Favourable Steel Structures using High Strength Steels (HSS)

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September 2021

STROBE _ Stronger Steels in the Built Environment

Duration of the EU Project: July 2017 – March 2021

Aim of the project is to overcome specific obstacles in the wider use of HSS (S460 to S700) in building structures

Research & Innovation
Research Fund for Coal and Steel

Results is presented under "https://steel-sci.com/strobe.html"

Institutions	RWTH	Aachen, DE
	Imperial College	London, UK
	University of Coimbra	Coimbra, PT
	Dillinger	Dillingen, DE
	Hochtief	Frankfurt, DE
	SCI	Ascot, UK

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B. General Parametric Study
C. Case Studies
D. Recommendations for Using of HSS

A. Online Design Tool

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STROBE

Stronger Steels in the Built Environment

Research Programme of the Research Fund for Coal and Steel

The web tool

This software has been engineered and developed by **SCI - The Steel Construction Institute** and **HOCHTIEF Engineering** for the Research Programme of the Research Fund for Coal and Steel "STROBE". The software performs the design of bare steel beam-column elements and offers an optimization tool. The design tool covers standard hot-rolled profiles and fabricated steel sections with normal and high strength steels up to S690. For fabricated sections, different steel grades may be specified for flanges and web plates (hybrid profiles). The optimization can be carried out for hot rolled sections (UK and Euro-standard profiles) and welded sections based on user inputs. The tool covers the design of class 1, 2, 3 and 4 cross sections. Core Eurocode, UK, German and Portuguese national annexes to Eurocode 3 are available. A quick user guide can be found **here**.

Disclaimer

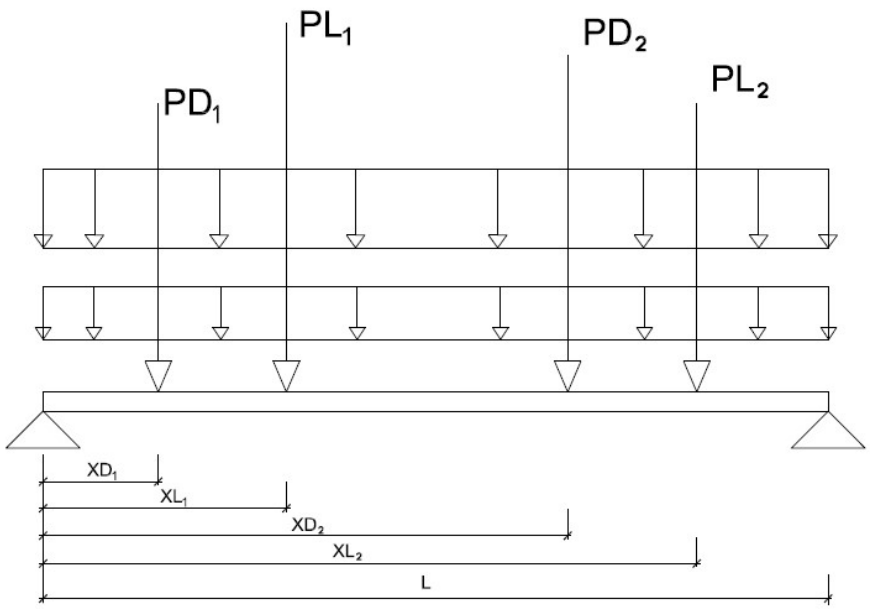
Although care has been taken to ensure that the calculated values are correct, users should verify the output. The Steel Construction Institute, HOCHTIEF Engineering and other parties associated with this software and website assume no responsibilities for errors or misuse of this software, or damage arising from the use of this software.

