

Introduction to the use of HSS in Structures

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Structural Design of HSS

19 January 2021: Introduction to the use of HSS in structures

26 January 2021: Design of HSS - plastic design

2 February 2021: Design of HSS - member stability & dynamic response

9 February 2021: Weight, cost and carbon savings with HSS

Web Page:

- Recordings of each webinar available
- SCI Pub: High strength steel design & execution guide
- Web tool for designing HSS plate girders
- Case studies



This Webinar

- Why use HSS?
- How do you make HSS?
- What's available in HSS?
- How to fabricate HSS?
- Examples of HSS structures

Today's webinar:

Setting the scene....

Nancy Baddoo (SCI)

Products, Properties & Process Metallurgy

Dr Jit Patel (International Metallurgy)

Higher strength steel plate for steel construction

Dr Tobias Lehnert (Dillinger)

Industry sectors using HSS

- Automotives
- Cranes
- Pipelines
- Offshore
- Shipbuilding
- Quarrying and mining
- Yellow goods



Why use HSS?

- Material (& carbon) savings
- Lighter supporting structure
- Reduced welding effort
- Easier transportation and handling
- More usable space

Typical uses of HSS in construction (1/3)

High rise construction

- Columns (low/medium slenderness)
- Lateral stability systems
- Transfer beams
- Bracing
- Hollow filled sections

Key structural engineering challenges in buildings are:

- Minimise construction material
- Maximise number of floors for a given height
- Maximise net-to-gross area on each floor



As height increases, vertical forces in columns & foundations increase, HSS resists high loads with minimal footprint

Typical uses of HSS in construction (2/3)

Long span structures (airports, stations, stadia)

- Tension chords
- Tension bracing members in trusses



- Less stringent deflections limits because the overall height is large, and stiffness can be increased by increasing truss depth
- Structure deadweight is a considerable proportion of the design

Typical uses of HSS in construction (3/3)

Bridges

- Tension zones of long spans
- Truss bridges
- Hybrid bridge girders



Reduction in deck weight is a priority for long span bridges (more important than reduction in fabrication costs)

HSS in structures: Drivers and Challenges

Drivers

- Material (& carbon) savings
- Lighter supporting structure
- Reduced welding effort
- Easier transportation and handling
- More usable space

Challenges

- Greater tendency to unstable failure modes
- Deflection and vibration criteria more likely to become critical
- No benefit where fatigue is critical
- Increased cost of some fabrication activities
- Minimum order size/Longer lead times/Limited suppliers


How to design HSS: EN 1993

Now:

EN 1993-1-1: S235 to S460

EN 1993-1-12: S500 to S700

‘Additional rules for the extension of EN 1993 up to steel grades S 700’

- 
- Stricter ductility requirements
 - Same buckling curve as S460
 - Restrictions on plastic analysis
 - Some restrictions on connections

Second Generation Eurocodes:

EN 1993-1-1 S235 to S700

EN 1993-1-12 S700 to S960

HIGH STRENGTH STEEL DESIGN AND EXECUTION GUIDE



INTRODUCTION

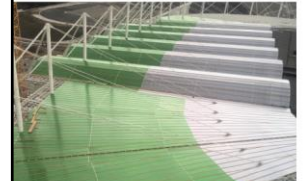


Figure 1.5
Roof trusses in
Stiga Sports Arena,
Sweden

© Sveinve Landbeck SE

1.4.4 Tension bars

HSS bars are widely used in threaded tension bar systems, typically in strengths S460, for applications including post-tensioning, ground engineering, and glass facades. Figure 1.6 shows the roof of the T1st Ouzouza, designed by Atak Engineering, which uses MSS S520 tie rods to



STRUCTURAL ANALYSIS AND MEMBER DESIGN

hollow sections can be seen to result in a larger increase in the buckling resistance. The increase of resistance of high strength cold formed CHS columns is shown in Figure 5.8.

