5.10.4 Shear ULS

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:

$$F_v \leqslant P_v$$

where

F_v ultimate shear force at point under consideration
P_v shear capacity of section: $P_v = 0.6 p_y A_v$
p_y design strength of steel, given in Table 5.1.
A_v area of section resisting shear: $A_v = tD$ for rolled sections, as shown in Figure 5.16
t total web thickness, from section tables
D overall depth of section, from section tables

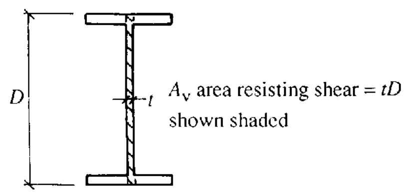


Figure 5.16 *Area of a rolled section resisting shear*

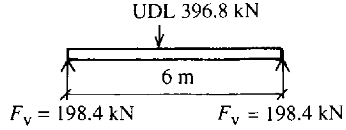
It is recommended in BS 5950 that the combination of maximum moment and coexistent shear, and the combination of maximum shear and coexistent moment, should be checked. The moment capacity of plastic and compact beam sections is reduced when high shear loads occur. A high shear load is said to exist when the ultimate shear force exceeds 0.6 times the shear capacity of the section, that is when $F_v > 0.6P_v$. However, as mentioned in Example 5.1, this is not usually a problem except for heavily loaded short span beams.

When the depth to thickness ratio d/t of a web exceeds 63ε, where $\varepsilon = (275/p_y)^{1/2}$ as previously referred to in Table 5.4, the web should be checked for shear buckling. This does not apply to any of the standard rolled sections that are available, but it may apply to plate girders made with thin plates.

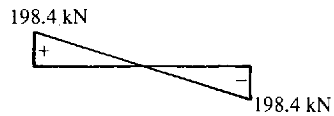
It should be appreciated that, if necessary, the web of a beam may be strengthened locally to resist shear by the introduction of stiffeners, designed in accordance with the recommendations given in BS 5950.

Example 5.5

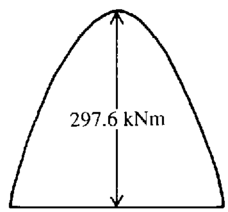
Check the shear capacity of the beam that was designed for bending in Example 5.1. The loading, shear force and bending moment diagrams for the beam are shown in Figure 5.17.



(a) Ultimate load diagram



(b) Shear force diagram



(c) Bending moment diagram

Figure 5.17 *Beam diagrams for ultimate loads*

The section selected to resist bending was a 457 × 152 × 60 kg/m UB, for which the relevant properties for checking shear, from Table 5.2, are $t = 8.0$ mm and $D = 454.7$ mm. Beam sections should normally be checked for the combination of maximum moment and coexistent shear, and the combination of maximum shear and coexistent moment. However, since the beam in this instance only carried a UDL the shear is zero at the point of maximum moment. Therefore it will only be necessary to check the section at the support where the maximum shear occurs and the coexistent moment is zero.

Ultimate shear at support $F_v = 198.4\,\text{kN}$

Shear capacity of section $P_v = 0.6p_yA_v = 0.6p_ytD$

$$= 0.6 \times 275 \times 8 \times 454.7 = 600\,204\,\text{N}$$

$$= 600\,\text{kN} > 198\,\text{kN}$$

That is $F_v < P_v$, and therefore the section is adequate in shear.

Example 5.6

Check the shear capacity of the beam that was designed for bending in Example 5.2. The loading, shear force and bending moment diagrams for the beam are shown in Figure 5.18.

The section selected to resist bending was a 457 × 152 × 74 kg/m UB, for which the relevant properties for checking shear, from Table 5.2, are $t = 9.9$ mm and $D = 461.3$ mm. In addition it should be noted that the flange thickness T of this section