Unit-V

10. Compute the ordinates of influence line ordinate at an interval of 1 m for the reaction at support A in a continuous beam shown in fig.-10. EI remains constant throughout.

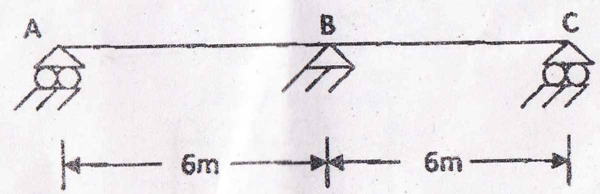

fig-10

11. Compute the ordinates of influence line ordinate at an interval of L/4 for the moment at support B in a continuous beam shown in fig.11. EI remains constant througout.

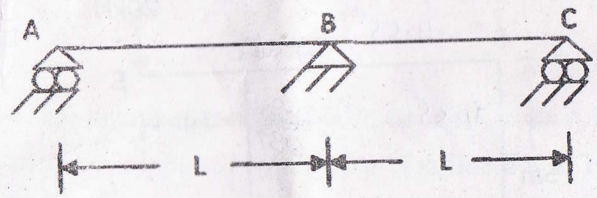

fig-11

Printed Pages– 10

Supply

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Centre No 84
I. T., G.G.V. Bilaspur [C.G.

AS-4136

B. Tech. (Fifth Semester) Examination, 2013

(Civil Engg. Branch) (I.T.)

STRUCTURAL ANALYSIS-II

Time Allowed : Three hours

Maximum Marks : 60

Note : *Attempt questions from all two sections as directed.*

Section-A 10×2

Note : *Attempt all questions. Each question carries 2 marks.*

1. Choose the correct alternative :

A continuous beam ABC is simply supported at A and C. Spans AB and BC are of equal length L. Each beam AB and BC is loaded with a concentrated load W acting at centers of AB and BC. The support moment M_B is ....

i) A two span continuous beam ABC is simply supported at A & C and is continuous over support B. Span AB = 6 m, BC = 6 m the beam carries a uniformly distributed load of 20 kN/m over both the spans. EI is constant for the entire beam. The fixed end moment at B in span BA or BC would be ....

iii) Determine the vertical reaction at support B for the continuous beam loaded as shown in fig.1. The EI is constant throughout.

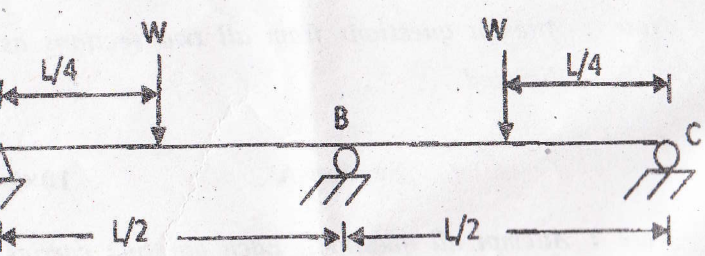


fig-1

(iv) The reaction at B in the propped cantilever loaded as shown in fig.2 is .... the EI is constant.

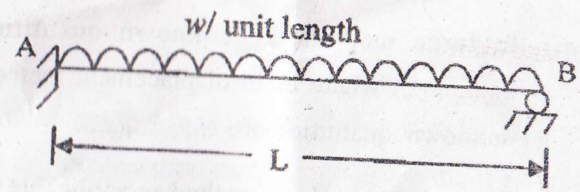


fig-2

(v) A steel frame is made of four members OA, OB, OC and OD. These members meet at the joint O, the joint O being rigid. Where $OA = OB = OC = l$ and $OD = l/2$. Joints A & B are fixed, joint C in hinged and point D is free. The rotational stiffness of the frame at joint is given by :

(a) 11 EI/l

(b) 10 EI/l

(c) 8 EI/l

(d) 6 EI/l

(vi) A two-span continuous beam simply supported at the ends and at the centers carries u.d.l. on both spans. If the central support settles by a small amount, the magnitudes of the maximum hogging BM will ....

In force method the unknown quantities are .... where as in displacement method, the unknown quantities are ....

The column analogy method is applicable for the indetermine structures having maximum redundancy equal to ....

The Mullter-Breslau principle for influence line is applicable for :

(a) Simple beam

(b) Continuous beam

(c) Redundant truss

(d) All the above

The variation of influence line for the stress function in a statically determine structure is :

(a) Linear

(b) Parabolic

(c) Circular

(d) None of above

Section-B

5×8=40

Note : One question from each unit is compulsory.

