The deflection should be based upon the unfactored imposed loads alone. These and the resulting shear and bending moment diagrams are shown in Figure 5.26. By equating the maximum bending moment of 129 kN m to the expression for the bending moment due to a UDL, an equivalent UDL can be calculated:

$$129 = \frac{WL}{8}$$

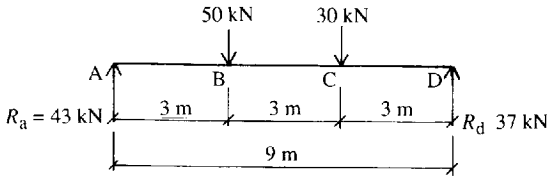
$$W = \frac{8 \times 129}{L} = \frac{8 \times 129}{9} = 115\,\text{kN}$$

This equivalent UDL of 115 kN may be substituted in the expression for the deflection of a simply supported beam:

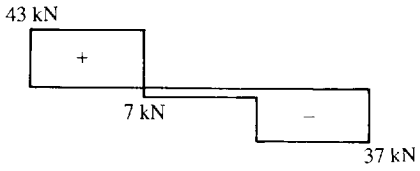
$$\text{Actual deflection } \delta_a = \frac{5}{384}\frac{WL^3}{EI} = \frac{5}{384} \times \frac{115 \times 10^3 \times 9000^3}{205 \times 10^3 \times 33\,400 \times 10^4} = 15.94\,\text{mm}$$

$$\text{Deflection limit } \delta_p = \frac{\text{span}}{360} = \frac{9000}{360} = 25\,\text{mm}$$

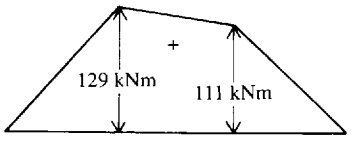
Thus $\delta_a < \delta_p$, and the beam is satisfactory in deflection.



(a) Unfactored imposed load diagram



(b) Shear force diagram



(c) Bending moment diagram

Figure 5.26 *Beam diagrams for unfactored imposed loads*

Web buckling and bearing

The web buckling and bearing requirements are not critical and therefore the calculations for these will be omitted.

Conclusion

That completes the check on the section, which has been shown to be adequate in bending, shear and deflection. Thus:

Adopt 457 × 191 × 74 kg/m UB.

5.11 Fabricated beams

In situations where standard rolled sections are found to be inadequate, consideration should be given to the following fabricated alternatives.

Compound beams

The strength of standard rolled sections can be increased by the addition of reinforcing plates welded to the flanges. Beams strengthened in this way are called compound beams. Examples are shown in Figure 5.27.

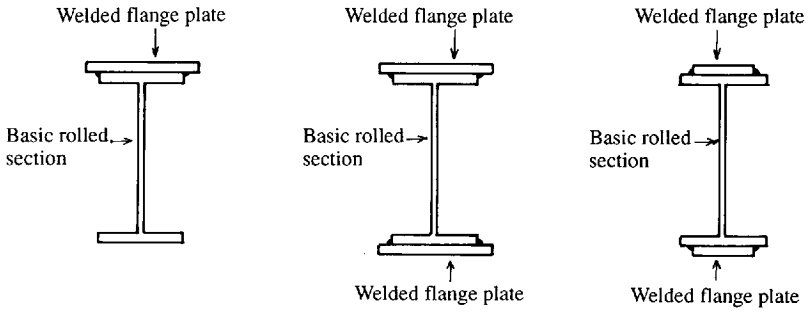


Figure 5.27 *Examples of compound beams*

Castellated beams

Standard rolled sections can be converted by cutting and welding into much deeper sections known as castellated beams. They offer a relatively simple method of increasing the strength of a section without increasing its weight.

To form a castellated beam, the basic rolled section is first flame cut along its web to a prescribed profile as shown in Figure 5.28a. Then the resulting two halves are rejoined by welding to form the castellated beam shown in Figure 5.28b. The finished section is stronger in bending than the original but the shear strength is less. However, this usually only affects heavily loaded short span beams, and may be overcome where necessary by welding fitted plates into the end castellations as shown in Figure 5.28c.