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Question: A continuous three-span fixed-ended beam carries a uniform ...

A continuous three-span fixed-ended beam carries a uniform dead load (including self-weight) and live load of 15 kN/m and 20kN/m, respectively. A live gravity point load is also applied at the mid-point of the right span with a magnitude of 100kN. If f'_c is 28 MPa, and f_y is 276 MPa, design the beam (SRB only) based on the maximum negative moment. List down all assumptions used. Draw the final details of the cross-section of the beam with dimensions and steel bars.

Here are the beam parameters:

- Left span = 3m
- Middle span = 4m
- Right span = 4m

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Expert Answer 



Anonymous answered this
57 answers

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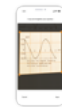
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$$M_{fBC} = -\frac{WL^2}{12} = -75.176 \text{ KNm}$$

$$M_{fCB} = +\frac{WL^2}{12} = +75.176 \text{ KNm}$$

$$M_{fCD} = -\frac{PL}{8} - \frac{WL^2}{12} = -125.176 \text{ KNm}$$

$$M_{fDC} = +\left(\frac{PL}{8} + \frac{WL^2}{12}\right) = +125.176 \text{ KNm}$$

(D) Distribution factor

Joint	member	Length	Stiffness 'k'	D.F = k/Σk
A	AB	3m	$\frac{4EI}{L_1}$	
	BA	3m		
B	BC	4m	$\frac{4EI}{L_2}$	
	CB	4m		
C	CD	4m	$\frac{4EI}{L_3}$	
	DC	4m		

$$E = 5000 \sqrt{F_{ck}} = 264575.5 \text{ Nmm}^{-2}$$

$$I = \frac{BD^3}{12} = \frac{230 \times 450^3}{12} = 17.46 \times 10^8 \text{ mm}^4$$

$$EI = 4.62 \times 10^{14} \text{ Nmm}^2$$

(E) Fixed Beam Reactions

$$R_{B1} = 84.57 \text{ KN}$$

$$R_A = 84.27 \text{ KN}$$

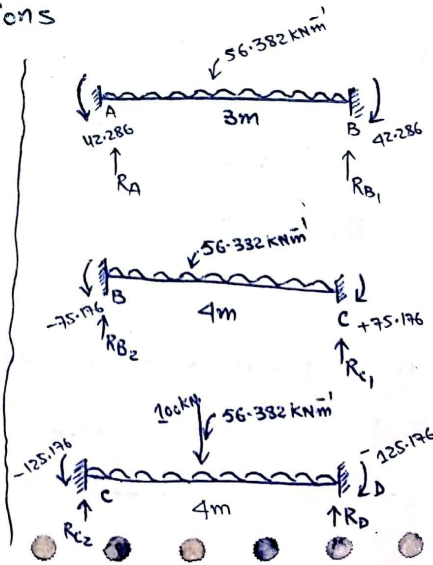
$$R_{C1} = 112.764 \text{ KN}$$

$$R_{B2} = 112.764 \text{ KN}$$

$$R_{C2} = 162.764 \text{ KN}$$

$$R_D = 162.764$$

$$\Rightarrow R_C = 275.52 \text{ KN} \text{ \& } R_B = 197.33 \text{ KN}$$

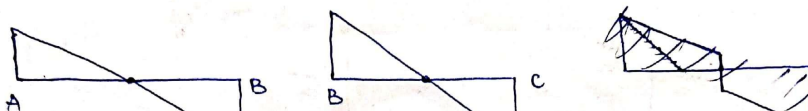


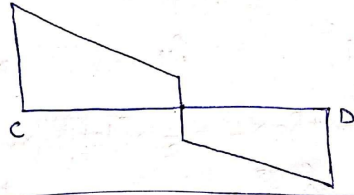
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① Zero-shear force for AB $\rightarrow x_1 = \frac{R_A}{W} = 1.5 \text{ m}$

