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Structure Analysis

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Date of Test : 09/11/2019

ANSWER KEY ➤ Structure Analysis

1.	(d)	7.	(b)	13.	(b)	19.	(c)	25.	(c)
2.	(c)	8.	(c)	14.	(b)	20.	(b)	26.	(d)
3.	(c)	9.	(a)	15.	(c)	21.	(a)	27.	(c)
4.	(b)	10.	(b)	16.	(d)	22.	(a)	28.	(a)
5.	(a)	11.	(c)	17.	(b)	23.	(b)	29.	(a)
6.	(d)	12.	(a)	18.	(a)	24.	(d)	30.	(d)

DETAILED EXPLANATIONS

1. (d)

$$D_x = 3j - R_e - m = 3 \times 4 - 5 - 1 = 6$$

2. (c)

$$D_s = m + R_e - 2j = 13 + 3 - 2 \times 7 = 2$$

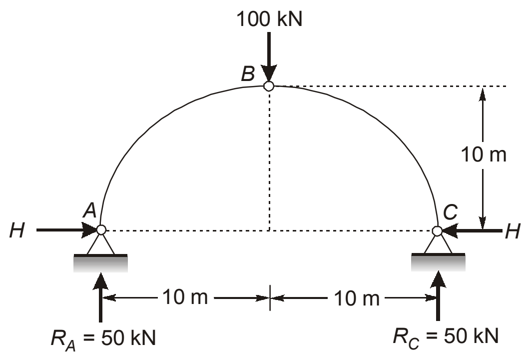
4. (b)

$$H = \frac{W}{\pi}\sin^2\theta \qquad [\theta = 90°]\ (\because \text{load at crown})$$

$$\therefore \quad H = \frac{W}{\pi}$$

5. (a)

Due to symmetrys the vertical reaction at supports A and C are 50 kN each.



From symmetry, $R_A = R_C = 50$ kN

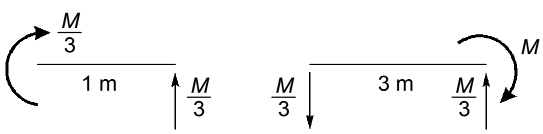
Bending moment at crown in three hinged arch is zero.

$$\therefore \quad M_B(\text{from RHS}) = 0$$

$$\Rightarrow R_C \times 10 - H \times 10 = 0$$

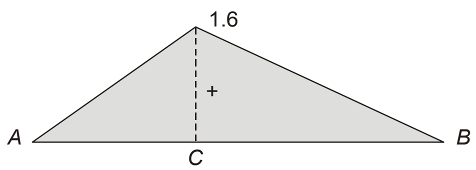
$$\Rightarrow H = R_A = 50 \text{ kN}$$

6. (d)

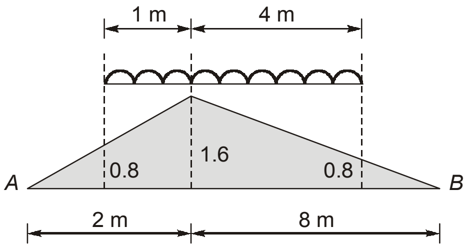


8. (c)

ILD for moment at C



Bending moment at C



$$M_C = \left(\frac{1}{2}(1.6+0.8)\times 1+\frac{1}{2}(0.8+1.6)\times 4\right)\times 30$$

$$= (1.2 + 4.8) \times 30 = 180 \text{ kNm}$$

11. (c)

Change in rise of the arch, $\Delta = \dfrac{l^2+4h^2}{4h}\alpha T$

$\Rightarrow \quad \Delta = \dfrac{(30)^2+4(6)^2}{4\times 6}\times 15\times 10^{-6}\times 40$

$\therefore \quad \Delta = 0.0261 \text{ m} = 2.61 \text{ cm}$

12. (a)

$$D_s = \text{no. of support reaction removed} - \text{no. of restraints added}$$
$$= 2 - 1 = 1$$

13. (b)

$$D_x = 3_i - R_e$$
$$= 3 \times 10 - 6 \times 3 = 12$$

14. (b)

$$D_x = 3_i + r - R_e = 3 \times 13 + 5 - 12 = 32$$

16. (d)

$$\delta_B = \frac{2Pl\left(l^2\right)}{2EI}$$

$$\delta_B = \frac{2Pl^3}{2EI} = \frac{Pl^3}{EI}$$

17. (b)

