^2}\right]$$

$\ell_e \rightarrow$ distance between bolt centre to toe of fillet

$\ell_v \rightarrow$ distance prying force & bolt centering

$$= 1.1t\sqrt{\beta\frac{f_o}{f_y}}$$

$\beta = 1$ (for pre tensioned)

$\eta = 1.5$

b_e = effective width of flange

f_o = proof stress $\ngtr 0.7\, f_{ub}$

t = thickness of end plate

Q may be reduced by

- increasing 't'
- increasing 'e'.

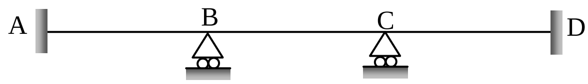
06. Ans: (c)

07. Ans: (a)

08. Ans: (b)

09. Ans: (c)

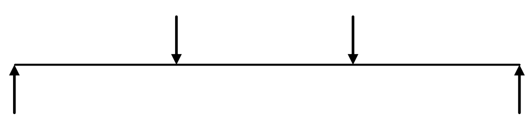
Sol:



Size of stiffness matrix = $D_K = 2\ (\theta_B \& \ \theta_C)$

10. Ans: (b)

Sol:

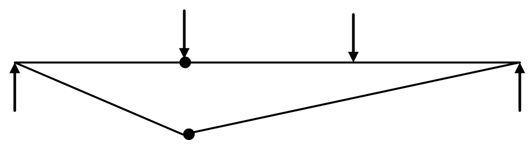


$D_s = D_{se} = r – s = 2–2 = 0$

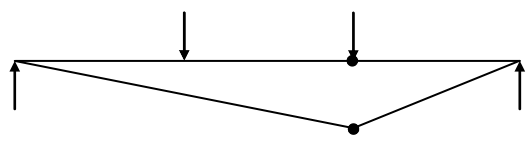
Number of plastic hinges required to form a mechanism

$n = D_s + 1$

$n = 1$



Mechanism-I



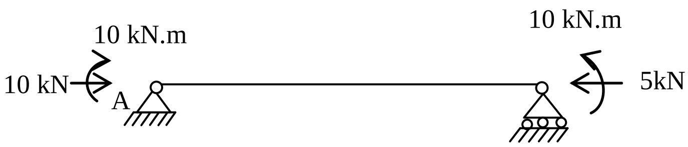
Mechanism-II

11. Ans: (b)

Sol: Net B.M = 0

Net S.F = 0

$\therefore$ The beam shown is subjected to axial Thrust only.



12. Ans: (c)

Sol: Maximum pitch for tension members is limited to (16 t or 200mm) whichever is less

Maximum pitch for compression members is limited to (12t or 200mm) whichever is less

13. Ans: (c)

14. Ans: (d)

15. Ans: (c)

Sol: Long bolted joints may fail due to stress concentration at end bolts

16. Ans: (d)

17. Ans: (c)

Sol: Crane capacity + trolley + hook [W_{CR}]

$= 200 + 40$

$= 240$ kN

Weight of crane girder [W_t] = 200 kN

Weight of crane girder [L_t] = 16 m

Minimum hook clearance (a) = 1.2 m

Maximum wheel load will be developed when hook is at minimum hook clearance

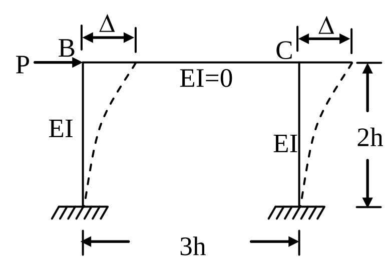
Maximum static wheel load

$$= \frac{1}{2}\left[\frac{W_{CR}(L_t - a)}{L_t} + \frac{W_t}{2}\right] = \frac{1}{2}\left[\frac{240(16-1.2)}{16} + \frac{200}{2}\right]$$

