AD 390: Lateral Torsional Buckling of channels in accordance with EN 1993-1-1

Questions have been asked about how the lateral torsional buckling resistance of a channel should be calculated and how the effect of the load position can be accommodated. This Advisory Desk Note offers guidance on the design of these sections.

Channels have only one axis of symmetry, so the immediate question concerns the calculation of M_{cr}. The 'standard' expression, given below, is generally offered for use with bi-symmetric sections, such as I and H shapes, with load applied at the shear centre.

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{L^2} \sqrt{\frac{I_w}{I_z} + \frac{L^2 GI_t}{\pi^2 EI_z}}$$

In fact, this expression is also appropriate for channel sections. Although a channel is monosymmetric, the shear centre and centroid are not displaced perpendicular to the bending axis, as shown in Figure 1(a). In Figure 1(b), an asymmetric beam is shown, where the centroid is displaced with respect to the shear centre – in this case the calculation for M_{cr} would need to be modified.

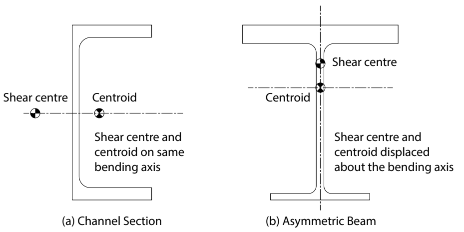

Figure 1 Channel section and asymmetric beam

In P363 (the Blue Book)[1] the 'standard' expression given above is used to calculate M_{cr}, and the lateral torsional buckling calculated using curve 'd', in accordance with Table 6.5 of the UK National Annex, where channels are covered by "All other hot rolled sections". In the Blue book, the reduction factor for lateral buckling resistance is calculated using clause 6.3.2.3.

The unsaid assumption in completing the preceding resistance calculation is that the vertical load is applied at the shear centre, as shown in Figure 2(a). If the load is applied in line with the web (Figure 2(b)), an additional torque is applied, which must be allowed for. The Eurocode is silent on how this should be accommodated.

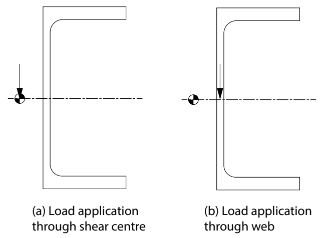

Figure 2 Point of load application

Several European researchers have looked at this problem. SCI recommend Snijder *et al*[2] who provide a recommendation for dealing with this issue in accordance with the Eurocodes. The research investigated several possible solutions and compared the results to an extensive set of non-linear analyses of members.

The recommendation from Snijder *et al* applies to all positions of eccentric load application between the shear centre and the web. The recommended approach is to modify the slenderness of the section with an adjustment for torsion. Then, the approach uses the "general case" expression of clause 6.3.2.2, but with buckling curve 'a'. This curve has been selected because it gives a good fit for the numerical results.

The rather strange observation when comparing the resistances in the Blue Book with the resistances calculated following the recommendations of Snijder *et al* is that the calculated resistances are almost the same. The 'advantage' of the 6.3.2.3 expression, combined with the 'penalty' of curve 'd' used in the Blue Book is balanced by the 'penalty' of 6.3.2.2 and the 'advantage' of curve 'a' used by Snijder *et al*.

Snijder *et al* do have a maximum cut off value for $\chi_{LT} = 0.67$, but this seems to be for historic reasons rather than the evidence of the results. For the present, SCI see no reason to provide more details of the Snijder *et al* approach, or to provide additional resistances in the Blue Book for channels with vertical loads applied at the web. By strange coincidence, it appears that the resistances in the Blue Book are adequate for all vertical load application lines between the shear centre and the web.

1 SCI P363 Steel Building Design: Design Data (Updated 2013)

2 Snijder, H. H; Hoenderkamp, J. C, D; Bakker, M. C. M; Steenbergen, H. M. G. M and de Louw, C. H. M. Design rules for lateral torsional buckling of channel sections subject to web loading. Stahlbau, Volumn 77, Issue 4, Pages 247-256, April 2008

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