Shear

Both the combination of maximum moment and coexistent shear, and the combination of maximum shear and coexistent moment, should be checked.

The shear resistance of a beam is checked by ensuring that the ultimate shear force F_v does not exceed the shear capacity P_v of the section at the point under consideration:

$$F_v \leqslant P_v$$

It should be noted that the moment capacity of plastic and compact beam sections must be reduced when high shear loads occur. However, this is not usually a problem except for heavily loaded short span beams.

A high shear load condition exists when

$$F_v > 0.6P_v$$

Deflection

The deflection requirement of a beam is checked by comparing the actual deflection produced by the unfactored imposed loads with the recommended limits given in BS 5950 Table 5:

$$\text{Actual deflection} < \text{recommended deflection limit}$$

Web buckling

The web buckling resistance of an unstiffened web must be greater than any concentrated load that may be applied.

Web bearing

The web bearing resistance of an unstiffened web must be greater than any concentrated load that may be applied.

It should be appreciated that the requirements for web buckling and bearing are not usually critical under normal loading conditions. Furthermore, they can if necessary be catered for by the inclusion of suitably designed web stiffeners.

Before leaving the topic of beams, let us look at a further example illustrating the complete design of a laterally unrestrained beam using the rigorous approach.

Example 5.10

The simply supported beam shown in Figure 5.24 is laterally restrained at the ends and at the points of load application. For the loads given below, determine the size of grade 43 section required.

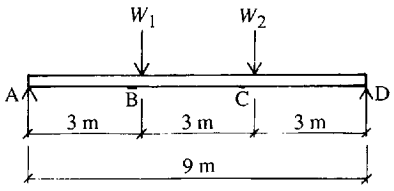


Figure 5.24 *Simply supported beam*

Specified dead loads:

Point load $W_{1d} = 30\,\text{kN}$; point load $W_{2d} = 20\,\text{kN}$

Self-weight = 1 kN/m; SW UDL = $1 \times 9 = 9\,\text{kN}$

Specified imposed loads:

Point load $W_{1i} = 50\,\text{kN}$; point load $W_{2i} = 30\,\text{kN}$

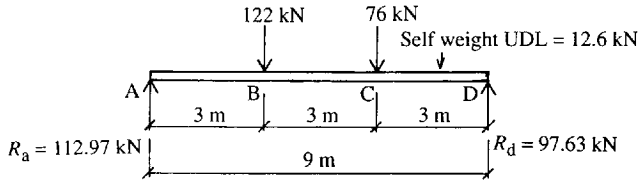
Ultimate design loads:

$W_1 = \gamma_f W_{1d} + \gamma_f W_{1i} = 1.4 \times 30 + 1.6 \times 50 = 42 + 80 = 122\,\text{kN}$

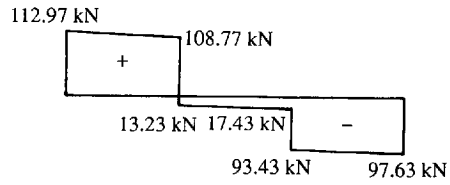
$W_2 = \gamma_f W_{2d} + \gamma_f W_{2i} = 1.4 \times 20 + 1.6 \times 30 = 28 + 48 = 76\,\text{kN}$

SW UDL = $1.4 \times 9 = 12.6\,\text{kN}$

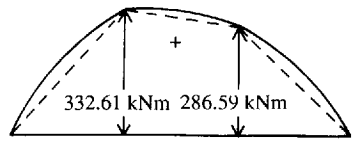
The ultimate design load diagram and the corresponding shear force and bending moment diagrams are shown in Figure 5.25. Since the loading is not symmetrical, the reactions and moments are calculated from first principles.



(a) Ultimate design load diagram



(b) Shear force diagram



(c) Bending moment diagram

Figure 5.25 *Beam diagrams for ultimate loads*