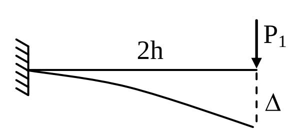
$= 161$ kN

18. Ans: (c)

Sol:



Point B and C will act as hinges



$$\Delta = \frac{P_1 L^3}{3EI} = \frac{P_1 (2h)^3}{3EI} = \frac{8P_1 h^3}{3EI}$$

$$\therefore\ P_1 = \frac{3EI\Delta}{8h^3}$$

Considering equilibrium of the structure

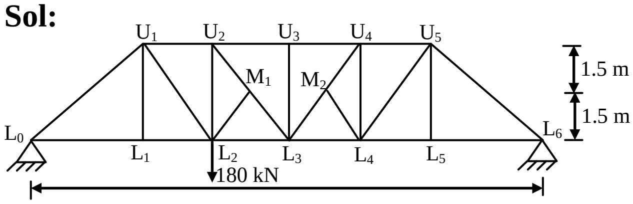
$$2P_1 = P \Rightarrow \frac{6EI\Delta}{8h^3} = P$$

$$\therefore \Delta = \frac{8Ph^3}{6EI} = \frac{4}{3}\frac{Ph^3}{EI}$$

19. Ans: (d)

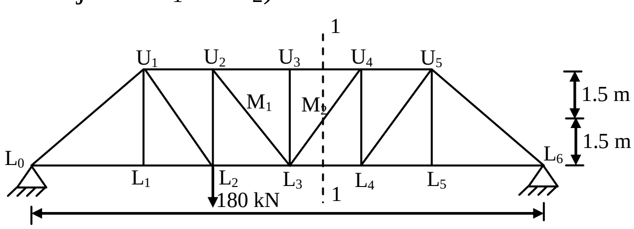
20. Ans: (a)

Sol:



$M_1L_2 = M_2L_4 = 0$

(∵ Other two members are linear with no force at joint M_1 & M_2)



$R_{L1} + R_{L6} = 180$

$R_{L6}\ 24 = 180 \times 8$

$R_{L6} = 60$ kN

Pass a section (1) = (1) as shown

$$\sum V = 0$$

$$P_{L3U4} \times \sin\theta = 60$$

$$P_{L3U4} = \frac{60}{\sin\theta}$$

$$= \frac{60}{\frac{3}{5}}$$

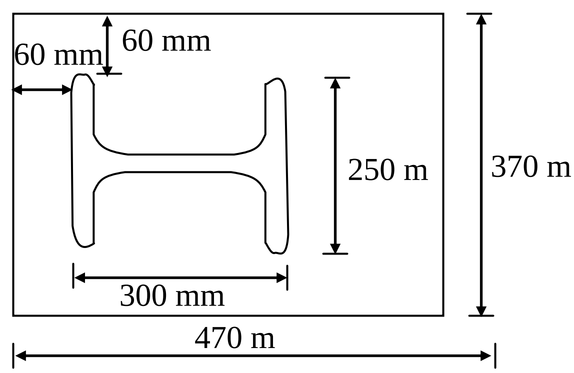
$P_{M2U4} = P_{L3U4} = 100$ kN (tension)

21. Ans: (b)

Sol: Area of base plate (A) = 470 × 370 mm^2

Factored load (P) = 1500 kN

$\Rightarrow$ Concrete pressure (w) = $\frac{P}{A}$ = 8.62 N/mm^2



From Figure: a = b = 60 mm

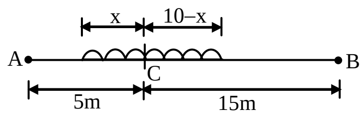
As per IS 800 : 2007;

$$t_p = \sqrt{\frac{2.5w(a^2 - 0.3b^2)}{\frac{f_y}{\gamma_{m_o}}}}$$

$= 15.9$ mm $\simeq 16$ mm

22. Ans: (b)

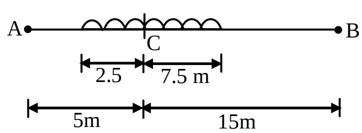
Sol:



Max. B.M at C occurs when avg. load on AC = avg load on BC

$\therefore \quad \frac{x}{5} = \frac{10 - x}{15}$

$3x = 10 - x \Rightarrow x = 2.5$ m



Centroid of total load from A = 2.5 + 5 = 7.5

$\therefore$ Distance b/w C.G of total load & mid span = 10 – 7.5 = 2.5

23. Ans: (d)

Sol: $U = \int_0^{\ell} \frac{M^2 dx}{2EI}$

$U = U_{AB} + U_{BC}$

$$U = \int_0^{\ell} \frac{\left(\frac{P\ell}{2}\right)^2 dx}{2EI} + \int_0^{\ell/2} \frac{(Px)^2 dx}{2EI}$$

$$U = \frac{7}{48} \frac{P^2 \ell^3}{EI}$$

24. Ans: (d)

25. Ans: (b)

Sol: Distribution factor

Joint	Member	Relative stiffness	Total	D.F
B	BA	I/4	0.5 I	0.5
	BC	$\frac{3}{4} \times \frac{I}{3} = \frac{I}{4}$		0.5

Moment applied at joint B = + 20 kN-m

This moments gets distributed to member BA and BC.

Moment distributed on LHS of B

= 0.5 × 20= 10 kN-m

Moment carried over at A

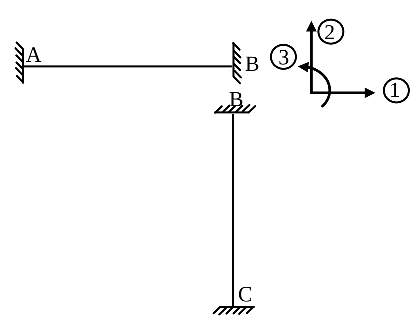
$= \frac{10}{2} = 5\,kN\text{-}m$

26. Ans: (d)

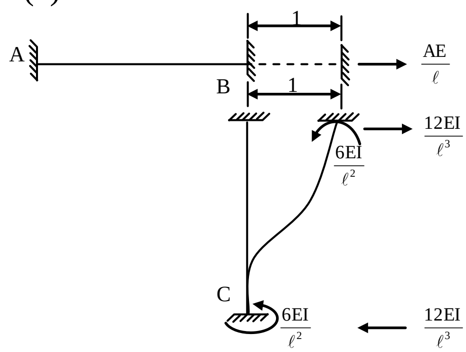
Sol: Junior beams are provided to resist lighter loads only i.e. for ex: purlins in roof truss.

27. Ans: (b)

Sol: Restrain the structure initially in the given coordinate directions (1,2,3)



Given unit displacement in the direction of (1)



$$\Delta = \frac{P\ell}{AE}$$

$$\Rightarrow \Delta = 1$$

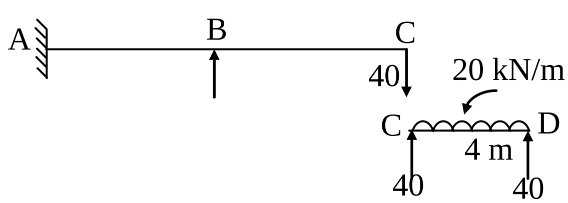
$$\Rightarrow P = \frac{AE}{\ell}$$

$$K_{11} = \frac{AE}{\ell} + \frac{12EI}{\ell^3}$$

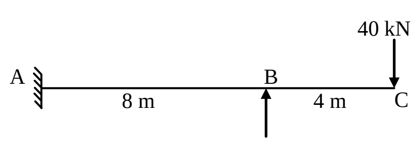
28. **Ans: (c)**

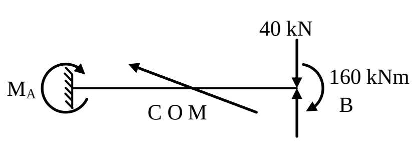
29. **Ans: (a)**

Sol: Free body diagram of the given structure is shown below



⇒





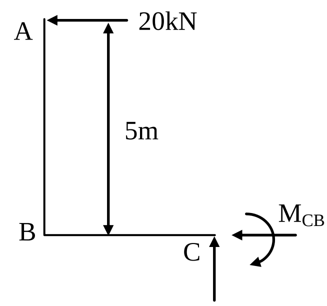
$$M_A = \frac{M}{2} = \frac{160}{2} = 80$$