Unit-I

2. A beam of length 4 m is loaded as shown in fig. 3. Using consistent deformation method, calculate the reaction at B.

2.19 kN

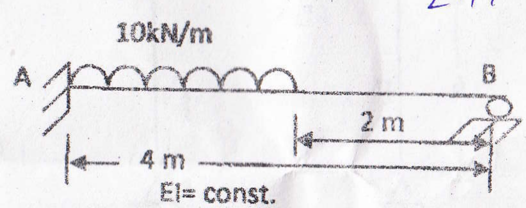


fig-3

3. A beam ABC of uniform EI rests on three simple supports A, B and C initialy at the same level. The spans AB and BC are each of length L. The span AB is loaded with a concentrated load W at the mid-span section and the span BC carries the load W uniformly distributed over the entire span. During loading, the middle support B sinks by an amount 5 $WL^3/96$ EI. Using three moment theorem, analyze the beam and compute the support reactions.

$M_A = M_B = M_C = 0$

$R_A = R_C = \frac{W}{2} \uparrow$

$R_B = W \uparrow$

PTO

Unit-II

. 4 shows a two-hinged portal carrying a uniformly tributed load w per meter run. Calculate the horizontal ust in the frame. The sectional moments of area of rtical members are I' and that of the horizontal member I as shown. Use strain energy method.

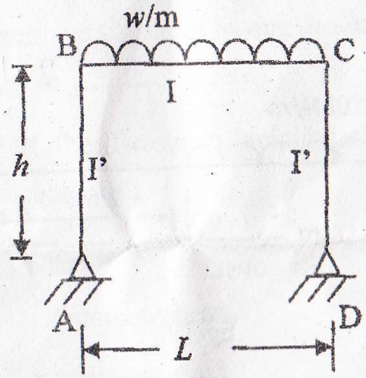


fig-4

A symmetrical triangular shaped arch ACB is hinged at upports A and C. The two members of the arch are of he same cross-section. A vertical load 'W' is placed as hown in fig. 5. Joint B is rigid. Determine the components of reactions and draw bending moment diagram indicating

maximum +ve and –ve magnitudes. Use strain energy method.

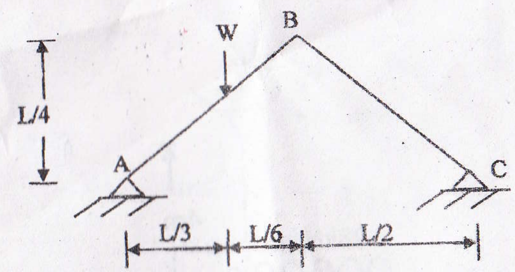


fig-5

Unit-III

6. Analyze the rigid frame show in fig-6 by moment distribution method. Draw the shear and moment diagrams.

1.85 199 3

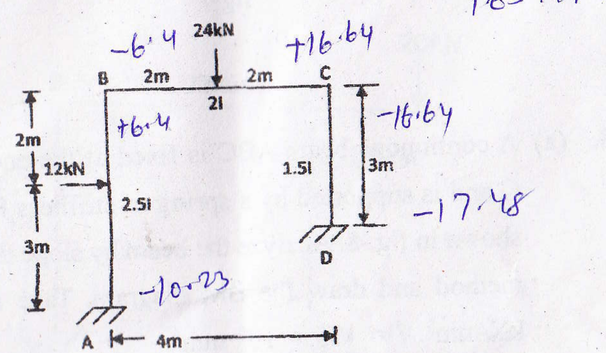


fig-6

PTO

alyze the rigid frame show in fig.-7 by moment tribution method. Also draw the BM diagram.

ES 2001

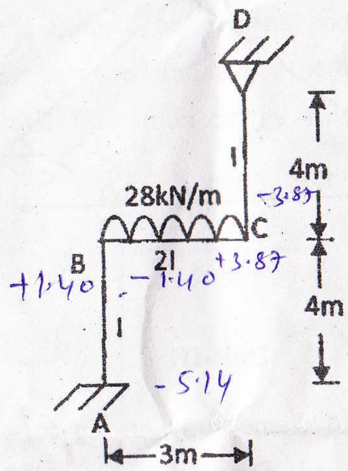


fig-7

Unit-IV

a) A continuous beam ABC is fixed at the ends A and C and is supported by a spring of stiffness K at B as shown in fig.-8. Analyze the beam by slope deflection method and draw the BM diagram. Take $E = 200$ kN/mm^2, $I = 175 \times 10^6$ mm^4.

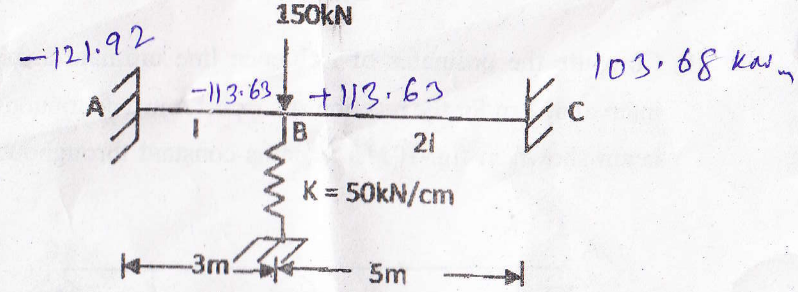


fig-8

(b) Explain the development of Column Analogy method.