European Commission | SCI Steel Knowledge | RWTH AACHEN UNIVERSITY | Imperial College London | UNIVERSIDADE D COIMBRA | DILLINGER | HOCHTIEF

http://strobe.steel-sci.org

A. Online Design Tool

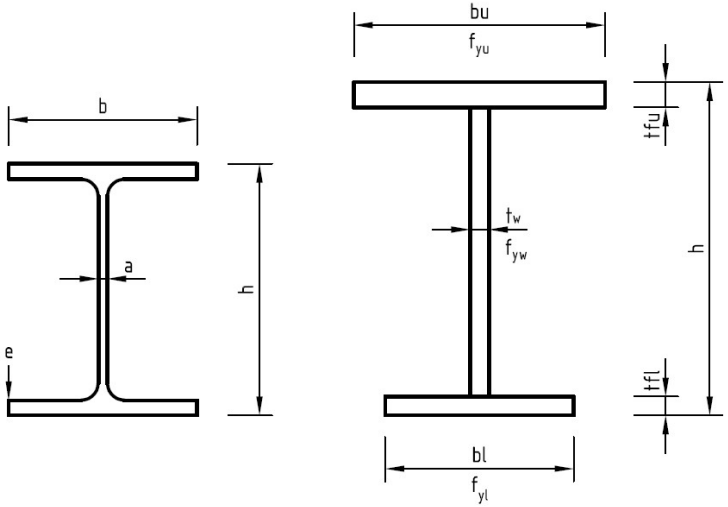
Scope of the design and optimization tool

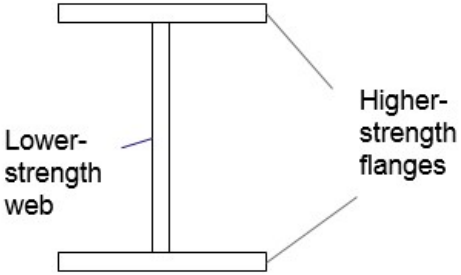


1. **Structural system**
   - simple beams
   - concentration loads and distribution loads
   - axial force
2. **Steel grades**
   - standard steels S235, S275, S355
   - HSS S420, S460, S690

A. Online Design Tool

Scope of the design and optimization tool





3. **Cross-sections**
   - cross-sections classes 1-4
   - standard hot-rolled sections
   - welded plate girders
   - welded hybrid girders
4. **Optimization**
   - determination of dimensions with the lightest weight
   - optimization considerations: deflection limit, lateral-torsional buckling, section height etc.

