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

A continuous three-span fixed-ended beam caries 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 fy 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

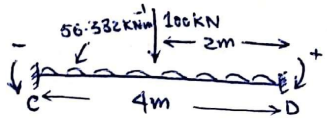
Was this answer helpful? 0 0

$M_f BC = -\frac{WL_2}{12} = -75.176\ KNm$

$M_f CB = +\frac{WL_2^2}{12} = +75.176\ KNm$

$M_f CD = -\frac{PL}{8} - \frac{WL^2}{12} = -125.176\ KNm$

$M_f DC = +(PL/8 + \frac{WL^2}{12}) = +125.176\ KNm.$



(D) Distribution factor

Joint	member	Length	Stiffness "k"	D.F = K/ΣK
A	~~AB~~	~~3m~~		
	~~BC~~			
B	BA	3m	$4EI/L_1$	
	BC	4m	$4EI/L_2$	
C	CB	4m	$4EI/L_2$	
	CD	4m	$4EI/L_3$	
D				

$E = 5000\sqrt{Fck} = 264575.5\ Nmm^{-2}$

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

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

(E) Fixed Beam Reactions

$R_{B_1} = 84.57\ KN$

$R_A = 84.27\ KN.$

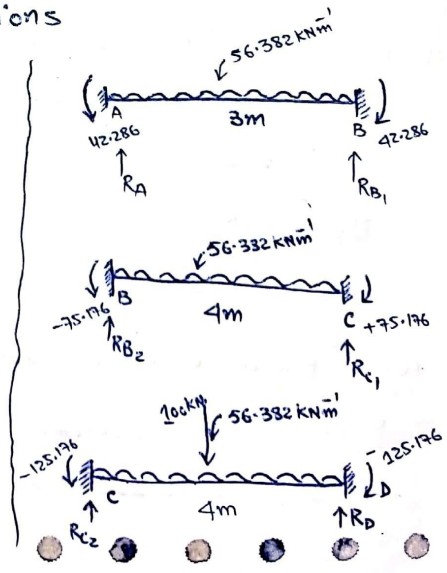
$R_{C_1} = 112.769\ KN.$

$R_{B_2} = 112.769\ KN.$

$R_{C_2} = 162.769\ KN$

$R_D = 162.769$

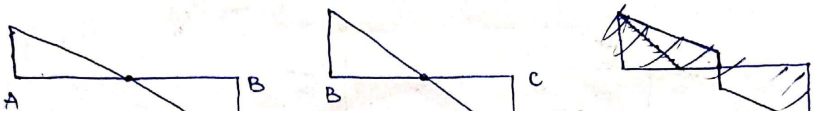
$\Rightarrow R_C = 275.52 KN$ & $R_B = 197.33 KN$