9. Analyze the rigid jointed frame in the fig.-9 and draw bending moment and shear force diagrams. Use slope deflection method. Assume constant EI for all the members.

ES 1996

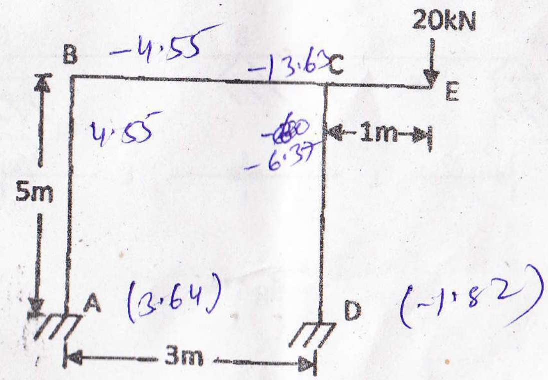


fig-9

Model Answer

AS – 4136

B. Tech. (V Sem) Examination, 2013
Civil Engg. Branch (I.T.)

STRUCTURAL ANALYSIS – II

SECTION – A

Q1. (i) – $\frac{3WL}{16}$

(ii) – 90 kNm

(iii) – $\frac{11W}{8}$

(iv) – $\frac{3wl}{8}$

(v) – (a)

(vi) – $\left(\frac{wl^2}{8} - \frac{3EI\Delta}{l^2}\right)$

(vii) – forces, displacements

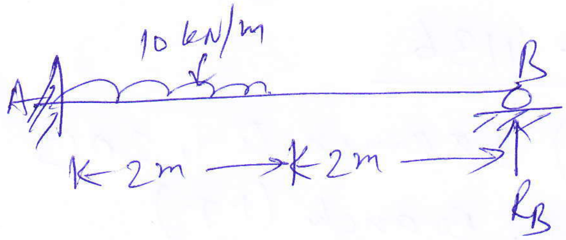
(viii) – 03

(ix) – (d)

(x) – (a)

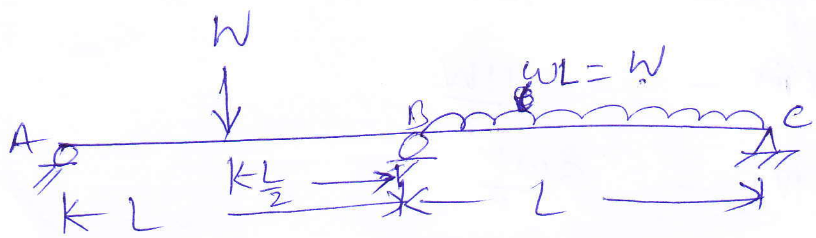
SECTION - B

Q2



$$R_B = \frac{21 WL}{384} = 2.190 \text{ kN}$$

Q3



$$\Delta_B = \frac{5WL^3}{96EI} \ (\downarrow)$$

w = intensity of u.d.l. per metre run.

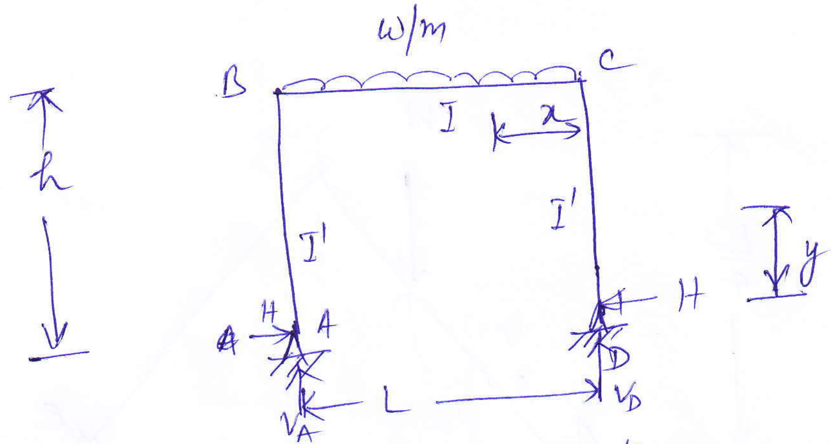
From three moment equation, we can get

$M_B = 0$. $M_A = M_B = 0$ (also)

$\therefore R_A = R_C = \frac{W}{2}$

and $R_B = W$.

Q 4



$V_A = V_B = \frac{wL}{2}$, H be redundant.