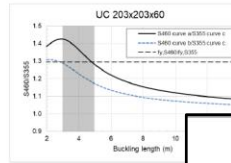


Figure 5.4
S460 CHS
comparative flexural
resistance:
UC 203x203x60

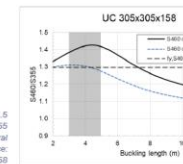


Figure 5.5
S460 CHS
comparative flexural
resistance:
UC 305x305x158

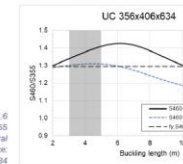


Figure 5.6
S460 CHS
comparative flexural
resistance:
UC 356x406x634

STRUCTURAL ANALYSIS AND MEMBER DESIGN

strength. Figure 5.13 illustrates the typical stress distributions for a hybrid cross-section depending on whether it is classified as Class 1 or 2, Class 3 and Class 4 (where the web is Class 4), which can be used to determine the bending resistance.

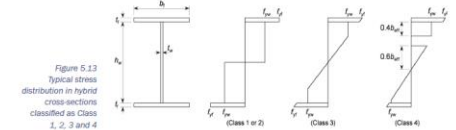


Figure 5.13
Typical stress
distribution in hybrid
cross-sections
classified as Class
1, 2, 3 and 4

Regarding the resistance of a hybrid girder to lateral-torsional buckling, research has shown that yielding of the web has little influence on the lateral stability of the girder, and therefore the reduction factor χ_{LT} can be determined in accordance with clause 6.3.2.2 of EN 1993-1-1 using the same buckling curve as for welded I-sections²⁰². Other checks, such as the shear resistance of the web, are identical to those required for a homogeneous beam.

Design resistance tables have been prepared by SCI for hybrid girders with steel grade up to S460²⁰³. The design process for a hybrid girder is illustrated in Design Example 4 in Appendix C.

5.8 Special considerations for design with HSS

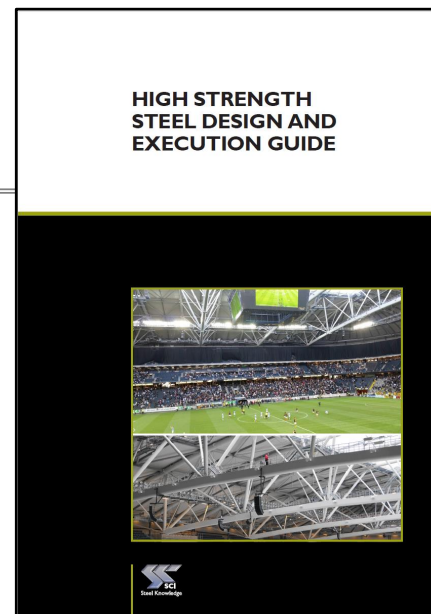
This section recommends some methods for increasing the resistance to local or global buckling at ULS and reducing the deflections and dynamic response at SLS. Section 8 discusses methods for improving the fatigue life of welded connections.

5.8.1 Methods to inhibit local buckling at ULS

Susceptibility to local buckling can be reduced by controlling the width to thickness ratio (b/t) of elements in compression by using welded or cold formed local stiffeners. Figure 5.14 shows two other types of cross-section where folds are used to stiffen the elements susceptible to local buckling. The use of I-sections with corrugated webs is another example (Figure 5.15). However, unless architectural issues dominate, it is usually cheaper to use a heavier section than to involve additional workmanship costs.

Local buckling can also be inhibited by filling a hollow section with concrete or encasing a section in concrete, or by the use of shallow floor beams or composite slabs.

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- SCI's Sponsors:

CBMM
(a Niobium products &
technology company)



International
Molybdenum
Association (IMOA)



Objectives of STROBE

- New **ductility and toughness** requirements
- Rules for **plastic design** of HSS beams & frames
- Rules for **stability** of HSS members
- Floor vibration analysis tool to assess **dynamic performance** of HSS floors
- Comparative designs (weight, carbon & cost savings)

But why?

- Conservative design rules
- Construction products are available
- Growing demand for sustainable solutions



- S460 to S700
- Hot rolled I shapes
- Fabricated I shapes
- Homogeneous & hybrid

STROBE Partnership

RWTH

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London, UK

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London

University of Coimbra

Coimbra, PT



Dillinger

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