The aim of this feature is to share up-dates, design tips and answers to queries. The Steel Construction Institute provides items which, it is hoped, will prove useful to the industry.

AD 250

Choice of Steel Sub-Grade

During a recent seminar on the Amendments to BS 5950-1, a straw poll of the (large) audience indicated that only 5% of the structural engineers present specified the steel sub-grade. A further 2% of the audience indicated that they checked that the steelwork contractor chose the correct sub-grade. This left over 90% of the audience who neither specified the sub-grade themselves, nor ensured that others were specifying the correct sub-grade.

The implication of this poll is that there is potential for an inappropriate sub-grade of material used in structures, which could lead to an unacceptably high risk of brittle fracture.

This advisory note serves as a reminder that an appropriate sub-grade must be specified. It should be noted that the requirement to specify an appropriate sub-grade is not new, being covered in BS 5950-1: 1990.

Brittle fracture becomes increasingly likely:

- At lower temperatures.
- As the stress level increases.
- As the strain rate increases.
- The more stress raisers that are present (which disrupt the uniform state of stress).
- The thicker the element.

If the circumstances make brittle fracture possible, a tougher steel must be specified. Tougher steels are generally more expensive.

BS 5950-1: 2000 requires the choice of a *K* factor from Table 3, which covers the 'circumstances' in which the steel is being used. Table 3 addresses stress level, type of detail and strain conditions which combine to indicate a *K* factor between 0.25 and 4. The lower the *K* factor, the tougher the steel will need to be.

In most circumstances, the *K* factor will be at least as low as 1, since this is the *K* factor for 'welded generally', with a stress higher than 30% of the normal yield strength.

The requirement in Clause 2.4.4 is that:

$t < Kt_1$

where t is the thickness of each element (commonly the flange)
t_1 is the limiting thickness at the minimum service temperature from Table 4 or 5 of BS 5950-1: 2000

Knowing the element thickness and knowing the K factor, Table 4 (plates, flats and rolled sections), or Table 5 (hollow sections), may be used to choose an appropriate sub-grade, such that $t_1 > t/K$.

Who should specify the steel sub-grade?

The designer of the structure knows the information needed to specify the steel sub-grade and should take responsibility for ensuring an appropriate steel is used. Unless steelwork contractors are designing the structure, they will need the sub-grade at tender stage to prepare a quotation. To leave the contractor to choose the sub-grade is not satisfactory, as it is not necessarily clear from arrangement drawings if steel is exposed, or if it is highly stressed.

Note that changes in the construction details could affect the choice of sub-grade. For example, a welded beam to column connection might be stiffened or unstiffened. The *K* factor is higher if the column flange is stiffened. Thus if a heavier, unstiffened column section is used to replace a stiffened column, the *K* factor would reduce, and a tougher steel may be required because of the revised detail and the increased flange thickness.

Steel used in external conditions

Specifiers should note that, generally, it will be necessary to specify at least a J0 sub-grade for steel used in external conditions. This represents a change from BS 5950-1: 1990 (as amended in 1992), which allowed less tough steels to be used in exposed conditions.

Why no history of failures to date?

If, according to the straw poll, there is every possibility of a less capable steel being used than the design standard would indicate, why is there no extensive catalogue of failure in service? Clearly, even though the risk is increased, this does not mean that failure occurs. One further contribution is the steel itself which, when of UK origin, has typically been tougher than specified. This, however, does not represent an excuse to avoid proper specification, particularly as more steel is sourced from foreign manufacturers.

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