AD 378
Web resistance to transverse loads according to BS EN 1993-1-5

Web resistance (which used to be described as web bearing and web buckling) is covered by Section 6 of BS EN 1993-1-5[1]. Although this Eurocode covers plated elements, the resistance checks of Section 6 apply to the webs of both rolled beams and plated elements. Designers will generally use these checks to decide if stiffeners are required under concentrated loads.

The design resistance of the web, F_{Rd} depends on the effective length, L_{eff}, which in turn depends on the effective loaded length, l_y. The effective loaded length depends on the stiff bearing length s_s and modification parameters m_1 and m_2. The purpose of this Advisory Desk is to explain the selection and use of the m_2 parameter.

Under an applied load, force in the web increases as the flange deforms. The resistance expressions assume that four hinges form in the flange, as shown in Figure 1. The influence of the flange width and web thickness is seen in the m_1 parameter.

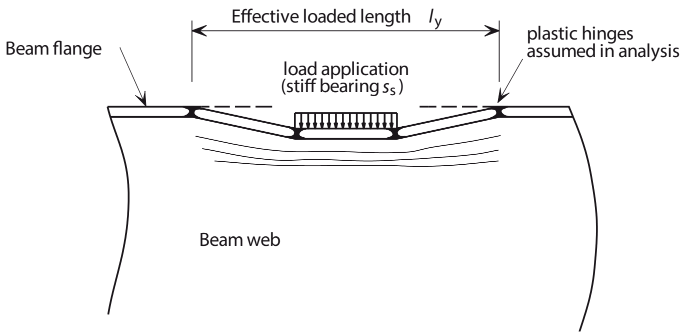

Figure 1: Deformation of the beam flange

In some circumstances (members with slender webs) physical tests showed an increased resistance. In these circumstances the design model assumes that part of the web acts with the flange as a tee section, thus increasing the bending resistance of the flange. This effect is introduced via the m_2 parameter.

m_2 depends on the slenderness of the web, but the web slenderness is only determined later in the calculation process. Thus an assumption needs to be made and subsequently verified. This is seen in expression 6.9 of BS EN 1993-1-5, where the value of m_2 depends on the web slenderness, $\overline{\lambda}_F$.

In some circumstances, two valid solutions may be found, when either assumption (a stocky web or a slender web) can be demonstrated to satisfy the requirements. In turn, this leads to two possible values for the resistance of the web.

A discussion on the subject is presented in *Designers' Guide to EN 1993-2*[2]. If two valid solutions are possible, the higher resistance may be taken.

Implications in practice

The effect of the discontinuity in the calculation process is that for a limited number of rolled sections, a step can be observed in the web resistance as presented in the Blue Book[3].

Figure 2 shows the results for a 1016 × 305 × 393 UKB in S355, with the web resistance calculated away from the end of the member (c = 1000 mm). For this beam, two valid solutions are possible over the range of stiff bearing lengths between 50 mm and 145 mm. This arises because if a stocky web is assumed, $\overline{\lambda}_F < 0.5$, which is satisfactory, and if a slender web is assumed, $\overline{\lambda}_F > 0.5$, which is also satisfactory. Following the guidance to take the higher value, the Blue Book resistances are shown in Figure 3, reflecting the jump in resistance at 50 mm.

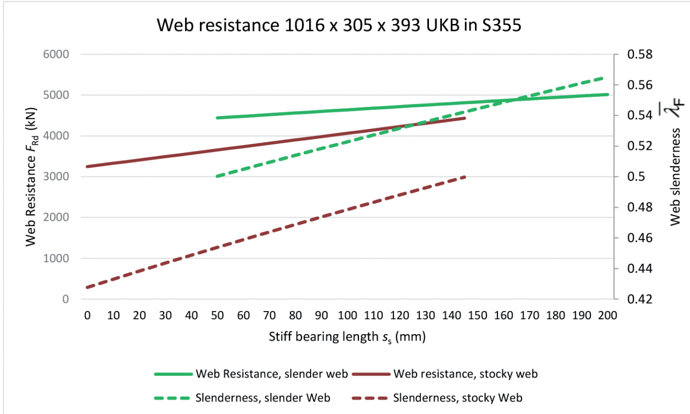

Figure 2: Web resistance and slenderness, c = 1000 mm

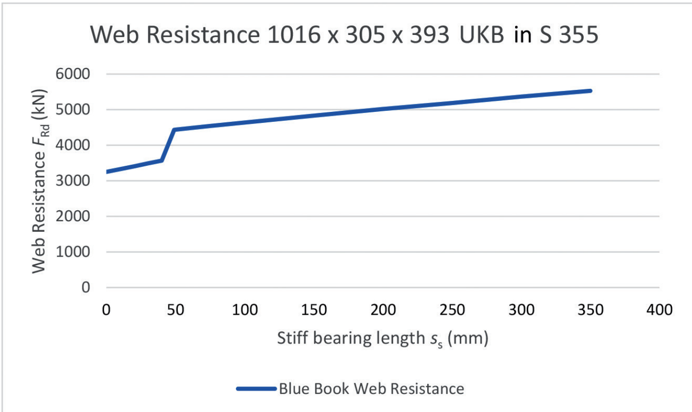

Figure 3: Web resistance from the Blue Book, $c > c_{lim}$

The Eurocode rules are attempting to reflect a complex problem, so perhaps it is not surprising that some discontinuities can be observed. The guidance in this Advisory Desk is that if two solutions are valid, the higher resistance may be taken.

Contact: **David Brown**
Tel: **01344 636525**
Email: **advisory@steel-sci.com**

1. BS EN 1993-1-5:2006 (incorporating corrigenda April 2009)
   Eurocode 3 – Design of steel structures –
   Part 1-5: Plated structural elements
2. Hendry, C. R. and Murphy, C, J.
   Designers' Guide to EN 1993-2. Eurocode 3:Design of Steel structure. Part 2: Steel Bridges
   Thomas Telford, 2007
3. Steel Building Design: Design Data (updated 2013) P363
   SCI and BCSA, 2013