STEEL INDUSTRY GUIDANCE NOTES

Structural Hollow Sections – Making the Correct Choice Hot Finished EN 10210: 2006 & Cold Formed EN 10219: 2006

Structural Hollow sections are widely used in the construction industry for both efficiency and aesthetics. This means the quality and type of hollow section employed is vitally important for the overall performance of a structure.

When understanding the differences in the quality and performance between hot finished and cold formed hollow sections, there are five main considerations that have to be taken into account: manufacture, properties, performance, certification and cost. The use of both hot finished and cold formed sections is allowed in BS 5950 and Eurocode 3 (EC3), however certain considerations need to be known before specifying or substituting one for the other.

It is important to remember that open sections are always manufactured for the construction industry and hollow sections are frequently used for commodity items as well as for quality structural applications. Therefore it is of utmost importance to have a clear understanding of the performance values that each hollow section product can offer.

Manufacture

The manufacturing processes of hot finished and cold formed hollow sections are very different. Hot finished hollow sections are formed at normalising temperature (approx 900°c) and are produced in accordance with standard EN 10210-1: 2006; while cold-formed hollow sections are formed at ambient temperatures and are produced in accordance with standard EN 10219-1: 2006.

This results in several key differences, the main one being that hot finished hollow sections pass through a furnace and have a much tighter corner profile as a result of the metal flow during the forming process (EN 10210-2: 2006 Table 2). Cold-formed, on the other hand, exhibit a high degree of cold working in the corner regions during the forming process. This means that they could be susceptible to corner cracking if manufactured with tight radius corners. The standard EN 10219-2: 2006, therefore stipulates larger radii to allow for this (see EN 10219-2: 2006 Table 3).

Properties

When choosing between hot finished or cold-formed hollow sections, particular issues must be considered to ensure the correct type is specified for a successful outcome.

Homogeneity

Hot formed hollow sections have the same properties throughout the section, whether on the flat or corner. This means that the grain structure and hardness are uniform across the entire section and the mechanical properties are stable. This is not the case for cold formed, where grain structure and hardness values vary within the section - particularly in the corners and weld region.

Ductility

Hot finished sections have a very high ductility, which means that even should they be overloaded beyond the yield point of the material, they will deform in a controlled way and thereby give adequate warning of any potential problems. This is particularly important where fire resistance is being considered. Comparatively, the ductility of cold-formed sections is lower and their structure is such that their performance in overload conditions is less predictable.

Buckling Strength

Hot finished sections have a higher buckling strength than cold formed sections, which means that the same curve cannot be used for design purposes. Structural design standards call for a lower strut curve for cold formed sections than for hot finished sections.

Performance

Fabrication

The very tight corner profile of square and rectangular hot finished sections makes them particularly suitable for applications where a branch member is to be welded to a main member of the same width. The larger corner profiles of cold formed sections can create welding difficulties in such circumstances.

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Galvanising

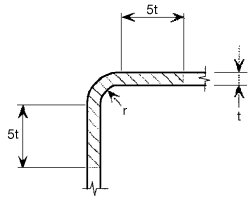
If the correct (specified) composition is used then the galvanising performance becomes a detailing issue. If cold formed sections of appropriate quality are not specified or used, then this may result in the section splitting or distorting during processing.

Welding

Taken from the point of view of welding in corner regions, a very distinct pattern can be seen to emerge. In terms of grain structure, ductility and residual stresses, there are no problems with welding in the corner region of hot formed hollow sections. Branch welding of cold formed hollow sections can give problems if the correct composition is not used. EN10219 specifies that ALL steel must be fully killed (i.e. deoxidised and aluminium treated steel). Care must also be taken when welding with cold formed as stated in EN 1993-1-8:2005 (table 4.2). The table sets out whether welding is allowed at the edges or if welding is not permitted within 5t from the radius (see table below).

Conditions for welding cold formed zones and adjacent material

r/t	Strain due to cold forming (%)	Maximum thickness (mm)		
		Generally		Fully killed Aluminium-killed steel (A1≥0.02%)
		Predominantly static loading	Where fatigue predominates	
≥ 25	≤ 2	any	any	any
≥ 10	≤ 5	any	16	any
≥ 3.0	≤ 14	24	12	24
≥ 2.0	≤ 20	12	10	12
≥ 1.5	≤ 25	8	8	10
≥ 1.0	≤ 33	4	4	6



Certification

A key topic in today's construction industry is the certification of material used and if it is suitable for the specified job. Both the Hot finished – EN 10210-1: 2006 and cold formed – EN 10219-1: 2006 say the same in regard to testing and certification and are split into two categories - 'specific test' and a 'non-specific test'. To ensure correct specification, the differences should be understood.

A non-specific test states that 'tests shall be carried out by the manufacturer, in accordance with his own procedures'. The results supplied need only be "representative" of the material grade and so are generally not from the products actually supplied and sometimes not even from material of the same dimensions. Non-specific testing is accompanied by a Test Report.

A specific test states that 'tests shall be carried out on the actual products to be supplied, or on test units of which the product to be supplied is a part, or when applicable on all hollow sections'. Specific testing is accompanied by a Test certificate.

To apply this to code standards used and recognised by Engineers, BS5950 and BS5400 both require specific inspection.

Both EN 10210-1:2006 and EN 10219-1:2006 have now been harmonized and have to comply to 'the European Construction Products Directive', which in the UK will mean the acceptance of CE marking.

Costing

We obviously need to consider material costs and at first it seems straightforward that cold formed section are far cheaper than hot finished of a similar grade. However, we also have to compare the correct specification of cold formed, in this case EN 10219, which must be supplied with specific testing to be truly suitable for construction and not commodity cold formed material intended for general engineering applications that is supplied with only a test report. This provides a more realistic price comparison between hot finished and cold formed, in which cold still has a price advantage, but against this we have to account for the better sectional properties of hot and its greater strut curve capacities. From this it can be seen that it may not be as simple as originally thought to compare hot finished v cold formed on a size by size basis.

Key Points

1. Ensure the correct specification is specified and used throughout.
2. Cold formed should not be substituted for hot finished without first considering the design and fabrication implications.
3. It is important to ensure that materials have the correct certification i.e. TEST CERTIFICATE NOT TEST REPORT.
4. Cold formed sections that are correctly specified, correctly produced and supplied with appropriate certification are suitable for all forms of construction.

Further sources of Information

Corus supply CELSIUS 355 (EN 10210: 2006: S355J2H) & HYBOX 355 (EN 10219: 2006: S355J2H)

For further information please visit www.corusconstruction.com