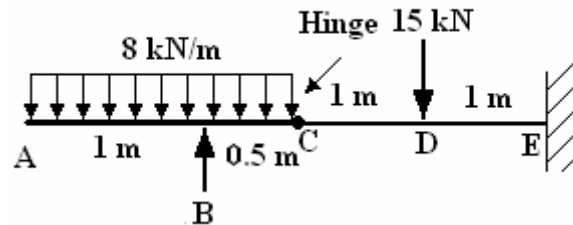


MECHANICAL AND STRUCTURAL ENGINEERING C105
EXAM QUESTIONS 2005 Q2

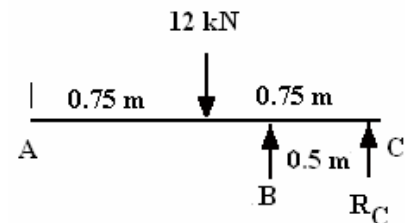
The horizontal beam a b c d e shown is rigidly built-in at E and simply supported at B. C is a pin jointed hinge and so the bending moment must be zero at C. It follows that the beam is statically determinate.

- Calculate the magnitude of the resulting vertical reactions at B and E and the value of the fixing moment at E.
- Sketch the shear-force diagram stating the values at A,B,C,D and E
- Sketch the bending moment diagram stating the values at A,B,C,D and E
- If the given beam (containing the hinge) is replaced by a continuous beam ABCDE (without a hinge) which is supported and loaded in the same way as the original, state only how you would determine the values of the reactions at B and E for this new condition of static indeterminacy.



- Replace the UDL with a single equivalent load i.e. $8 \times 1.5 = 12 \text{ kN}$.

This will act at the middle between A and C Section ABC is equivalent to the following.



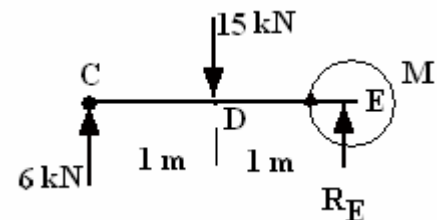
Take moments about C

$12 \times 0.75 + R_B \times 0.5 = 0$ (pin joint cannot have a bending moment) Hence $R_B = 18 \text{ kN}$

Take moments about B

$12 \times 0.25 + R_C \times 0.5 = 0$ Hence $R_C = -6 \text{ kN}$

Check $R_B + R_C = 18 - 6 = 12 \text{ kN}$

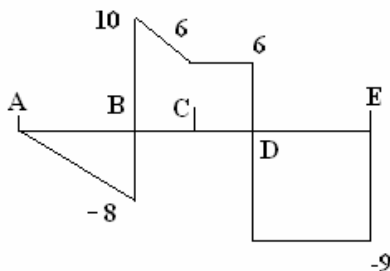


Now consider section CDE. The 6 kN at C acts down on this section so it is apparent that R_E is 9 kN up

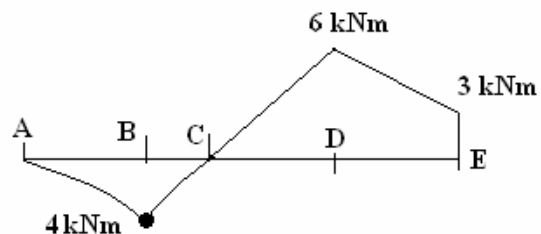
Moments at E

$6 \times 2 - 15 \times 1 + M = 0$ Hence $M = 3 \text{ kNm}$ (clockwise as shown)

- Shear Force



- Bending Moment



- Set up an equation for the bending moment at distance x from the free end. From the theory of beams we know that

$$M = EI \frac{d^2y}{dx^2}$$

$$\text{Integrating } EI \frac{dy}{dx} = \int M \, dx$$

$$\text{Integrating } EI y = \int \int M \, dx$$

The resulting equation contains unknown reactions and constants of integration A and B. These must be found from boundary conditions. These are $y = 0$ at B and E and $dy/dx = 0$ at E