Member	M	$\frac{\partial M}{\partial H}$	I	Limits
AB	$-Hy$	$-y$	I'	0 – h
DC	$-Hy$	$-y$	I'	0 – h
CB	$\left(\frac{wL}{2}x - \frac{wx^2}{2} - Hh\right)$	$-h$	I	0 – L

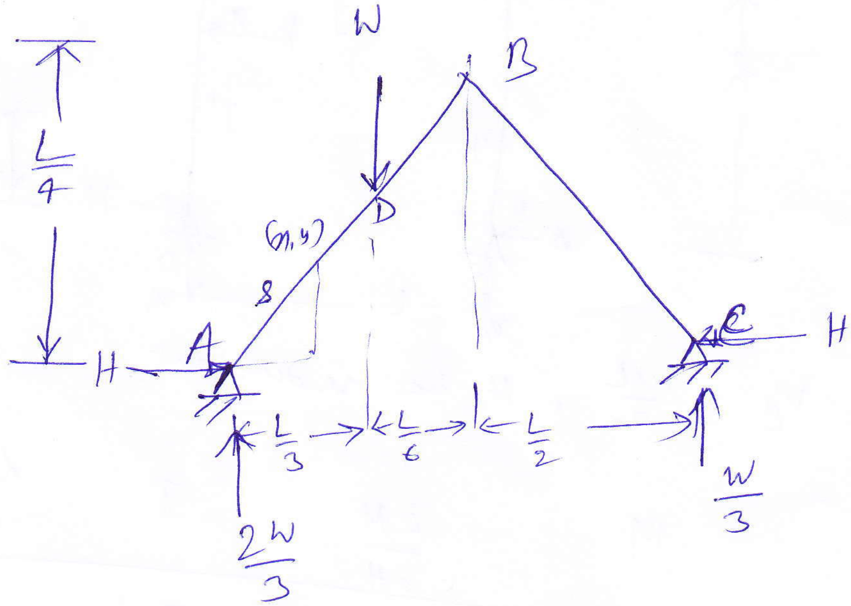
$$\int M \frac{\partial M}{\partial H} \frac{dx}{EI} = 0$$

$$\Rightarrow 2\int_0^h Hy^2 \frac{dy}{I'} - h\int_0^L \left(\frac{wL}{2}x - \frac{wx^2}{2} - Hh\right)\frac{dx}{I} = 0$$

$$\Rightarrow H\left[\frac{2}{3}\frac{h^2}{I'} + \frac{hL}{I}\right] = \frac{wL^3}{12I}$$

$$\boxed{H = \frac{\frac{wL^3}{12I}}{\frac{2}{3}\frac{h^2}{I'} + \frac{hL}{I}}}$$

Q5



$x = 0.894s$, $y = 0.447s$

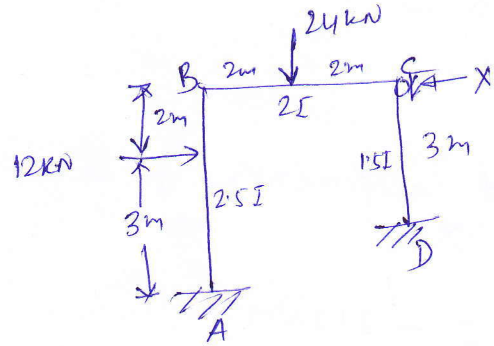
Member	origin at	limit	M	$\frac{\partial M}{\partial H}$
AD	A	0 – 0.373L (AD)	$\frac{2W}{3}x - Hy$	$-y$
DB	A	0.373L – 0.559L	$\frac{2W}{3}x - Hy - W(x - 0.333L)$	$-y$
BC	C	$0 - \frac{0.5L}{0.894}$ = 0 – 0.559L	$\frac{W}{3}x - Hy$	$-y$

$$\frac{\partial U}{\partial H} = 0 \Rightarrow \int_0^{0.373L} \left(\frac{2W}{3}x - Hy\right)(-y)\frac{ds}{EI} +$$

$$\int_{0.373L}^{0.559L} \left[\frac{2W}{3}x - Hy - W(x - 0.333L)\right](-y)\frac{ds}{EI} +$$

$$\int^{0.559L} \left(\frac{W}{3}x - Hy\right)(-y)\frac{ds}{EI} = 0$$

Q 6.



$M^F_{AB} = -5.76$ kNm

$M^F_{BA} = +8.64$ kNm

$M^F_{BC} = -12$ kNm

$M^F_{CB} = +12$ kNm

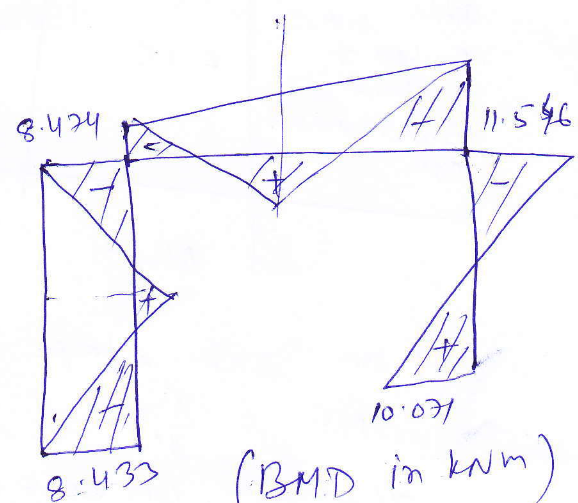
Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	0	0.5	0.5	0.5	0.5	0
FEM	−5.76	8.64	−12	+12	0	0
Bal	—	1.68	1.68	−6	−6	0
COF	0.84	0	−3	+0.84	0	−3
Bal	0	1.5	1.5	−0.42	−0.42	0
After 3 cycles End moments	−4.071	12.026	−12.026	+6.845	−6.845	−3.41