② span BC $\rightarrow x_2 = \frac{R_{B2}}{W} = 2 \text{ m}$

③ span CD $\rightarrow R_{C2} - Wx_3 - 100 \Rightarrow x_3 = 2 \text{ m}$





$$M_{max} = 87.58 \text{ kNm}$$

Grade: Fe250

$$x_{u\max} = 0.53d$$

$$M_{ulim} = 0.148 f_{ck} b d^2$$

Fe415

$$0.48d$$

$$0.138 f_{ck} b d^2$$

Fe500

$$0.46d$$

$$0.133 f_{ck} b d^2$$

$$\therefore \text{Fe 276} \rightarrow 0.522d \rightarrow 0.136 f_{ck} b d^2$$

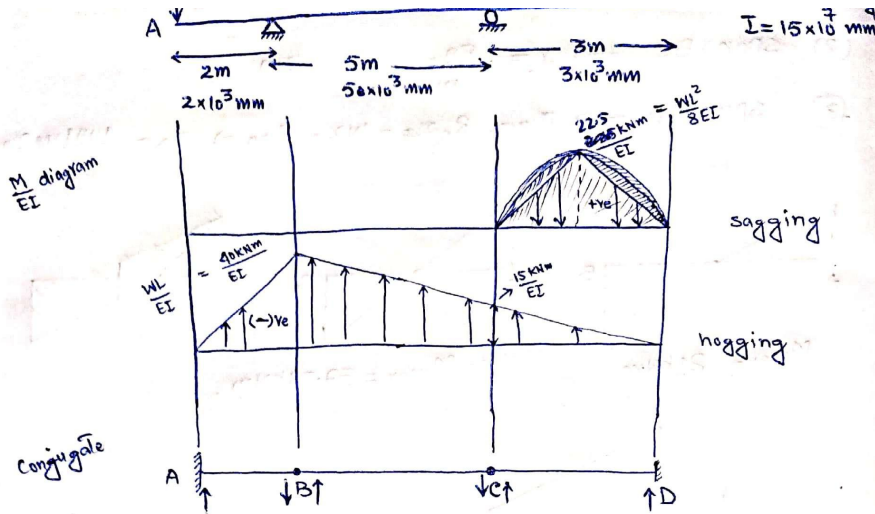
$$x_{u\max} = 0.522 \times 400 = 208.8 \text{ mm} \quad [\text{Fe 276 MPa}]$$

$$M_{ulim} = 0.36 f_{ck} \cdot b \cdot x_{u\max} (d - 0.42 x_{u\max})$$

$$= 0.36 \times 28 \times 230 \times 208.8 (400 - 0.42 \times 208.8)$$

$$= 151.18 \text{ kNm}$$

$$M_{u \text{ support \& span}} < M_{ulim} \quad \left[\text{singly beam design} \right]$$



$$\sum M_B = 0 \Rightarrow +R_B \times 5 + \frac{1}{2} \times \left[\frac{40+15}{EI} \right] \times 5 \times \frac{5}{2} - \frac{1}{3} \times \frac{22.5}{EI} \times 3 \times 1.5$$

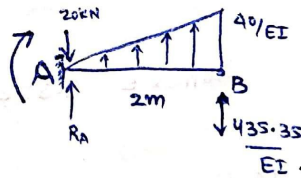
$$\Rightarrow R_B = \frac{435.35 \text{ kN}}{EI}$$

$$R_B + R_C = -\frac{1}{2} \left[\frac{40+15}{EI} \right] \times 5 \times 2.5 = 0$$

$$\Rightarrow R_C = \frac{343.75}{EI} - \frac{435.35}{EI} = -\frac{91.6}{EI}$$

$$\therefore R_A + \frac{1}{2} \times 2 \times \frac{40}{EI} - R_B = 0$$

$$\Rightarrow R_A = \frac{395.35 \text{ kN}}{EI}$$



$$M_A = -\frac{435.35}{EI} \times 2 + \frac{1}{2} \times 2 \times \frac{40}{EI} \left(\frac{2}{3} \times 2 \right) = -\frac{817.36 \text{ kNm}}{EI}$$

$$\therefore \text{slop } \theta_A = \frac{395.35 \times 10^3 \text{ N}}{2 \times 15 \times 10^{12} \text{ Nmm}^2} = 1.31 \times 10^{-3} \text{ mm}$$

$$\text{Deflect } \Delta_A = \frac{817.36 \times 10^6 \text{ Nmm}}{2 \times 15 \times 10^{12} \text{ Nmm}^2} = 2.72 \times 10^{-5} \text{ mm}$$

