β = 0.75 for rolled sections

$$\bar{\lambda}_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}}$$

where:

W_y is the appropriate section modulus for the section classification

M_{cr} is the elastic critical moment for lateral-torsional buckling

An expression to evaluate M_{cr} is not given in BS EN 1993-1-1. Three methods are given in this publication to assist in the determination of lateral-torsional buckling resistance.

Method 1
Access Steel Document SN003 (available from www.access-steel.com) provides appropriate expressions to calculate M_{cr}. For loads which are not destabilizing, and for doubly symmetric sections (i.e. UKB and UKC)

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

where:

E and G are material properties

I_z, I_t, I_w are section properties

L is the buckling length of the member

C_1 is a factor that depends on the shape of the bending moment diagram – see Table 6.4 of this publication

Method 2
The value of M_{cr} may be determined using the software *'LTBeam'* available from www.cticm.com

Method 3
As an alternative to calculating M_{cr} and hence $\bar{\lambda}_{LT}$, the value of $\bar{\lambda}_{LT}$ may be calculated directly from the expression given below.

Where loads are not destabilising, for simply supported rolled I, H and channel sections, the non-dimensional slenderness $\bar{\lambda}_{LT}$ is given by:

$$\bar{\lambda}_{LT} = \frac{1}{\sqrt{C_1}} UV\bar{\lambda}_z \sqrt{\beta_w}$$

where:

$\frac{1}{\sqrt{C_1}}$ is a parameter dependant on the shape of the bending moment diagram,

and which may conservatively be taken as 1.0, or otherwise given in Table 6.4 for loads which are not destabilising

U is a section property (given in section property tables, or may conservatively be taken as 0.9)

V is a parameter related to slenderness, and for symmetric rolled sections where the loads are not destabilising, may be conservatively taken as 1.0

or as $V = \frac{1}{\sqrt[4]{1 + \frac{1}{20}\left(\frac{\lambda_z}{h/t_f}\right)^2}}$

Conservatively, the product and U and V may be taken as 0.9

where:

λ_z $= \frac{kL}{i_z}$, in which k may conservatively be taken as 1.0 for beams supported and restrained against twist at both ends. With certain additional restraint conditions k may be less than 1.0, as described in Appendix F, Section F.1 For the value of k for cantilevers, see Section F.3

$\bar{\lambda}_z$ $= \frac{\lambda_z}{\lambda_1}$

L is the distance between points of lateral restraint

λ_1 is given in 6.3.1.2(2) for steel grades S275 and S355

β_W $= \frac{W_y}{W_{pl,y}}$

It is conservative to assume that the product $UV = 0.9$ and that $\beta_w = 1.0$

In its most conservative form, $\bar{\lambda}_{LT} = \frac{L/i_z}{96}$ for S275 and $\frac{L/i_z}{85}$ for S355

Method 3 is amenable to presentation in a tabular format whereby χ_{LT} may be calculated directly, based on the slenderness L/i_z and h/t_f. This is presented in Appendix E, with an example.

Methods 1 and 2 give similar results. In method 3, the assumptions that $C_1 = 1.0$ and that $UV = 0.9$ can be very conservative.

Where loads are destabilizing, a parameter D should be introduced in the expression for $\bar{\lambda}_{LT}$. As shown in Appendix F Section F.1. The values of D are shown in Sections F.1 and F.3.