Also, $X = -5.37$ kN $(\rightarrow)$

After sway analysis, $X' = 31.21$ kN, $MF = \frac{X}{X'} = 0.172$

Hence, Final end moments are

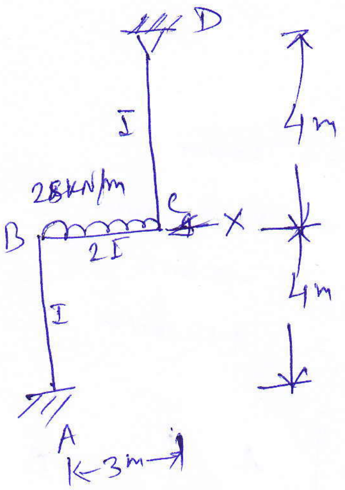
$$\left.\begin{aligned} M_{AB} &= -8.433 \\ M_{BA} &= +8.474 \\ M_{BC} &= -8.474 \\ M_{CB} &= +11.546 \\ M_{CD} &= -11.546 \\ M_{DC} &= -10.071 \end{aligned}\right\} \text{kNm}$$



(BMD in kNm)

Q7

Let restraining force is X.



$M^F_{BC} = -21 \text{ kNm}$

$M^F_{CB} = +21 \text{ kNm}.$

I - Moment distribution

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	0	3/11	8/11	32/41	9/41	1
FEM	0	0	−21	21	0	0
Bal	0	5.73	15.27	−16.40	−4.60	0
COF	2.860	0	−8.20	7.64	0	[illegible]
Bal	0	2.24	5.96	−5.96	−1.68	0
after six cycles of operation End moments are	5.15	9.29	−9.29	7.32	−7.32	0

Also, $X = 5.44 \text{ kN}.$

From 2nd stage moment distn, $X' = 4.28$

$MF = \frac{X}{X'}$

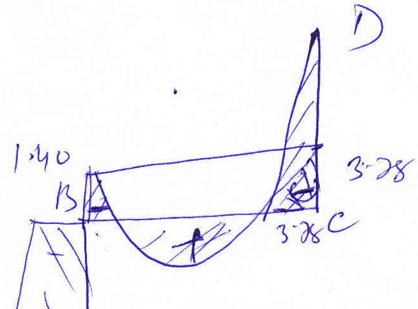
The net BM are

$M_{AB} = -5.14$

$M_{BA} = 1.40$

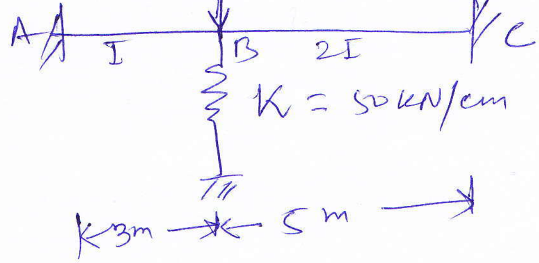
$M_{BC} = -1.40$

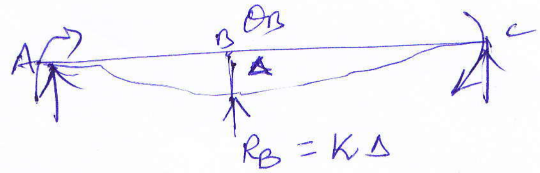
kNm



$EI = 200 \times 175 \times 10^6 \ kNmm^2$

$EI = 200 \times 175 \ kN\,m^2$





$M_{AB} = \frac{2EI}{3}\left(\theta_B - \frac{3\Delta}{3}\right)$

$M_{BA} = \frac{2EI}{3}\left(2\theta_B - \frac{3\Delta}{3}\right)$

$M_{BC} = \frac{4EI}{5}\left(2\theta_B + \frac{3\Delta}{5}\right)$

$M_{CB} = \frac{4EI}{5}\left(\theta_B + \frac{3\Delta}{5}\right)$

$\Sigma M_B = 0 \Rightarrow \frac{2EI}{3}\left(2\theta_B - \frac{3\Delta}{3}\right) + \frac{4EI}{5}\left(2\theta_B + \frac{3\Delta}{5}\right) = 0$