Relative stiffness, $$K_{BA} = \frac{I}{4}$$

$$K_{BC} = \frac{3}{4} \times \frac{I}{3} = \frac{I}{4}$$

$\therefore$ $$K_{BA} = K_{BC}$$

Hence distribution factor, $$\text{D.F.} = \frac{1}{2}$$

Moment distribution table

	A	B	B	C
DF		1/2	1/2	
	0	0	0	
		15	15	
	7.5	—		
	—	—		
	7.5	15	15	

18. (a)

Since, Fixed end moment (FeM) $$M_{FAB} = \frac{-wl^2}{12}$$

$$M_{FBA} = \frac{wl^2}{12}$$

Drawing the MD diagram

Support	A	B
FeM	$-\frac{Wl^2}{12}$	$\frac{Wl^2}{12}$
Release 'B'	—	$-\frac{Wl^2}{12}$
C.O.M	$-\frac{Wl^2}{24}$	—
	—	—
Total moment	$-\frac{Wl^2}{8}$	0

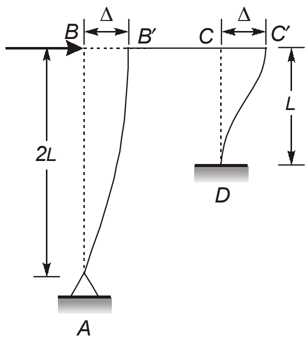
19. (c)

Joint	Member	Stiffness	D.F.
E	EC	$\frac{4E(2I)}{6}$	0.69
	EF	$\frac{3EI}{5}$	0.31

20. (b)

Sway Moment, $$M_{BA} = \frac{3EI\Delta}{L^2} = \frac{3E(2I)\Delta}{(2L)^2} = \frac{6EI\Delta}{4L^2}$$

Sway Moment, $$M_{CD} = \frac{6EI\Delta}{L^2}$$



Now, required ratio, $$\frac{M_{BA}}{M_{CD}} = \frac{\frac{6}{4}\frac{EI\Delta}{L^2}}{6\frac{EI\Delta}{L^2}} = \frac{1}{4} = 0.25$$

21. (a)

Distribution Factors:

Joint	Members	Relative Stiffness	Total Relative Stiffness	Distribution Factor
B	BA	$\frac{2I}{5} = \frac{24I}{60}$	$\frac{59I}{60}$	0.41
	BC	$\frac{3}{4} \times \frac{I}{3} = \frac{15I}{60}$		0.25
	BD	$\frac{I}{3} = \frac{20I}{60}$		0.34

22. (a)

At joint E,

F_{EA} and F_{ED} will cancel each other

$\therefore$ $$F_{EB} + P = 0$$

$\therefore$ $$F_{EB} = -P$$

and $$R_A = R_C = \frac{P}{2}$$

at joint C,

$$\Sigma F_V = 0$$

$$R_C + F_{CD} = 0$$

$$F_{CD} = -\frac{P}{2}$$

23. (b)

$$\Delta_{CD} = -\Delta_x \cos 60° + \Delta_y \sin 60° = -40 \cos 60° + 50 \sin 60°$$
$$\Delta_{CD} = 23.301 \text{ mm}$$

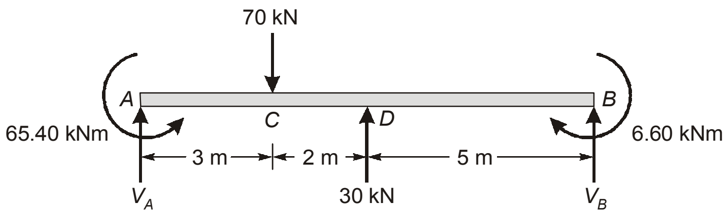
24. (d)

Taking hogging moments as negative and sagging moments as positive

$$\text{Fixed end moment at } A,\ M_A = \frac{-70\times3\times7^2}{10^2} + \frac{30\times10}{8} = -65.40 \text{ kNm}$$

$$\text{Fixed end moment at } B,\ M_B = \frac{70\times3^2\times7}{10^2} - \frac{30\times10}{8} = 6.60 \text{ kNm}$$

Reactions due to simply suported condition:

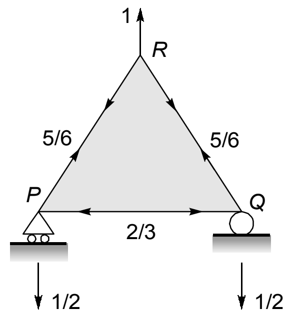


$$\Sigma M_B = 0$$
$$\Rightarrow V_A \times 10 - 65.4 - 70(2+5) + 30 \times 5 + 6.6 = 0$$
$$\Rightarrow \quad V_A = 39.88 \text{ kN}$$