$\therefore M_A = 80$ kNm (Clockwise)

30. **Ans: (d)**

31. **Ans: (c)**

Sol: Cut the section at "C" and take the free body of the left hand side



Applying $\Sigma M_C = 0$

$20\times5 - M_{CB} = 0$

$\Rightarrow M_{CB} = 100$kN-m

We know at joint C

$M_{CB} + M_{CD} = 0$

$\Rightarrow M_{CD} = -100$kN-m

32. **Ans: (b)**

Sol: Factored axial load (P) = 1100 kN

Transverse shear force as per IS800:2007 (V) = 2.5% of P = 27.5 kN

No. of parallel planes (N) = 2

Spacing between battens (C) = 1.3 m

Spacing between CG of components (S) = 250 mm

As per IS800:2007

Longitudinal shear $(L) = \frac{VC}{NS} = 71.5\,kN$

Moment $(M) = \frac{VC}{2N} = 8.93\,kN\text{-}m$

33. Ans: (b)

Sol: The beam and both springs will have the same displacement at end of cantilever 'B'. Therefore all the three springs act in parallel

$K_{eq} = K_{beam} + K_1 + K_2$

$= \frac{3EI}{L^3} + K_1 + K_2$

$= \frac{3\times 8\times 10^4}{20^3} + 10 + 10$

= 50 N/cm

Natural period from equation

$$T = 2\pi\sqrt{\frac{W}{K_{eq}\times g}}$$

$$= 2\pi\sqrt{\frac{500}{50\times 1000}}$$

$$= \frac{\pi}{5} \text{ seconds}$$

34. Ans: (b)

Sol: Deflection at centre = $\frac{W\ell^3}{192EI}$

$$k = \frac{192EI}{L^3}$$

$$\omega = \sqrt{\frac{k}{m}}$$

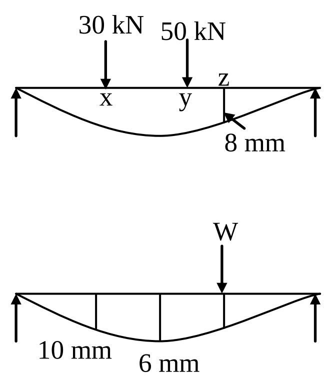
$$= \sqrt{\frac{192EI\times g}{L^3W}}$$

$$= 8\sqrt{\frac{3EIg}{L^3W}}$$

35. Ans: (c)

36. Ans: (c)

Sol:



As per Maxwell Betties theorem

$30 \times 10 + 50 \times 6 = W \times 8$

W = 75 kN

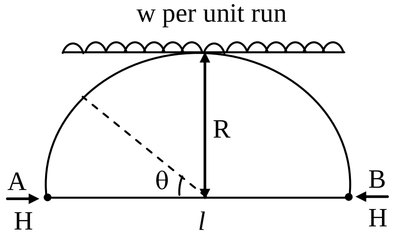
37. Ans: (a)

Sol:

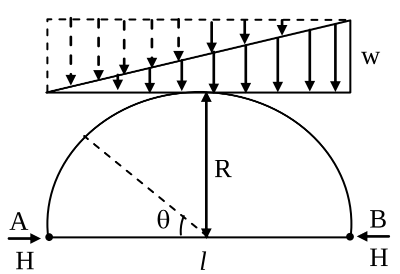
1. If force is not transferred uniformly it will result in shear lag, which is maximum at the extreme bolt and reduces with length of connection.
2. A_{net} increases with increase in length of connection [as shear lag decreases]
3. Strength of bolts/welds decreases with increase in length of connection [due to stress concentration]. Hence statement 3 is incorrect.

