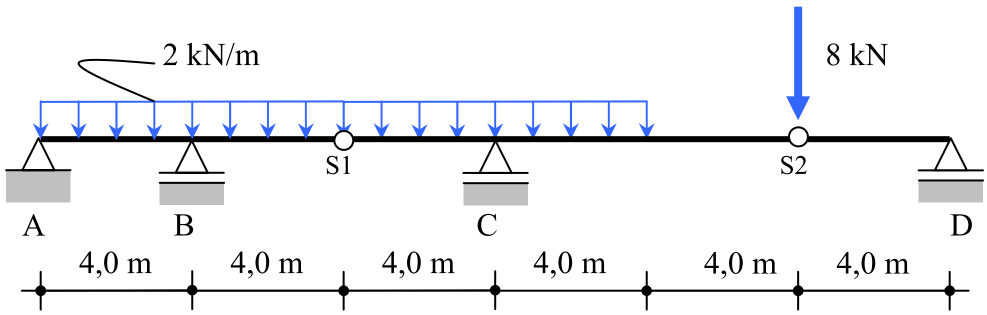
Assignment (30 minutes)

The hinged beam shown in the figure is loaded with a force and a distributed load. For this beam the forces at the support C are asked for. The generalised forces in the beam (shear and bending) and the support reaction have to be determined by using the principle of **Virtual Work**.

Note: You may check your answers with equilibrium conditions. A correct mechanism is vital so pay extra attention to a complete sketch of the problem including the assumed direction of the generalised forces and applied virtual displacements.



Question

a) Determine the support reaction at C with Virtual Work.
b) Determine the beam moment at C with Virtual Work.
c) Determine the shear force directly to the right of the support at C with Virtual Work.
d) Determine the shear force directly to the left of the support at C with Virtual Work.
e) Free the support and part of the beam at C and show a free body diagram with all generalised forces. Daw these forces in the directions in which these forces actually work.

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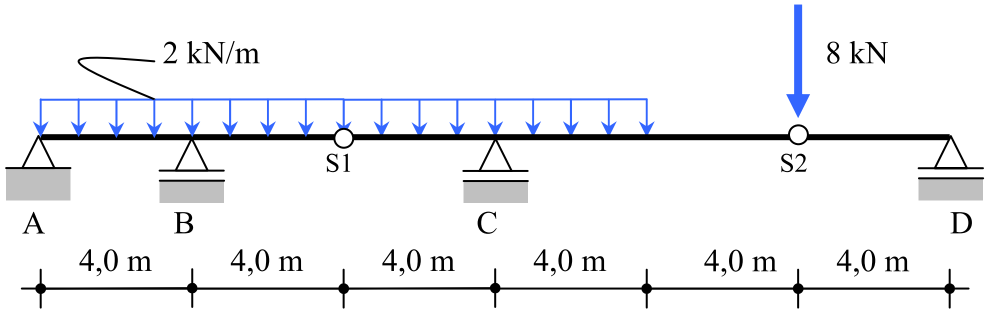
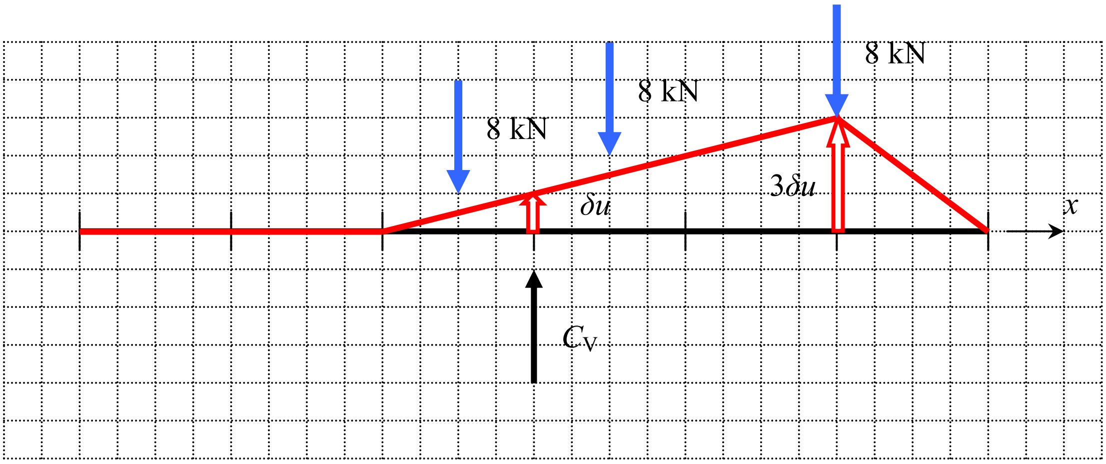
Solution



Questions

a) Support reaction at C.



$$\delta A = 0; \quad C_V \times \delta u - 8 \times \tfrac{1}{2}\delta u - 8 \times \tfrac{3}{2}\delta u - 8 \times 3\delta u = 0 \quad \Rightarrow \quad C_V = 40 \text{ kN} \uparrow$$