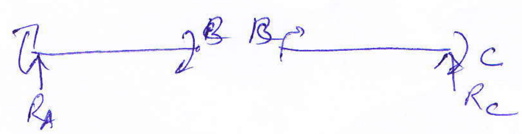
$\frac{50(2\theta_B - \Delta) + 60\left(2\theta_B + \frac{3\Delta}{5}\right)}{75} = 0$

$100\theta_B - 50\Delta + 120\theta_B + 36\Delta = 0$

$220\theta_B - 14\Delta = 0$

$110\theta_B - 7\Delta = 0 \quad (1)$

$R_A + R_C - 150 + R_C = 0, \quad R_C = K\Delta$



$R_A = \frac{M_{AB} + M_{BA}}{3} \qquad R_C = \frac{M_{BC} + M_{CB}}{5}$

$\Rightarrow \left\{-(5M_{AB} + 5M_{BA}) + 3M_{BC} + 3M_{CB}\right\}\frac{1}{15} = 150 - \frac{50}{10^2}\Delta = 150 - 5000\Delta$

$-5M_{AB} * 5M_{BA} + 3M_{BC} + 3M_{CB} = 2250 - 750 \times 10^2\Delta$

$-\frac{10EI}{3}(\theta_B - \Delta) - \frac{10EI}{3}(2\theta_B - \Delta) + \frac{12}{5}EI\left(2\theta_B + \frac{3\Delta}{5}\right)$

$+ \frac{12}{5}EI\left(\theta_B + \frac{3\Delta}{5}\right) = 2250 - 750 \times 10^2\Delta$

$$-3.33\theta_B + 3.33\Delta - 6.67\theta_B + 3.33\Delta \quad = 0.0643 - 2.143\Delta$$

$$+4.8\theta_B + 1.44\Delta + 2.4\theta_B + 1.44\Delta$$

$$-2.8\theta_B + 9.54\Delta = 0.0643 - 2.143\Delta$$

$$-2.8\theta_B + 11.683\Delta = 0.0643 \qquad (2)$$

From (1), $\theta_B = \frac{7}{110}\Delta$

From (2), $\Delta = 5.59 \times 10^{-3}$

$\theta_B = 3.56 \times 10^{-4}$

$\therefore$ $M_{AB} = -122.13$ kNm

$M_{BA} = -113.82$ kNm

$M_{BC} = 113.82$ kNm

$M_{CB} = 103.68$ kNm

Q 8 (b)

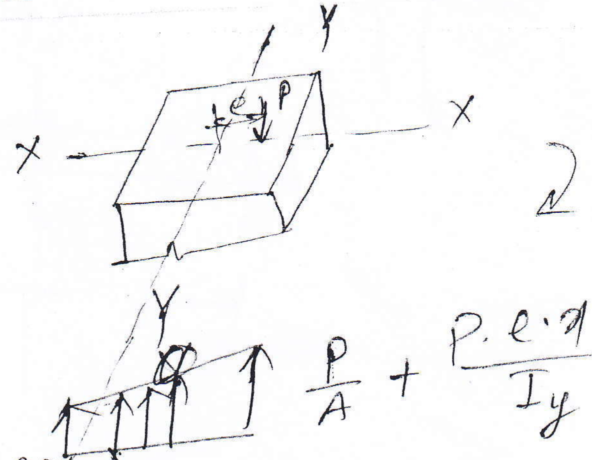
Column Analogy

Hardy Cross in 1932.

This method can be applied to fixed beam, frames, single span arches, closed frames having degree of redundancy not more than THREE.

Development of the method

Consider a short column as loaded shown in Fig.



