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:

$$V_{c,Rd} = V_{pl,Rd} = A_{v} \left( \frac{f_{y}}{\gamma_{M0}} \right)$$

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
- $\gamma_{M0}$ 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:

$$\frac{h_{w}}{t_{w}} > 72 \frac{\epsilon}{\eta}$$

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
- $\eta$ is given in NA.2.4 of UK NA to BS EN 1993-1-1 permits $\eta$ 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 $\times$ 140 $\times$ 39 UKB, with $h_{w}/t_{w} = 59.5$ and 762 $\times$ 267 134 UKB, with $h_{w}/t_{w} = 59.9$) require shear buckling resistance verification because the ratios exceed the limit of $72\epsilon/\eta = 72 \times 0.81 = 58.3$.

Clause 5.1(2) of BS EN 1993-1-5 states that plates with $h_{w}/t_{w}$ greater than $72\epsilon/\eta$ 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 $\times$ 140 $\times$ 39 UKB grade S355.

$$h_{w}/t_{w} = \frac{398.0 - 2 \times 8.6}{6.4} = 59.5 > 58.3$$

Therefore, shear buckling resistance is to be determined.

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

$$\lambda_{w} = \frac{h_{w}}{t_{w}} = \frac{380.8}{86.4} \times \frac{6.4 \times 0.81}{0.85} = 0.85$$

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

$$\chi_{w} = \frac{0.83}{0.85} = 0.976$$

Expression (S.2) of BS EN 1993-1-5 gives:

$$V_{bw,Rd} = \frac{0.976 \times 355 \times 380.8 \times 6.4}{\sqrt{3} \times 1.0} = 488 \text{kN}$$

Ignoring the contribution from the flange to the shear buckling resistance:

$$V_{bw,Rd} = \frac{f_{y} h_{w} t_{w}}{3 \gamma_{M1}} = \frac{355 \times 380.8 \times 6.4}{3 \times 1.0} = 500 \text{kN}$$

Therefore $V_{bw,Rd} = 488 \text{kN}$.

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

Similarly, for a 762 $\times$ 267 134 UKB grade S355, $V_{bw,Rd} = 1768 \text{kN}$ and $V_{c,Rd} = 1970 \text{kN}$.

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.

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