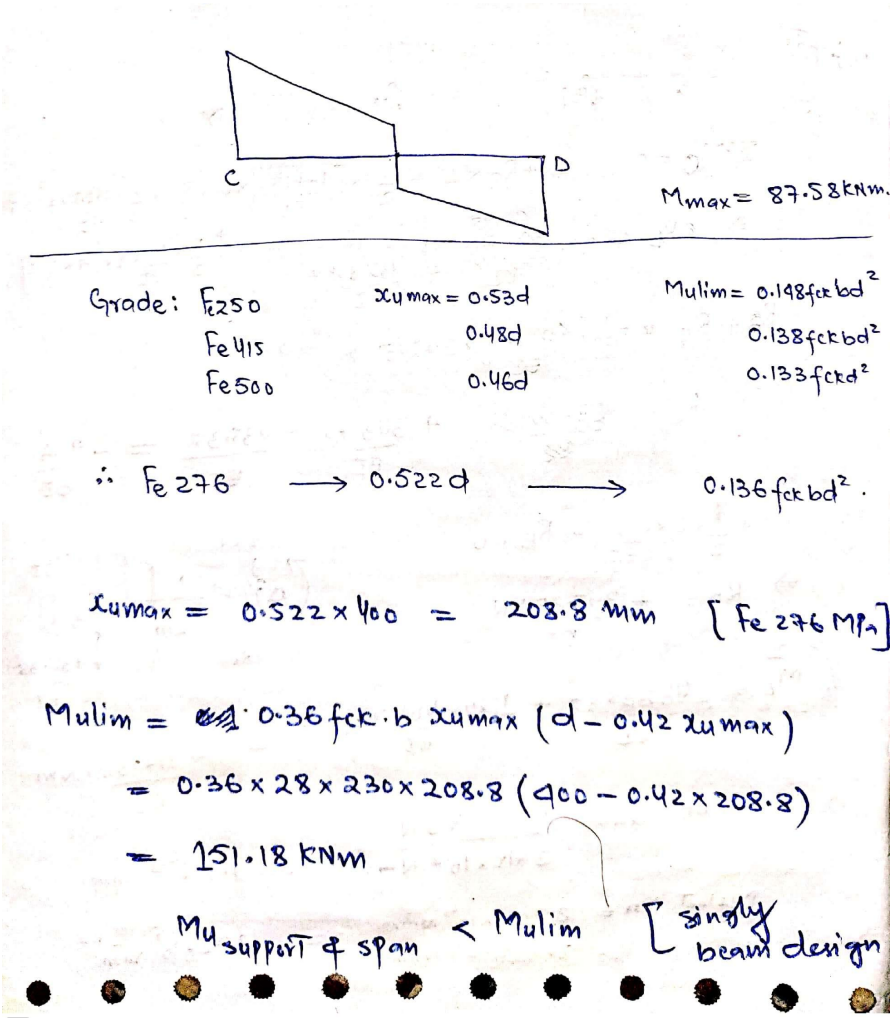


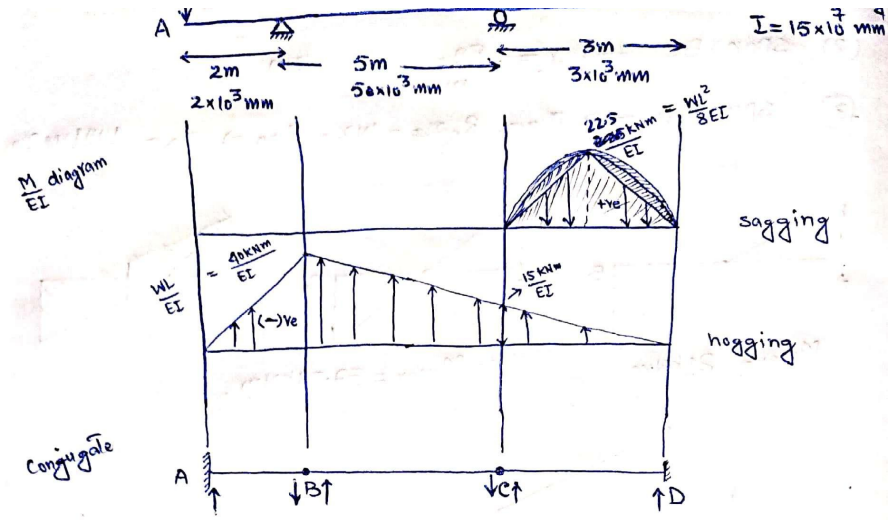
① Zero-shear force for AB $= x_1 = \frac{R_A}{W} = 1.5m$

② Span BC $\rightarrow x_2 = \frac{R_{B_2}}{W} = 2m$

③ Span CD $\rightarrow R_{C_2} - Wx_3 - 100 \Rightarrow x_3 = 2m.$







$\Sigma M_B = 0 \Rightarrow +R_B \times 5 + \frac{1}{2}\times\left[\frac{40+15}{EI}\right]\times 5\times\frac{5}{2} - \frac{1}{3}\times\frac{225}{EI}\times 3\times 1.5$

$+\frac{1}{2}\times\frac{40}{EI}\times 2\times\left[5+\frac{1}{3}\times 2\right]$

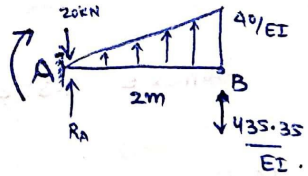
$\Rightarrow R_B = \frac{435.35\ \text{kN}}{EI}$

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

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

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

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



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

$\therefore$ slop $Q_A = \frac{395.35\times10^3\ \text{N}}{2\times15\times10^{12}\ \text{Nmm}^2} = 1.31\times10^{-8}$ mm.