38. Ans: (c)

Sol:



$$H = \frac{4}{3}.\frac{wR}{\pi}$$



$$2H = \frac{4}{3}.\frac{wR}{\pi}$$

The horizontal thrust due to u.d.*l*. throughout the span is equal to twice the horizontal thrust due to u.v.*l* throughout the span.

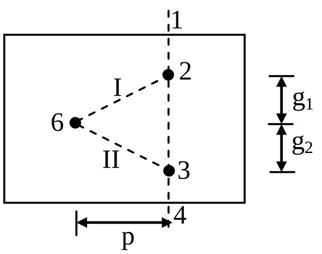
39. Ans: (d)

Sol:

A_{net} in 1-2-3-4 = [B –2d_h] × t → (1)

A_{net} in 1–2–6–3–4

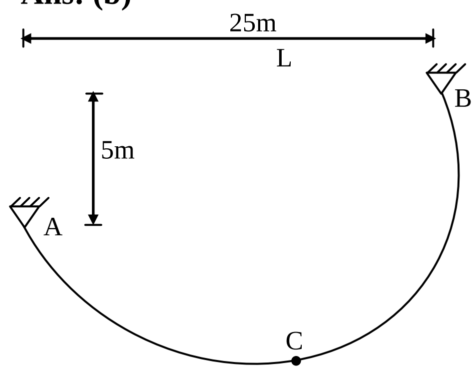
$$= \left[B - 3d_h + \frac{p_1^2}{4g_1} + \frac{p_2^2}{4g_2}\right] \times t \quad \rightarrow (2)$$



Since p & g are not given, A_{net} cannot be determined.

A_{net} would be minimum of (1) & (2), which require 'p' & 'g'. Hence data insufficient.

40. Ans: (b)



Maximum tension will be at higher support, i.e., at B.

41. Ans: (a)

42. Ans: (c)

Sol:

Angular frequency,

$$\omega_n = \sqrt{\frac{k}{m}}$$

$$= \sqrt{\frac{40000 \times 4}{1440 + 160}}$$

$$= \frac{200 \times 2}{40}$$

= 10 rad/sec

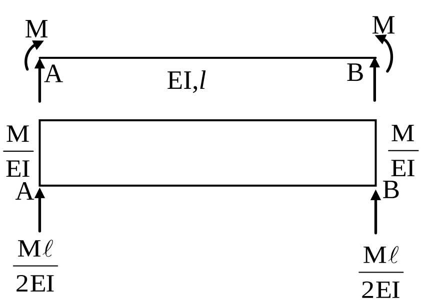
43. Ans: (b)

Sol: Nominal shear strength $= \frac{f_{ub}}{\sqrt{3}}$

Design shear strength = $\frac{f_{ub}}{\sqrt{3}\gamma_{mb}}$

44. Ans: (a)

Sol:



Conjugate beam

Slope of beam A = Shear force at A of conjugate beam

$$= \frac{M\ell}{2EI}$$

$$\therefore \quad \frac{M\ell}{2EI} = \theta$$

$$\frac{M\ell}{EI} = 2\theta$$

45. Ans: (c)

Sol: Efficiency of joint (η) = $\frac{B - d_n}{B} \times 100\%$

Width of plate (B) = 200 mm

Diameter of hole (d_n) = 22 mm

$$\eta = \frac{200 - 22}{200} \times 100 = 89\%$$

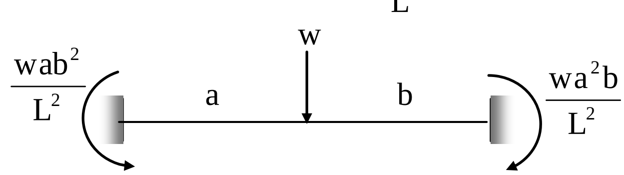
46. Ans: (c)

47. Ans: (c)

Sol: Fillet welds are easier to fabricate, and hence cheaper than butt welds. Whereas butt welds may be stronger if properly fabricated. Hence (1) is incorrect.

