S.No. : 05 SK1_CE_GX_170719

Structure Analysis

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Date of Test : 17/07/2019

ANSWER KEY ➤ Structure Analysis

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

DETAILED EXPLANATIONS

1. (d)

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

2. (c)

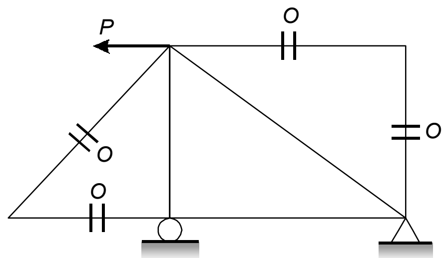
$$D_s = m + R_e - 2j = 13 + 3 - 2 \times 7 = 2$$

4. (b)

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

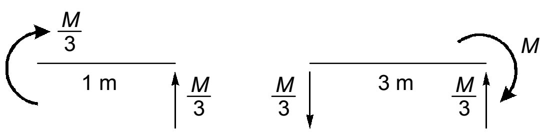
$$\therefore \quad H = \frac{W}{\pi}$$

5. (d)



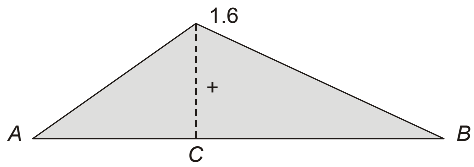
$\therefore$ no. of zero force member = 4.

6. (d)

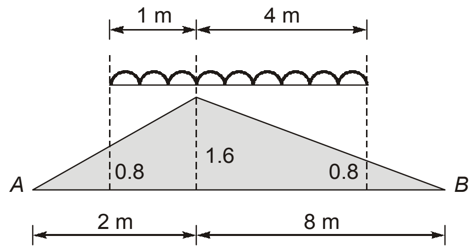


8. (c)

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)

$$D_s = 6 \times 4 - 3 \times 4 - 5 - 3$$
$$D_s = 24 - 12 - 8 = 4$$

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, $K_{BA} = \dfrac{I}{4}$

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

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

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

Moment distribution table

	A	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) $M_{FAB} = \dfrac{-wl^2}{12}$

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

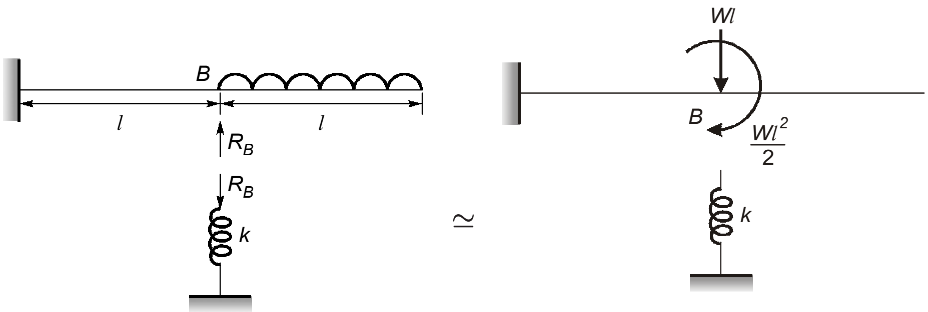
Drawing the MD diagram

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

21. (d)



$$\delta_{beam} = \delta_{spring}$$

$$\delta_{spring} = \frac{R_B}{k}$$

$$[\delta_{beam}]_B = \frac{R_B.l^3}{3EI} - \frac{(Wl).l^3}{3EI} - \frac{\left(\frac{Wl^2}{2}\right).l^2}{2EI}$$

$$\frac{R_B}{k} = \frac{R_B.l^3}{3EI} - \frac{7}{12}\frac{Wl^4}{EI}$$

$$R_B\left[\frac{1}{k} - \frac{l^3}{3EI}\right] = -\frac{7}{12}\frac{Wl^4}{EI}$$

$$R_B = \frac{\frac{7}{12}\frac{Wl^4}{EI}}{\frac{l^3}{3EI} - \frac{1}{k}}$$

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)