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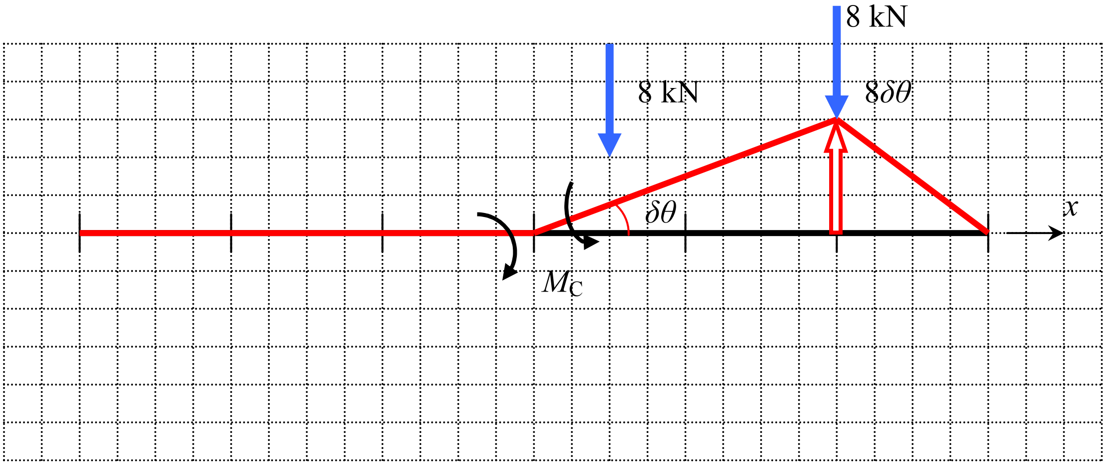
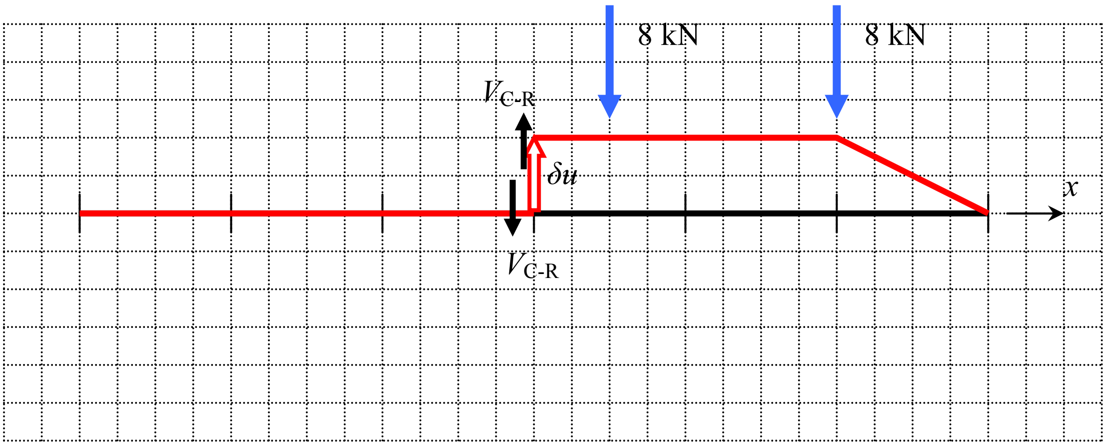
b) Beam moment at C



$$\delta A = 0; \quad M_C \times \delta\theta - 8 \times 2\delta\theta - 8 \times 8\delta\theta = 0 \quad \Rightarrow \quad M_C = 80 \text{ kNm}$$

c) Shear force directly to the right of C



$$\delta A = 0; \quad V_{C-R} \times \delta u - 8 \times \delta u - 8 \times \delta u = 0 \quad \Rightarrow \quad V_{C-R} = 16 \text{ kN}$$

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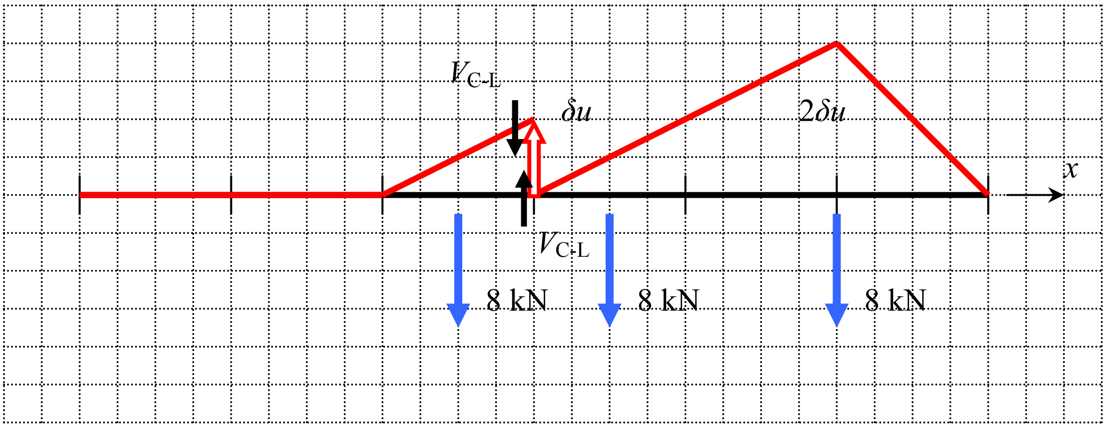
d) Shear force directly to the left of C



$$\delta A = 0; \quad -V_{C-L} \times \delta u - 8 \times \tfrac{1}{2}\delta u - 8 \times \tfrac{1}{2}\delta u - 8 \times 2\delta u = 0 \quad \Rightarrow \quad V_{C-L} = -24 \text{ kN}$$

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The assumed direction was incorrect. In reality the shear
force acts opposite.
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e) Draw the free body diagram of C