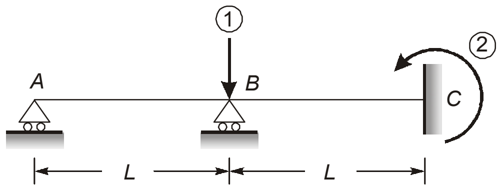
25. (c)

By virtual load method

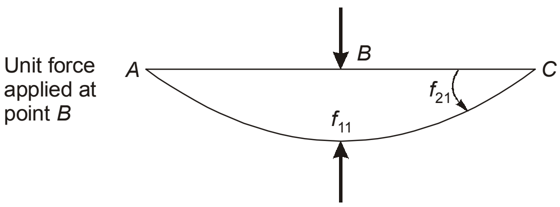
Now,
$$1 \times \Delta R = U_i \lambda_i$$
$$\Delta R = -\frac{2}{3}\times(-5)$$
$$\Delta R = 3.33 \text{ mm}$$

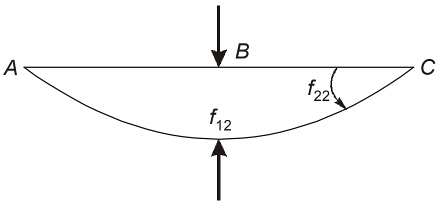


26. (d)



The elements of the flexibility matrix are obtained by applying unit values of redundants at the coordinates one after the other as shown below.





$$f_{11} = \frac{(2L)^3}{48EI} = \frac{L^3}{6EI}$$

$$f_{21} = f_{12} = \frac{1(2L)^2}{16EI} = \frac{L^2}{4EI}$$

$$f_{22} = \frac{2L}{3EI}$$

$\therefore$
$$[F] = \frac{L}{12EI}\begin{bmatrix} 2L^2 & 3L \\ 3L & 8 \end{bmatrix}$$

28. (a)

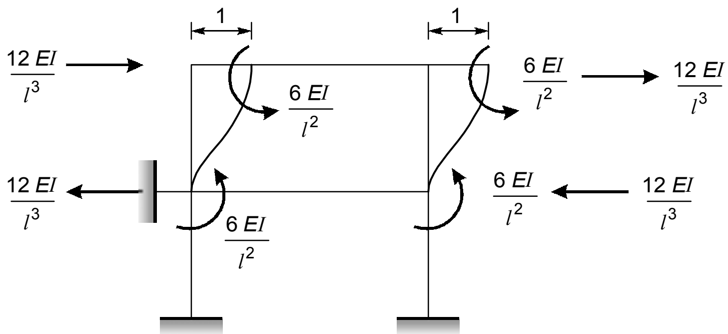
(i) When unit load is at joint A, $F_{GB} = 0$.

(ii) When unit load is at joint B, $F_{GB} = +5/12$.

(iii) When unit load is at joint C, $F_{GB} = -5/6$.

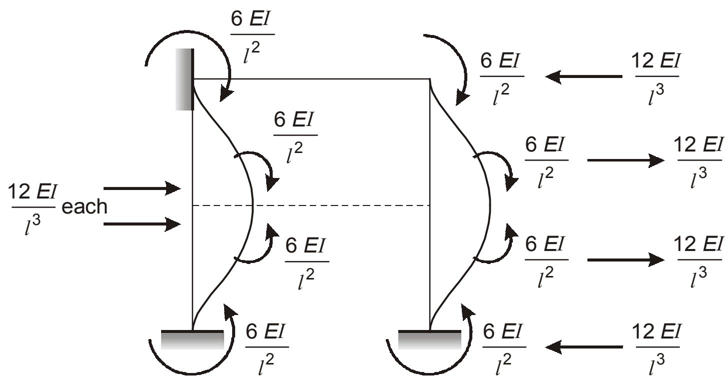
(iv) When unit load is at joint D, $F_{GB} = -5/12$.

29. (a)



$\therefore$
$$K_{11} = \frac{24EI}{l^3}$$

$$K_{21} = -\frac{24EI}{l^3} = K_{12}$$



$$\therefore \quad K_{22} = \frac{12EI}{l^3} \times 4 = \frac{48EI}{l^3}$$

$$\therefore \quad [K_{ij}] = \frac{1}{l^3}\begin{bmatrix} 24EI & -24EI \\ -24EI & 48EI \end{bmatrix}$$

30. (d)

(i) K_{ij} : force at i due to deformation at j.

(ii) if K is doubled, deflection is halved.

(iii) Stiffness matrix method is used for structure with lesser degree of kinematic indeterminacy.

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