$$\frac{P}{A} + \frac{P.e.x}{I_y}$$

~~M = P.e~~

$$\left(\frac{P}{A} - \frac{Pex}{I_y}\right)$$

where $M_y = P.e$

i.e, $f = \frac{P}{A} \pm \frac{Pex}{I_y}$

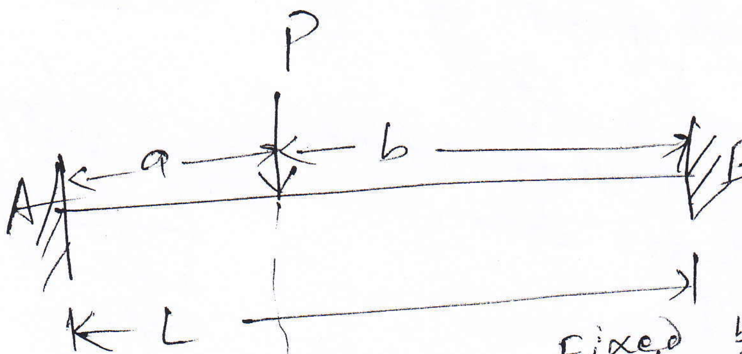
Conclusions

Summary

1. The resultant of the stresses is equal to the applied load P.

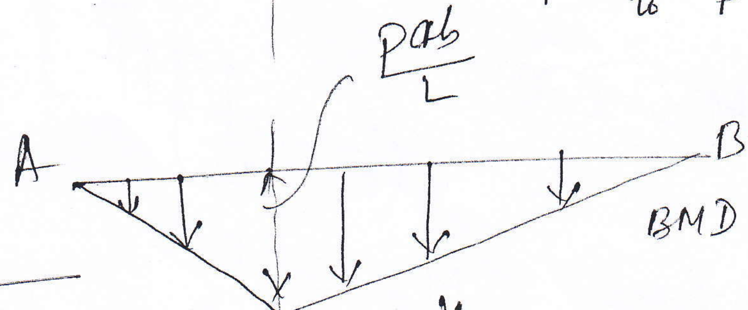
2. Centroid of the resultant coincides with the line of action of P.

Consider a fixed beam as shown below.

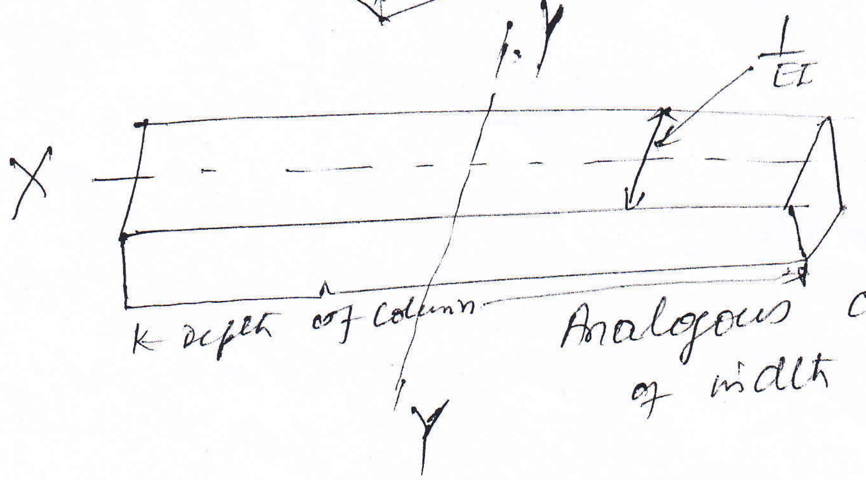


Fixed beam subjected to P.

S/S beam



BMD for M_s



Analogous column of width $\left(\frac{1}{EI}\right)$

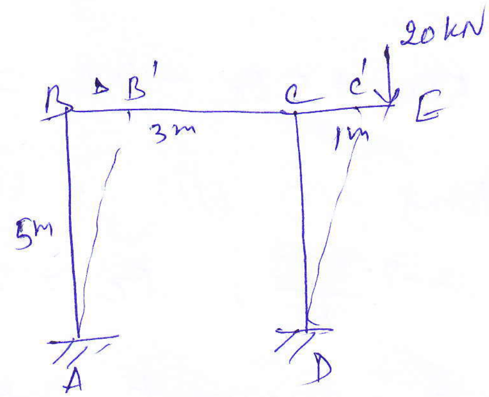
In the analogous column

- width $= \frac{1}{EI}$
- depth = Length of beam along the axis.
- Loading on column is the M_s diagram acting downward.
- The upward stress distribution across the depth of the column is M_i diagram (FEM distribution).

(Q9) (12)

Q9

EI = const.



$\theta_A = \theta_D = 0$

$BB' = \Delta = CC'$

$M^F_{AB} = M^F_{BA} = M^F_{BC} = M^F_{CB} = 0$

$M^F_{CD} = M^F_{DC} = 0 \quad , \quad M_{CE} = -20\,kNm.$

$M_{AB} = 0 + \frac{2EI}{5}\left(\theta_B - \frac{3\Delta}{5}\right) \Rightarrow M_{AB} = \frac{2}{5}EI\theta_B - \frac{6}{25}EI\Delta$

$M_{BA} = \frac{4EI\theta_B}{5} - \frac{6EI\Delta}{25}$

$M_{BC} = 0 + \frac{2EI}{3}(2\theta_B + \theta_C) = \frac{4EI\theta_B}{3} + \frac{2EI\theta_C}{3}$

$M_{CB} = 0 + \frac{2EI\theta_B}{3} + \frac{4EI\theta_C}{3}$

$M_{CD} = 0 + \frac{2EI}{5}\left(2\theta_C - \frac{3\Delta EI}{5}\right) = \frac{4EI\theta_C}{5} - \frac{6EI\Delta}{25}$