B. General Parametric Study

Investigated parameters

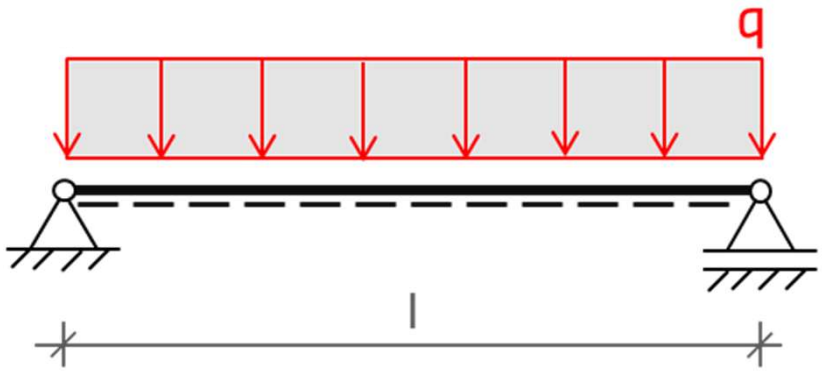
System:
- simple beams

Loading:
- uniform distributed load
- p_k = 2.5/5/10/15/20/30/40/50 kN/m

Span:
- l = 2.5 / 5 / 10 / 20 m

Deflection limit:
- Yes / No

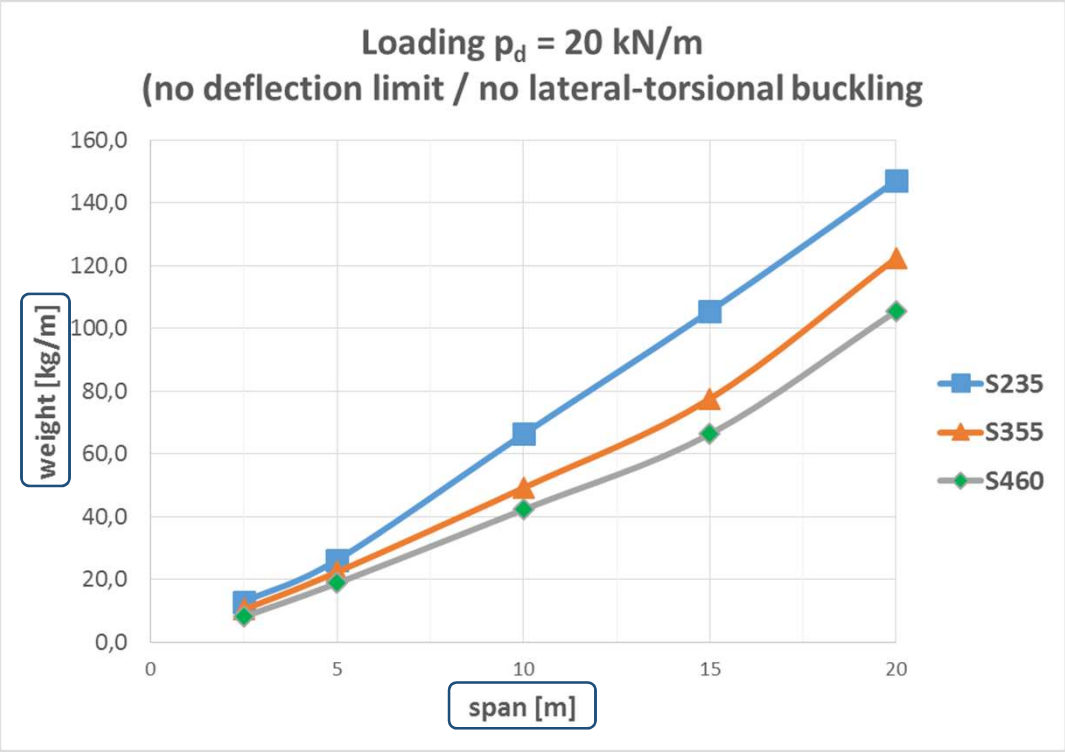
Lateral-torsional buckling:
- Yes / No

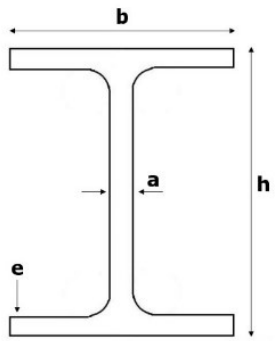


Sections and steel grades:
- hot-rolled sections in S235/S355/S460
- welded plate/hybrid girders in S235/S355/S460/S690