48. Ans: (a)

Sol: Maximum free BM, $M = \frac{Wab}{L}$



Sum of fixed end moments = $\frac{Wab^2}{L^2}+\frac{Wa^2b}{L^2}$

$$=\frac{Wab}{L^2}[b+a]$$

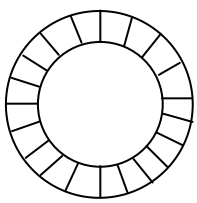
[L = a + b]

$$=\frac{Wab}{L}$$

= M

49. Ans: (a)

Sol:



Throat thickness (t_t) = 0.7S

= 5.6 mm

I_P of weld = $\frac{\pi}{4}D^3t_t$

Where D = 150 mm

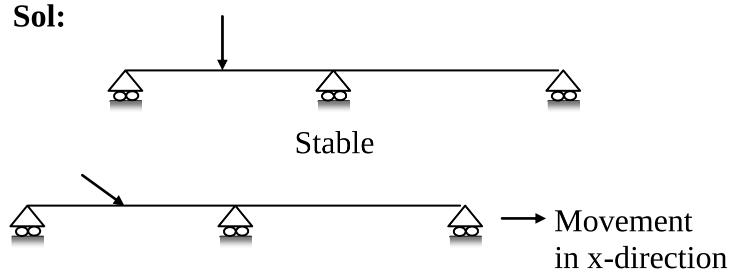
Shear stress developed in weld = $\frac{T}{I_p}\times r$

$$=\frac{10\times10^6\,N.mm}{\frac{\pi}{4}\times150^3\times5.6\,mm^4}\times75mm$$

= 50.5 MPa

50. Ans: (c)

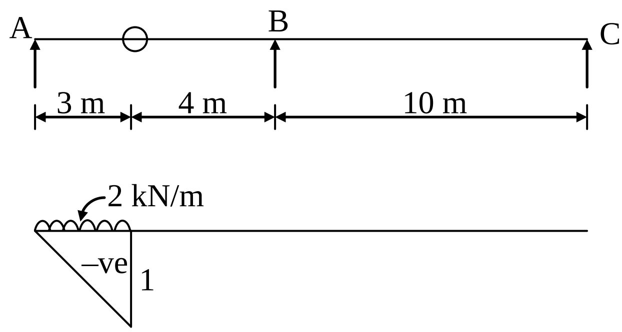
Sol:



51. Ans: (b)

52. Ans: (c)

Sol:



ILD for SFD

SFD = Intensity of udl × Area of shaded ILD

$$=2\left(\frac{1}{2}\times3\times1\right)$$

= 3 kN

53. Ans: (a)

Sol: Design weld strength of shop weld

$$=\frac{f_{ub}}{\sqrt{3}\gamma_{mw}}$$

$$= \frac{f_{ub}}{\sqrt{3}\times 1.25_{mw}}$$

Design weld strength of field weld

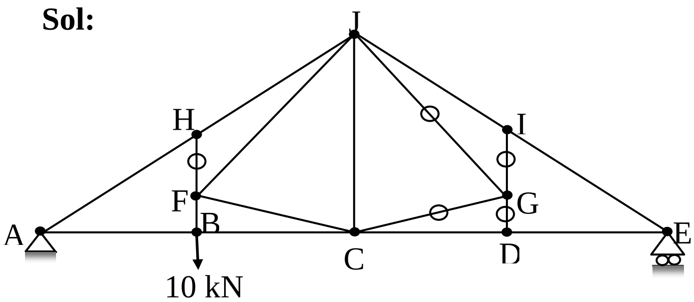
$$= \frac{f_{ab}}{\sqrt{3}\times 1.5}$$

$$\% \text{ reduction} = \frac{\frac{f_{ab}}{\sqrt{3}\times 1.25} - \frac{f_{ub}}{\sqrt{3}\times 1.5}}{\frac{f_{ub}}{\sqrt{3}\times 1.25}} \times 100$$

$$\simeq 16.6\%$$

54. Ans: (c)

Sol:



55. Ans: (d)

56. Ans: (b)

Sol: Joint equilibrium equation at 'B'

$M_{BA} + M_{BC} = 0$

$$M_{BA} = M_{FBA} + \frac{2EI}{L}\left[2\theta_B + \cancelto{0}{\theta_A} - \cancelto{0}{\frac{3\delta}{L}}\right]$$

$$= \frac{WL}{8} + \frac{4EI\theta_B}{L}$$

$$= \frac{10\times 4}{8} + EI\theta_B$$

$M_{BA} = 5 + EI\theta_B$

$$M_{BC} = \cancelto{0}{M_{FBC}} + \frac{2EI}{L}\left[2\theta_B + \cancelto{0}{\theta_C} - \cancelto{0}{\frac{3\delta}{L}}\right]$$

$= EI\theta_B$

$M_{BA} + M_{BC} = 0$

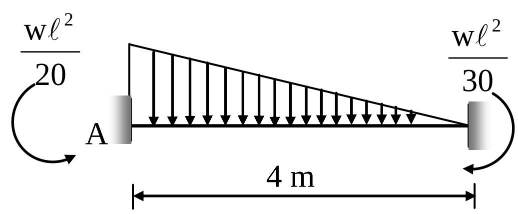
$5 + EI\theta_B + EI\theta_B = 0$

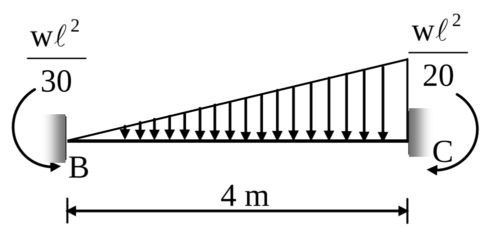
$$\theta_B = \frac{-2.5}{EI}$$

57. Ans: (c)

58. Ans: (b)

Sol:





$$\text{Moment at B} = \frac{\frac{10\times 4^2}{30} + \frac{10\times 4^2}{30}}{2} = \frac{5.33+5.33}{2}$$

$M_B = 5.33$ kN-m

59. Ans: (c)

60. Ans: (b)

Sol: Static indeterminacy $D_s = D_{se} + D_{si}$

External indeterminacy $D_{se} = r - s$

$= 3 - 3 = 0$

Indeternal indeterminaly 'D_{si}' = 3c = 0

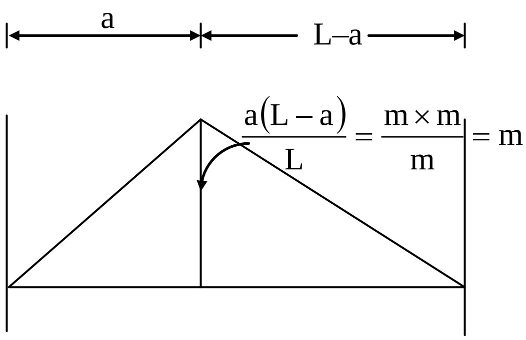
$D_S = 0 \rightarrow$ Determinate structure

The above diagram, support reactions are non-parallel & concurrent. Hence structure is stable

61. Ans: (c)

62. Ans: (b)

Sol:



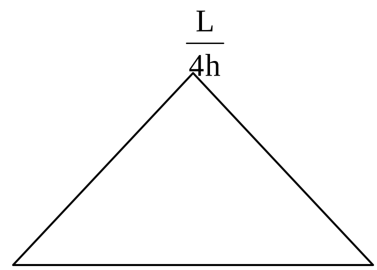
63. Ans: (a)

Sol: Buckling of web depends on $\frac{'d'}{t_w}$ ratio hence chance of buckling in a thicker web is very rare.