$M_{DC} = \frac{2EI\theta_C}{5} - \frac{6EI\Delta}{25}$

$\Sigma M_B = 0 \Rightarrow M_{BA} + M_{BC} = 0$

$$EI\left[\frac{4\theta_B}{5} - \frac{6\Delta}{25} + \frac{4\theta_B}{3} + \frac{2\theta_C}{3}\right] = 0$$

$$\frac{60\theta_B - 18\Delta + 100\theta_B + 50\theta_C}{75} = 0$$

$\Rightarrow 160\theta_B + 50\theta_C - 18\Delta = 0$

$\Rightarrow 80\theta_B + 25\theta_C - 9\Delta = 0 \qquad (1)$

$\Sigma M_C = 0 \Rightarrow M_{CB} + M_{CD} + M_{CE} = 0$

$$\Rightarrow \left(\frac{2\theta_B}{3} + \frac{4\theta_C}{3}\right)EI + EI\left(\frac{4\theta_C}{5} - \frac{6\Delta}{25}\right) - 20 = 0$$

$$\Rightarrow \frac{50\theta_B + 100\theta_C + 60\theta_C - 18\Delta}{75} = \frac{20}{EI}$$

$\Rightarrow 25\theta_B + 80\theta_C - 9\Delta = 750 \qquad (ii)$

13

$\Rightarrow \quad 5\theta_B + 5\theta_C - 4\Delta = 0 \quad -(iii)$

Solving (i), (ii) & (iii)

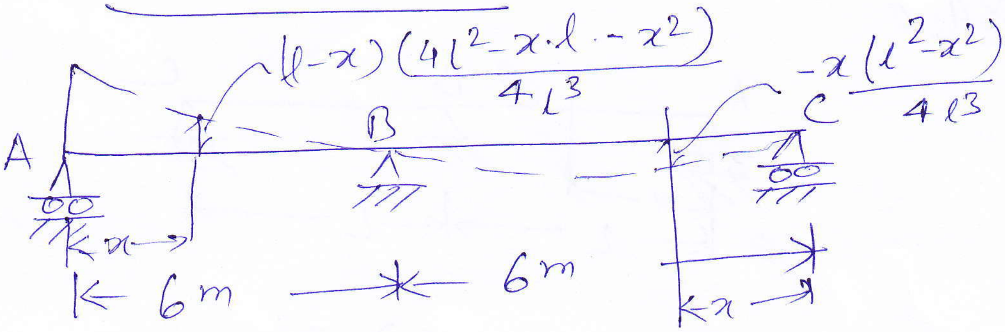
$\theta_B = -\frac{2.273}{EI}, \quad \theta_C = \Delta = \frac{11.364}{EI}$

Then, end moments are

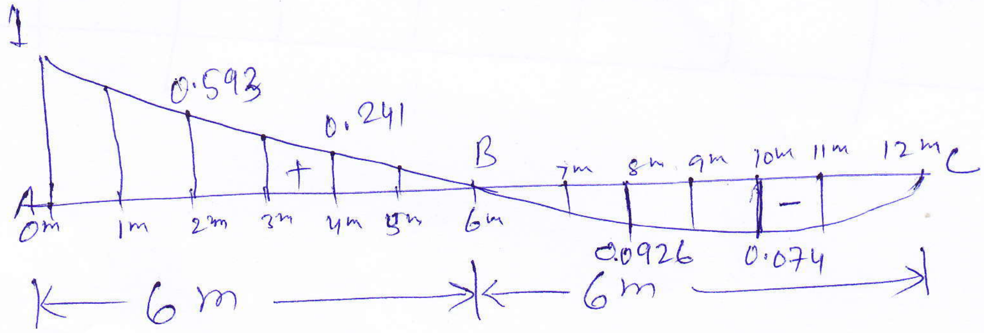
$$
\left.
\begin{aligned}
M_{AB} &= -3.64 \text{ kNm} \\
M_{BA} &= -4.55 \text{ kNm} \\
M_{BC} &= +4.55 \text{ kNm} \\
M_{CB} &= 13.632 \text{ kNm} \\
M_{CD} &= 6.37 \text{ kNm} \\
M_{DC} &= 1.818 \text{ kNm} \\
M_{CE} &= -20 \text{ kNm}
\end{aligned}
\right\}
$$

Q10

IL for R_A ?

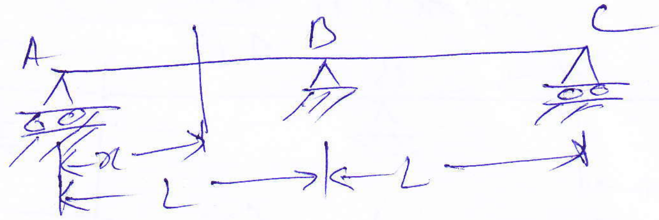


ILD for R_A.



IL for R_A at 1m interval

Q 11



$$M_B = -\frac{x}{4L^2}\left(x^2 - L^2\right)$$

from A x	0	$\frac{L}{4}$	$\frac{L}{2}$	$\frac{3L}{4}$	L	$\frac{5L}{4}$	$\frac{3L}{2}$	$\frac{7L}{4}$	$2L$
IL for M_B	0	0.059	0.094	0.0820	0	0.0820	0.094	0.059	0