Deflect $\Delta_A = \frac{817.36\times10^6\ \text{Nmm}}{2\times15\times10^{12}\ \text{Nmm}^2} = 2.72\times10^{-5}\ \text{mm}^{-1}$

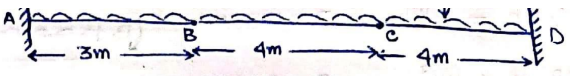
% reinforcement from ben...

of span and support = 0.432 & 0.947 resp.

$A_{st_{req}}(mm) = \frac{\%p \times bxd}{100}$

span	support
$= \frac{0.432 \times 400 \times 230}{100}$	$= \frac{0.8947 \times 230 \times 400}{100}$
$= 397.44\ mm^2$	$871.29\ mm^2$
$\phi = 16mm$	$\phi = 16mm$
No of bars = 3	No of bars = 5
$A_{st_{prov}} = 602.8\ mm^2$	$A_{st_{prov}} = 1004.8\ mm^2$

f_y = 276 MPa



For Continous Beam we can use Two methods:

(1) Moment - Distribution method

(2) Is - 456 - Table - 12 - Coeff usage

(a) Size of Beam:-

Effective depth of Beam = span/10 - span/15

= 400mm to 267 mm.

Assume d = 400mm as effective depth

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

⇒ Assume b_w = 230 mm

∴ Size = 230 x 450 mm.

(b) Load Determination:

Self - weight = 0.23 x 0.45 x 25 = 2.58 KN/m.

D_L = 15 KNm^{-1} & L_L = 20 KNm^{-1}.

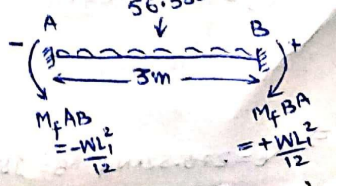
Total - load = W = 37.58 KNm^{-1}

Wu = factored load = 1.5W = 56.382 KNm^{-1}

(c) Fixed End - moment:

$M_f AB$ = − 42.286 KNm.

$M_f BA$ = + 42.286 KNm.



span Ast is provided in Top and Support Ast is provided in Bottom

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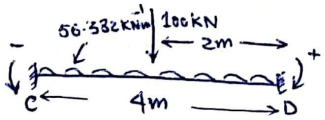

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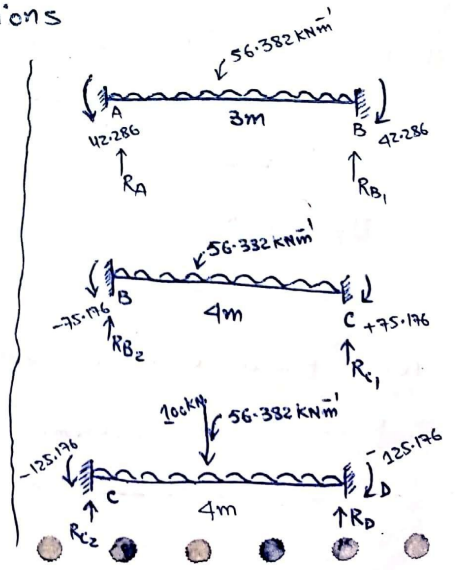

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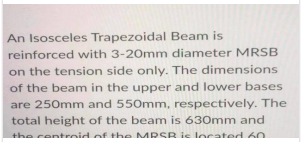
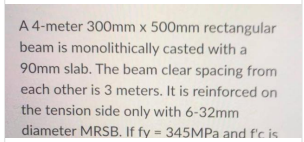
3-20mm diameter MRSB on



See answer

rectangular beam is monolithically casted with



See answer

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