AD 368
Shear resistance of I-sections in P363

This Advisory Desk Note provides clarification and further guidance on the design shear resistance values given in SCI P363 *Steel building design: Design data* (Euro Blue Book) for I-Sections, under the tables for web bearing and buckling.

In P363, Section 9.1(a) of the Explanatory notes states that the design shear resistance of the cross section $V_{c,Rd}$ is calculated in accordance with BS EN 1993-1-1, Clause 6.2.6 using:

$$V_{c,Rd} = V_{pl,Rd} = \frac{A_v(f_y/\sqrt{3})}{\gamma_{M0}}$$

where:

A_v is the shear area ($A_v = A - 2bt_f + (t_w + 2r)$ tf but not less than $\eta h_w t_w$ for rolled I sections)

f_y is the yield strength

γ_{M0} is the partial factor for resistance of cross sections ($\gamma_{M0} = 1.0$, according to the UK in the National Annex).

However, in addition, BS EN 1993-1-1, Clause 6.2.6(6) requires the shear buckling resistance to be verified in accordance with BS EN 1993-1-5 if the web slenderness is such that:

$$\frac{h_w}{t_w} > 72\frac{\varepsilon}{\eta}$$

where:

h_w is the clear web depth between the flanges (= h - 2t_f for rolled I-sections, see BS EN 199315, Clause 1.4) . Note that this is not the same as c, as defined in Table 5.2 of BS EN 1993-1-1.

t_w is the web thickness

t_f is the flange thickness

$$\varepsilon = \sqrt{\frac{235}{f_y}} \quad (f_y \text{ in N/mm}^2)$$

η is given in NA.2.4 of UK NA to BS EN 1993-1-5 as $\eta = 1$ (and BS EN 1993-1-1 permits η to be conservatively taken as equal to 1.0)

There is no need to verify the shear buckling resistance for any UKB sections made of steel grade S275 because h_w/t_w is within the above limit. For grade S355, only two UKB sections (406 × 140 × 39 UKB, with $h_w/t_w = 59.5$ and 762 × 267 134 UKB, with $h_w/t_w = 59.9$) require shear buckling resistance verification because the ratios exceed the limit of $72\varepsilon/\eta = 72 \times 0.81 = 58.3$.

Clause 5.1(2) of BS EN 1993-1-5 states that plates with h_w/t_w greater than $72\varepsilon/\eta$ should be checked for resistance to shear buckling and should be provided with transverse stiffeners at the supports.

Example

Consider the shear resistance of a 406 × 140 × 39 UKB grade S355.

$h_w/t_w = (398.0 - 2 \times 8.6)/6.4 = 59.5 > 58.3$

Therefore, shear buckling resistance is to be determined

For transverse stiffeners at supports only, Expression 5.5 of BS EN 1993-1-5 gives

$$\bar{\lambda}_w = \frac{h_w}{86.4t\varepsilon} = \frac{380.8}{86.4 \times 6.4 \times 0.81} = 0.85$$

For a non-rigid end post, Table 5.1 of BS EN 1993-1-5 gives

$$\chi_w = \frac{0.83}{\lambda_w} = \frac{0.83}{0.85} = 0.976$$

Expression (5.2) of BS EN 1993-1-5 gives

$$\chi_w = \frac{0.83}{\lambda_w} = \frac{0.83}{0.85} = 0.976$$

Expression (5.1) of BS EN 1993-1-5 gives

$$V_{bw,Rd} = \frac{\chi_w f_{yw} h_w t_w}{\sqrt{3}\gamma_{M1}} = \frac{0.976 \times 355 \times 380.8 \times 6.4}{\sqrt{3} \times 1.0} = 488 \text{ kN}$$

Ignoring the contribution from the flange to the shear buckling resistance

$$V_{b,Rd} = V_{bw,Rd} \le \frac{f_{yw} h_w t_w}{\sqrt{3}\gamma_{M1}} = \frac{355 \times 380.8 \times 6.4}{\sqrt{3} \times 1.0} = 500 \text{ kN}$$

Therefore $V_{b,Rd} = 488$ kN

The Blue Book gives $V_{c,Rd} = 566$ kN for this section.

Similarly, for a 762 × 267 134 UKB grade S355, $V_{b,Rd} = 1768$ kN and $V_{c,Rd} = 1970$ kN

For these two sections, the shear resistances given in the Blue Book are greater than given by the full application of the rules in the Eurocodes. The lesser values should always be used in design. Although the difference between the shear buckling resistance and the cross-section shear resistance appear large (14% and 10% respectively), in practical cases this will not be critical for member sizing.

Contact: **Dorota Koschmidder**
Tel: **01344 636525**
Email: **advisory@steel-sci.com**