6.3 Shear and bending

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS shear force • bending moment

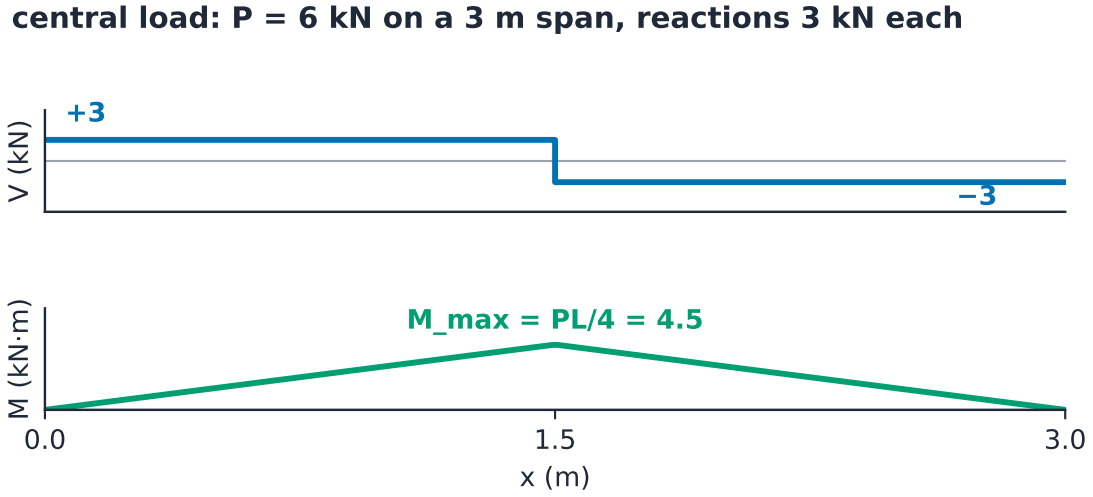
Objective

Construct shear-force and bending-moment diagrams by sections, keep the sign convention, and use the differential relations to check the shapes.

1 Key knowledge and worked examples

■ The differential chain

$dV/dx = -w(x)$ and $dM/dx = V$; sagging positive. Central load: $M_{max} = PL/4$; uniform load: $M_{max} = wL^2/8$.



*The shear steps, the moment peaks

■ Worked example. The 3 m arm

Central $P = 6$ kN: reactions 3 kN, V steps ± 3 kN, $M_{max} = PL/4 = 4.5$ kN · m; as a uniform $w = 2$ kN/m instead: $M_{max} = wL^2/8 = 2.25$ kN · m.

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2 Practice

2.1 A simply supported span of $L = 5$ m carries a central point load $P = 10$ kN: the support reactions and the maximum bending moment (one decimal, kN · m). [3]

2.2 A simply supported span of $L = 4$ m carries a uniform load $w = 3$ kN/m over the whole span: the support reactions, the maximum shear force and the maximum bending moment (one decimal, kN · m). [4]

2.3 For the beam of 2.2: where does the bending moment peak, and what are the two differential relations that connect load, shear and moment? [4]

2.4 One sentence each: what does a hinge do to the bending moment diagram, and why does a kink in the moment diagram mean a point load acts there? [3]

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Solutions

2.1

- Symmetric span: $R = P/2 = \mathbf{5}$ kN each.
- $M_{max} = PL/4 = 10 \times 5/4 = \mathbf{12.5}$ kN · m at mid-span.

2.2

- $R = wL/2 = 3 \times 4/2 = \mathbf{6}$ kN each.
- $V_{max} = \mathbf{6}$ kN at the supports.
- $M_{max} = wL^2/8 = 3 \times 16/8 = \mathbf{6.0}$ kN · m at mid-span.

2.3

- It peaks at mid-span, where the shear diagram crosses zero.
- $dV/dx = -w(x)$ - the load intensity tilts the shear diagram.
- $dM/dx = V$ - the shear is the slope of the moment diagram.

2.4

- A hinge carries no moment: $M = 0$ at the hinge pin.
- A kink means the moment slope changes abruptly, and $dM/dx = V$ - a step in V, i.e. a point load.

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