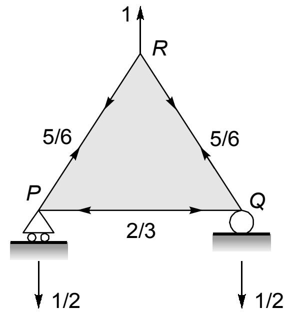
$$\Delta_{CD} = -\Delta_x \cos 60° + \Delta_y \sin 60° = -40 \cos 60° + 50 \sin 60°$$
$$\Delta_{CD} = 23.301 \text{ mm}$$

24. (b)

Since there is a temperature rise of ΔT in member BD, it should expend, but since it is restrained at its ends compressive force develops in member BD.

25. (c)

By virtual load method

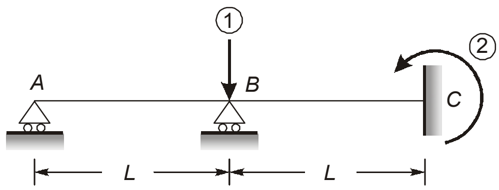


Now, $$1 \times \Delta R = U_i \lambda_i$$

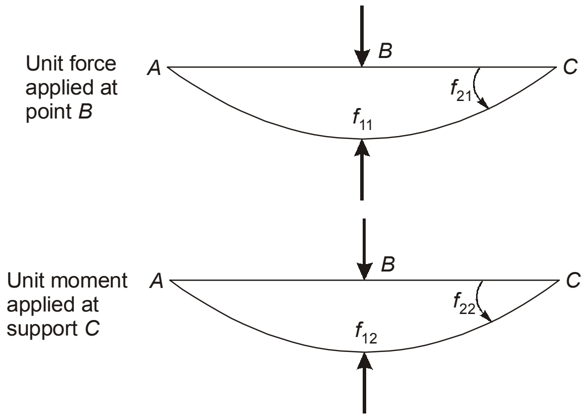
$$\Delta R = -\frac{2}{3} \times (-5)$$

$$\Delta R = 3.33 \text{ mm}$$

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.



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

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

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

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

28. (a)

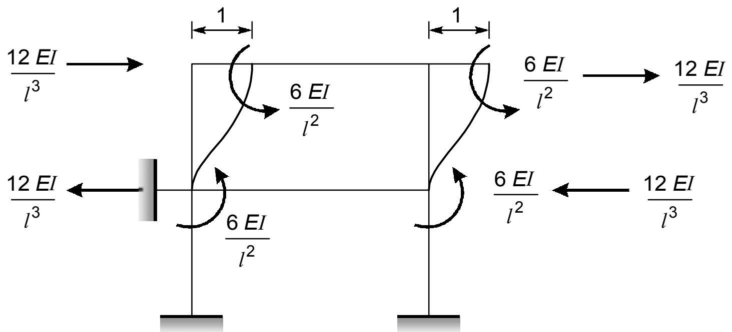
(i) When unit load is at joint A, $F_{GB} = 0$.

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

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

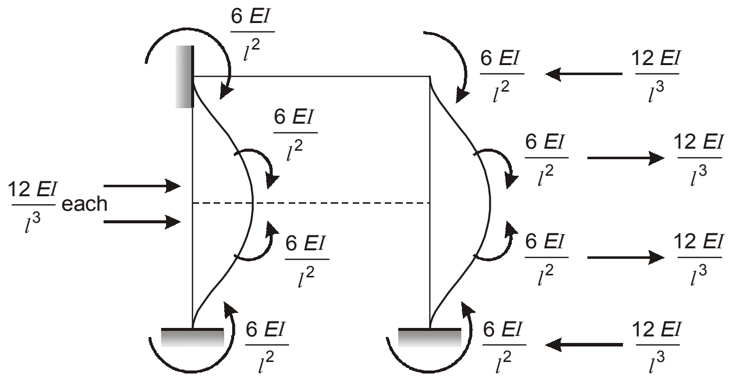
(iv) When unit load is at joint D, $F_{GB} = -5/12$.

29. (a)



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

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



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

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

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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