B. General Parametric Study

Results for the hot-rolled sections





When <u>no deflection limit</u> &

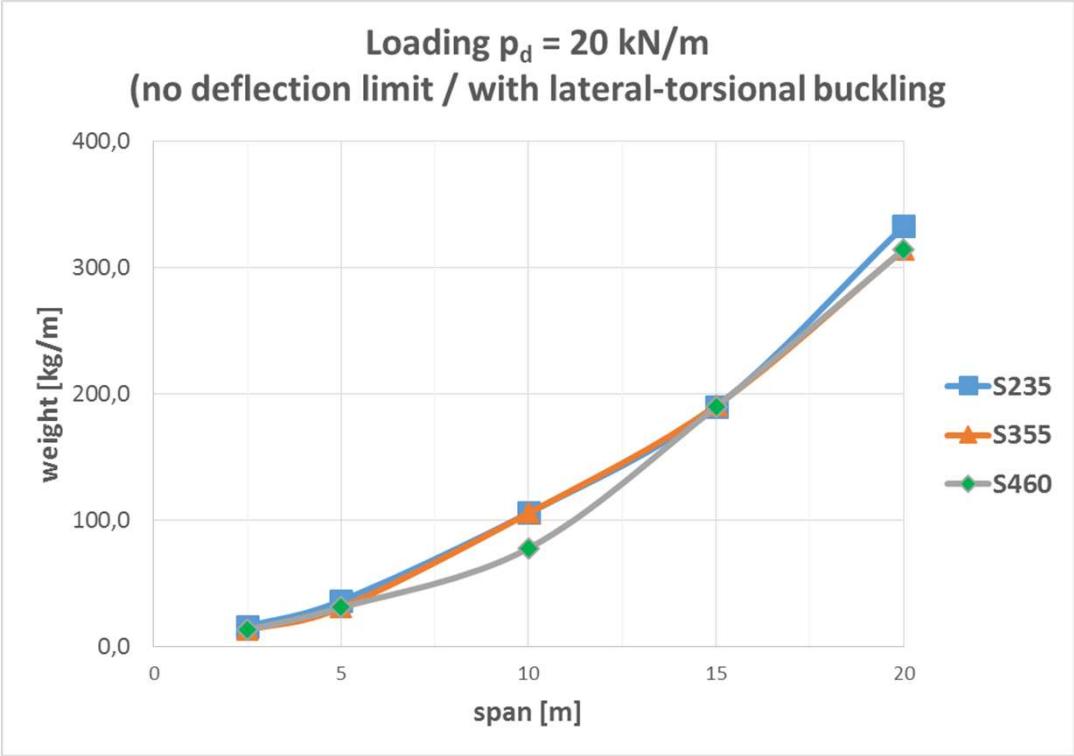
<u>no lateral-torsional buckling</u>

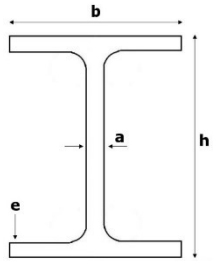
→ weight reduction up to **40%**

for **S460** compared to **S235**

B. General Parametric Study

Results for the hot-rolled sections





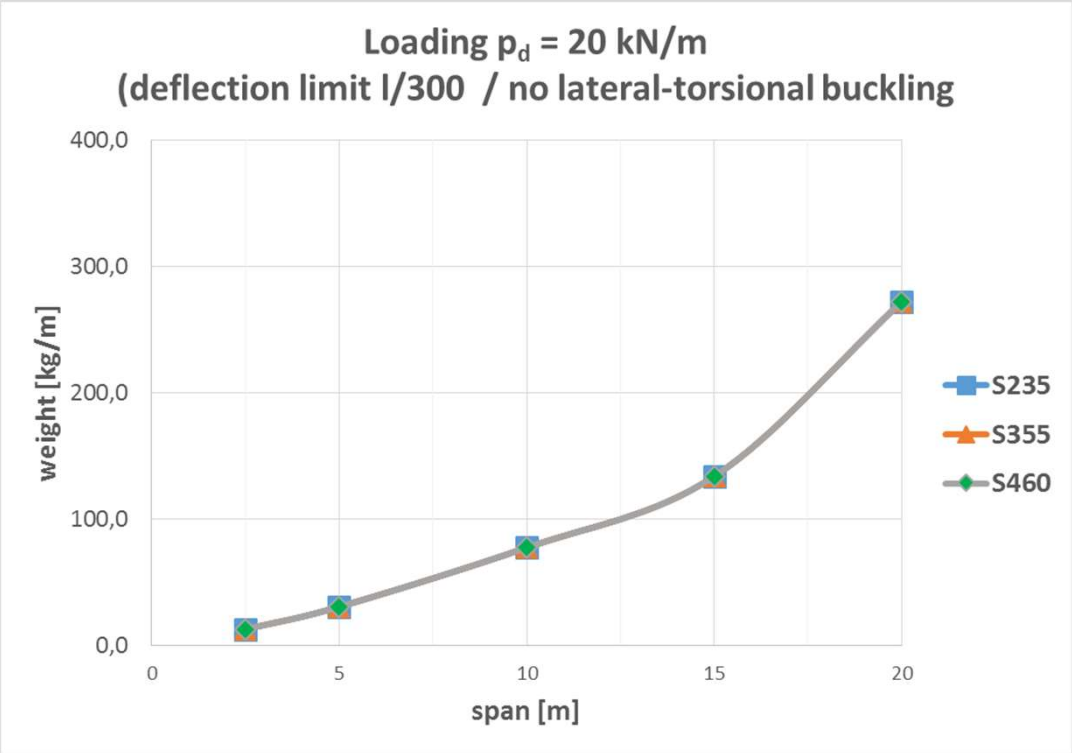
When <u>no deflection limit</u> & <u>with lateral-torsional buckling</u>

