AD 407: Section Classification

SCI have been advised that some checking authorities have questioned the approach to calculating α and ψ, which are found in Table 5.2 of BS EN 1993-1-1:2005 and used when classifying the web of a section under combined bending and compression. The Eurocode is silent on how these two factors should be calculated, which leads to some differences across Europe.

In the UK, SCI provided the following formulae for both α and ψ, in Table 5.1 (page 37) of P362[1]

$$\alpha = \frac{1}{2}\left(1 + \frac{N_{ed}}{f_y c t_w}\right) \text{ and } \psi = \frac{2N_{ed}}{Af_y} - 1$$

These formulae may be found in a number of authoritative sources, including Gardner and Nethercot[2] (page 32). Conceptually, these formulae imagine that the axial force N_{Ed} remains constant, and the moment is increases until f_y is attained (across the section in Class 1 and 2; at the extreme fibres in Class 3). The UK and France follow this approach, as do a number of European guides[3,4].

Some other European authorities follow a different approach, increasing both N_{Ed} and the applied moment in proportion. A different value of α and ψ will result, and potentially, a different Class of section. In some circumstances, if this second approach is followed, the Class becomes more onerous.

These different approaches are discussed in more detail in ECCS publication[3] (Section 2.4 pages 110/111, Section 3.7.2 pages 243/246 and Example 3.17 pages 279/281).

A second issue is that using the above formulae may lead to values of α greater than 1.0. This simply indicates that (in the case of α), all the web is in compression. α should be limited to the range between -1 and 1. ψ will be between 0 and -1.

When the calculated value of α exceeds 1, and thus is limited to 1, the limiting c/t ratio for a Class 1 section is given by $\frac{396\varepsilon}{13\alpha - 1} = \frac{396\varepsilon}{12} = 33\varepsilon$

which is simply the same as the value for "part subject to compression". Similar comparisons may be made with the other Class limits when the calculation of α and ψ indicate that the web is entirely in compression.

References

1. SCI P362 Steel Building Design: Concise Eurocodes (2009)
2. L. Gardner, D.A. Nethercot. Designers' Guide to EN 1993-1-1 (2005)
3. ECCS Eurocode Design Manuals. Design of Steel Structures 2nd Edition. Eurocode 3: Design of Steel Structures. Part 1.1: General rules and rules for buildings (2016)
4. ECCS Eurocode Design Manuals. Fire Design of Steel Structures. Eurocode 1: Actions on structures. Part 1-2: Actions on structures exposed to fire. Eurcode 3: Design of steel structures. Part 1-2: Structural fire design (1st edition, 2010) (Pages 114/115)

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