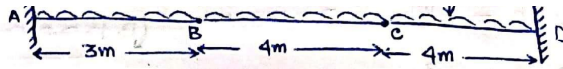


% reinforcement from span and support = 0.432 & 0.947 resp.

$$A_{st, req} (mm^2) = \frac{\%P \times b \times d}{100}$$

span	support
$= \frac{0.432 \times 400 \times 230}{100}$	$= \frac{0.947 \times 230 \times 400}{100}$
$= 397.44 \text{ mm}^2$	$= 871.29 \text{ mm}^2$
$\phi = 16 \text{ mm}$	$\phi = 16 \text{ mm}$
$\text{No of bars} = 3$	$\text{No of bars} = 5$
$A_{st, prov} = 602.8 \text{ mm}^2$	$A_{st, prov} = 1009.8 \text{ mm}^2$

$$f_y = 276 \text{ MPa}$$



For Continuous Beam we can use two methods:

- (1) Moment - Distribution method
- (2) IS - 456 - Table - 12 - Coeff usage

(a) Size of Beam:-

$$\begin{aligned} \text{Effective depth of Beam} &= \text{Span}/10 - \text{Span}/15 \\ &= 400 \text{ mm to } 267 \text{ mm} \end{aligned}$$

Assume $d = 400 \text{ mm}$ as effective depth

$$D = d + C_{nom} + \phi/2 = 400 + 30 + 20/2 = 450 \text{ mm}$$

⇒ Assume $b_w = 230 \text{ mm}$

$$\therefore \text{Size} = 230 \times 450 \text{ mm}$$

(b) Load Determination:

$$\begin{aligned} \text{Self-weight} &= 0.23 \times 0.45 \times 25 = 2.58 \text{ kN/m} \\ D_L &= 15 \text{ kN/m} \quad \& \quad LL = 20 \text{ kN/m} \end{aligned}$$

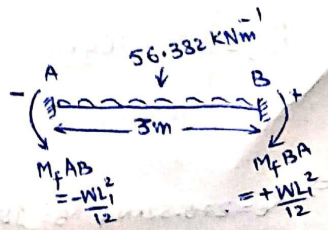
$$\text{Total Load} = W = 37.58 \text{ kN/m}$$

$$W_u = \text{factored load} = 1.5W = 56.382 \text{ kN/m}$$

(c) Fixed End - moment:

$$M_{fAB} = -42.286 \text{ kNm}$$

$$M_{fBA} = +42.286 \text{ kNm}$$



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C	CB	4m	$4EI/L_2$	
	CD	4m		
D	CD	4m	$4EI/L_3$	

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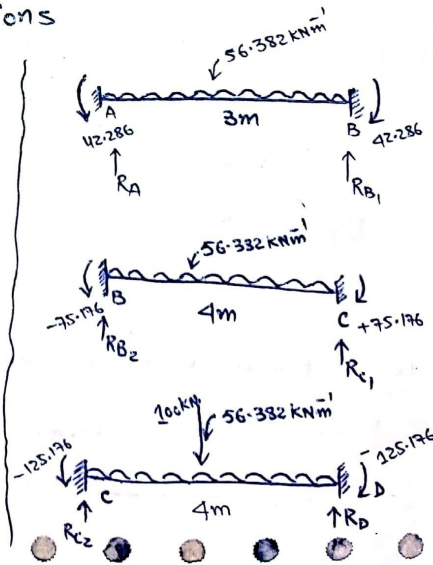
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3-20mm diameter MRSB on

An Isosceles Trapezoidal Beam is reinforced with 3-20mm diameter MRSB on the tension side only. The dimensions of the beam in the upper and lower bases are 250mm and 550mm, respectively. The total height of the beam is 630mm and the centroid of the MRSB is located 60

[See answer](#)

rectangular beam is monolithically casted with

A 4-meter 300mm x 500mm rectangular beam is monolithically casted with a 90mm slab. The beam clear spacing from each other is 3 meters. It is reinforced on the tension side only with 6-32mm diameter MRSB. If $f_y = 345\text{MPa}$ and f_c is

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