However it may fail due to shear yielding if stresses developed exceeds permissible shear stress.

64. Ans: (c)

Sol:



ILD for horizontal thrust

ILD for horizontal thrust is straight line.

65. Ans: (c)

Sol: as per IS 800 : 2007

$e_{o\,max} = 40\text{ mm} + 4t$ OR 12 tE

66. Ans: (c)

67. Ans: (d)

Sol: Moment capacity of base plate per mm width,

$$M_d = 1.2 \frac{f_y}{\gamma_{mo}} Z_e$$

$$= 1.2 \times \frac{250}{1.1} \left(\frac{1 \times t_b^{\ 2}}{6} \right)$$

$$= 1.2 \times \frac{250}{1.1}\left(\frac{1\times 12^2}{6}\right)$$

= 6545.45 N-mm

= 6.54 kN-mm

68. Ans: (c)

Sol: $D_K = 4\ [\theta_{B1}, \theta_{B2}, \theta_{B3}\ \&\ \theta_{B4}]$

69. Ans: (d)

70. Ans: (d)

71. Ans: (d)

72. Ans: (d)

73. Ans: (a)

74. Ans: (d)

Sol: Tack rivets do not transfer the stresses it just join 2 sections to act as a single unit. Force is transferred through main rivets.

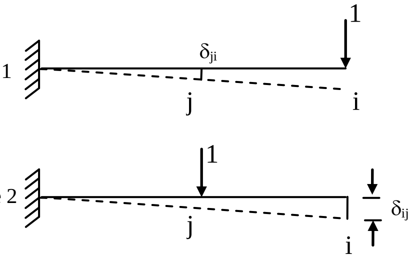
Figure 1


Figure 2

75. Ans: (a)

Sol: According to Maxwell's law of reciprocal deflections

$\delta_{ij} = \delta_{ji}$

$\therefore$ The elastic curve of the beam due to unit load placed at the free end (figure 1 below) is the I.L.D for deflection.

ACE
Engineering Academy
Leading Institute for ESE/GATE/PSUs

ACE ENGINEERING ACADEMY – Since 1995

23 Years of Excellence

CONGRATULATIONS TO OUR ESE - 2018 TOP RANKERS

AIR		
1	SHASHANK	E&T
1	CHIRAG JHA	EE
1	VINAY PRAKASH	CE
1	AMAN JAIN	ME
2	CHERUKURI SAIDEEP	E&T
2	SHADAB AHAMAD	EE
2	PUNIT SINGH	CE
2	CHIRAG SINGLA	ME
3	RAMESH KAMULLA	E&T
3	SRIJAN VARMA	EE
3	PRAVEEN KUMAR	CE
3	MAYUR PATIL	ME
4	JAPJIT SINGH	E&T
4	ANKIT GARG	EE
4	AMIT KUMAR	ME
5	NARENDRA KUMAR	E&T
5	KARTHIK KOTTURU	EE
5	RISHABH DUTT	CE
5	VITTHAL PANDEY	ME
6	KUMUD JINDAL	E&T
6	NATIPALLI NAGESWAR	EE
7	KARTIKEYA DUTTA	E&T
7	TEKCHAND DESHWAL	EE
7	ROHIT KUMAR	CE
8	SURYASH GAUTAM	E&T
8	RAVI TEJA MANNE	EE
8	VIJAYA NANDAN	CE
8	ROHIT BANSAL	ME
9	SHANAVAS CP	E&T
9	SOUVIK DEB ROY	EE
9	ROOPESH MITTAL	CE
10	PRATHAMESH	E&T
10	MILAN KRISHNA	EE
10	SRICHAND POONIYA	CE

TOTAL SELECTIONS in Top 10	E&T TOP 10	EE TOP 10	CE TOP 10	ME TOP 10
34	10	10	8	6

and many more...

www.aceenggacademy.com