STEEL INDUSTRY GUIDANCE NOTES

Steel Specification

It is vitally important that the structural designer specifies the structural steelwork correctly. The steel specification must cover not only the strength grade (typically S275 or S355) but also the steel sub-grade. Specifying the correct steel sub-grade is important to ensure that any possibility of brittle fracture is avoided.

The way to specify structural steel correctly is to understand the relationship between the material or steel specification and the in service condition.

Steel specification

Steel sections used for structural applications in the UK must comply with the EU Directive on Construction Products (CPD 89/106/EEC) and will generally comply with EN10025:2004:Part 2 technical delivery conditions for non-alloy structural steels.

Although CE marking of products is not mandatory in the UK it has been generally agreed that CE marking represents best practice and simplifies the process of material selection. CE marking of a product is a declaration by the manufacturer that it complies with all the appropriate provisions of, and the essential safety requirements, embodied in the legislation implementing relevant European Directives including CPD89/106/EEC.

Table1: Comparison of grades for EN10025:2004:Part 2 and Advance™ sections

EN10025:Part 2:2004					Advance Section
Grade	Yield	Tensile	Charpy		Grade
	Mpa		Temp (°C)	Energy (J)	
S275JR	275	410/560	20	27	Advance S275JR
S275J0	275	410/560	0	27	Advance 275J0
S275J2	275	410/560	-20	27	Advance 275J2
S355JR	355	470/630	20	27	Advance 355JR
S355J0	355	470/630	0	27	Advance 355J0
S355J2	355	470/630	-20	27	Advance 355J2
S355K2	355	470/630	-20	40	Advance 355K2

Table 1 shows the typical UK grades and properties for structural sections to EN10025:2004:Part 2 and how these relate to the simplified material specification for Advance sections from Corus which are CE marked as a matter of course.

The sub-grade designation indicates the Charpy impact value at a test temperature, which gives a measure of toughness (a combination of strength and ductility). S275 and S355 steel grades can be specified in JR, J0 and J2 sub-grades. For situations where greater toughness is required, sub-grade K2 is available in S355 grade steel

Avoiding Brittle Fracture

The possibility of brittle fracture can be avoided by using a steel quality with adequate toughness, taking account of the minimum service temperature, the thickness; the steel grade; the type of detail; the stress level and the strain level or strain rate.

The Design Standard, BS5950-1:2000 addresses this by relating the service temperature, the state of stress, the type of detail and the strain rate to a limiting thickness for each steel sub-grade.

Specifying in Service Conditions

Following selection of members for given locations, the thickness of each element will be known. Knowing the service temperature (taken in the UK as -5°C internally and -15°C externally), the state of stress and the likely details, an appropriate sub-grade can be specified. Based on the information given in the following tables, which have been reproduced from BS5950–1:2000, the structural designer can choose an appropriate sub-grade (or quality) such that $t<Kt_1$.

Where

- **t** is the thickness of the member usually taken as the flange
- **K** is the factor from table 3 and
- $\mathbf{t_1}$ is the limiting thickness from table 4

In practice

In most circumstances, it is appropriate to make simple assumptions about the state of stress and the sorts of

details expected in a structure, and base the choice of sub-grade on these simple assumptions.

- generally, it would be expected that the stress due to factored loads would be more that 0.3 *Y*nom (the nominal material yield strength – typically 275 or 355Mpa). The tensile stress may arise from member bending
- in most structures, components will be welded.
- most steelwork is not subject to high strain rates

Thus in most circumstances, it would be appropriate to take K = 1. The structural designer can then directly compare the flange thickness with the limiting thickness and choose an appropriate steel sub-grade.

Example

Although this example is for open sections a similar methodology is followed for hollow sections.

For instance, if the nominated section is a 356x171x51 beam with a nominal material yield strength of 275 Mpa. Then the flange thickness is 11.5mm (t).

Assuming K = 1 (from Table 4) and that the steelwork is to be used inside a structure (Tmin = -5°C).

S275JR (Advance275JR) steel is satisfactory, since t_1 = 36mm (from Table 3).

Note that the same specification would be suitable if the section was exposed in service (Tmin = -15°C), since t_1 = 15mm. (from Table 3)

Notes on the example

The assumption that K = 1 is not conservative in three situations

- at high strain rates (where the K values should be halved) and in the specific situations
- where welded connections are made to unstiffened flanges, and
- welds occur across the ends of cover plates.

Table 3: Factor K for type of detail, stress level and strain conditions (extract from full table)

Type of detail or location	Components in tension due to factored loads		Compo-nents not subject to applied tension
	Stress > 0.3 Ynom	Stress < 0.3 Ynom	
Plain steel	2	3	4
Drilled holes or reamed holes	1.5	2	3
Flame cut edges	1	1.5	2
Punched holes (un reamed)	1	1.5	2
Welded, generally	1	1.5	2
Welded across ends of cover plates	0.5	0.75	1

Table 4: Limiting Thickness (t_1) for plates, flats and rolled sections

EN10025:Part 2:2004	Maximum thickness t_1 (mm) when K=1 according to mini-mum service temperature Tmin	
	Normal temperature Internal -5°C	Normal temperature External -15°C
S275JR	36	15
S275J0	65	54
S275J2	94	78
S355JR	25	11
S355J0	46	38
S355J2	66	55
S355K2	79	66

Key Points

1. The steel specification must cover not only the strength grade (typically S275 or S355) but also the steel sub-grade. Specifying the correct steel sub-grade is important to ensure that any possibility of brittle fracture is avoided
2. Steel sections used for structural applications in the UK must comply with the EU Directive on Construction Products (CPD 89/106/EEC). Advance sections from Corus are CE marked as a matter of course.
3. From EN10025:Part2:2004 S275 and S355 steel grades can be specified in JR, J0 and J2 sub-grades. For situations where greater toughness is required, sub-grade K2 is available in S355 grade steel
4. The possibility of brittle fracture can be avoided by using a steel quality with adequate toughness, taking account of the minimum service temperature, the thickness; the steel grade; the type of detail; the stress level and the strain level or strain rate.
5. Following selection of members for given locations, the thickness of each element will be known. Knowing the service temperature (taken in the UK as -5°C internally and -15°C externally), the state of stress and the likely details, an appropriate sub-grade can be specified.

Further sources of Information

1. **BS EN 10025:2004 (published by BSi)**
2. **European structural steel standard EN10025:2004, Explanation and comparison to previous standards (published by Corus)**
3. **BS5950:2000 (published by BSi)**
4. **Advance™ sections (Published by Corus)**

All Corus publications are available from www.corusconstruction.com