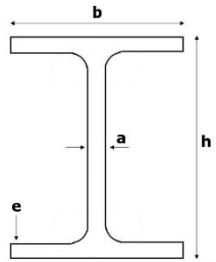
→weight reduction for **S460** compared to **S235** is reduced to 0-20%

→<u>no benefit</u> for **S460** compared to **S355**

B. General Parametric Study

Results for the hot-rolled sections





When <u>deflection limit is l/300</u>

for dead and imposed load &

<u>no lateral-torsional buckling</u>

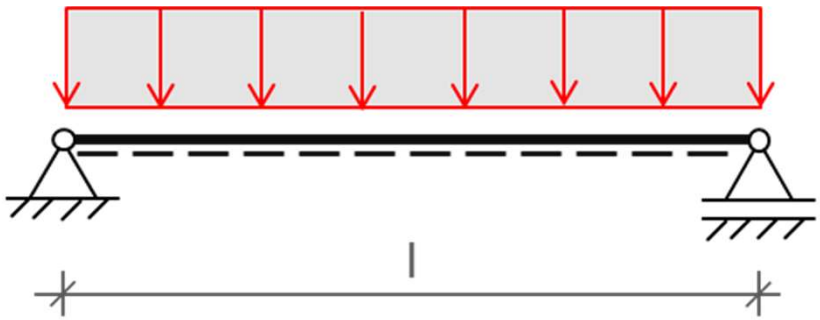
→ <u>no benefit</u> for **S460**

compared to **S235** and **S355**

B. General Parametric Study

Example: Beam with large span (L=20m)

Total load: $p_d = g+q = 40$ kN/m



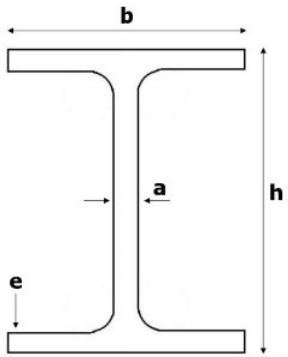
Load ratio: g /q =1

Deflection limit: l/300 for imposed load

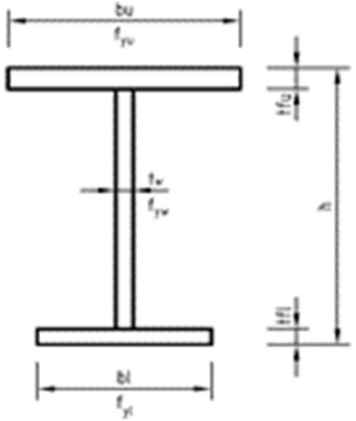
+ precamber the beam for dead load

No lateral-torsional buckling

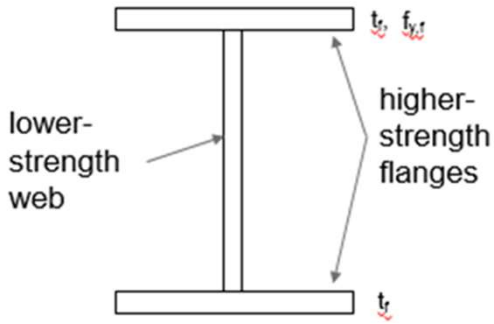
Hot-rolled section



Welded plate girder

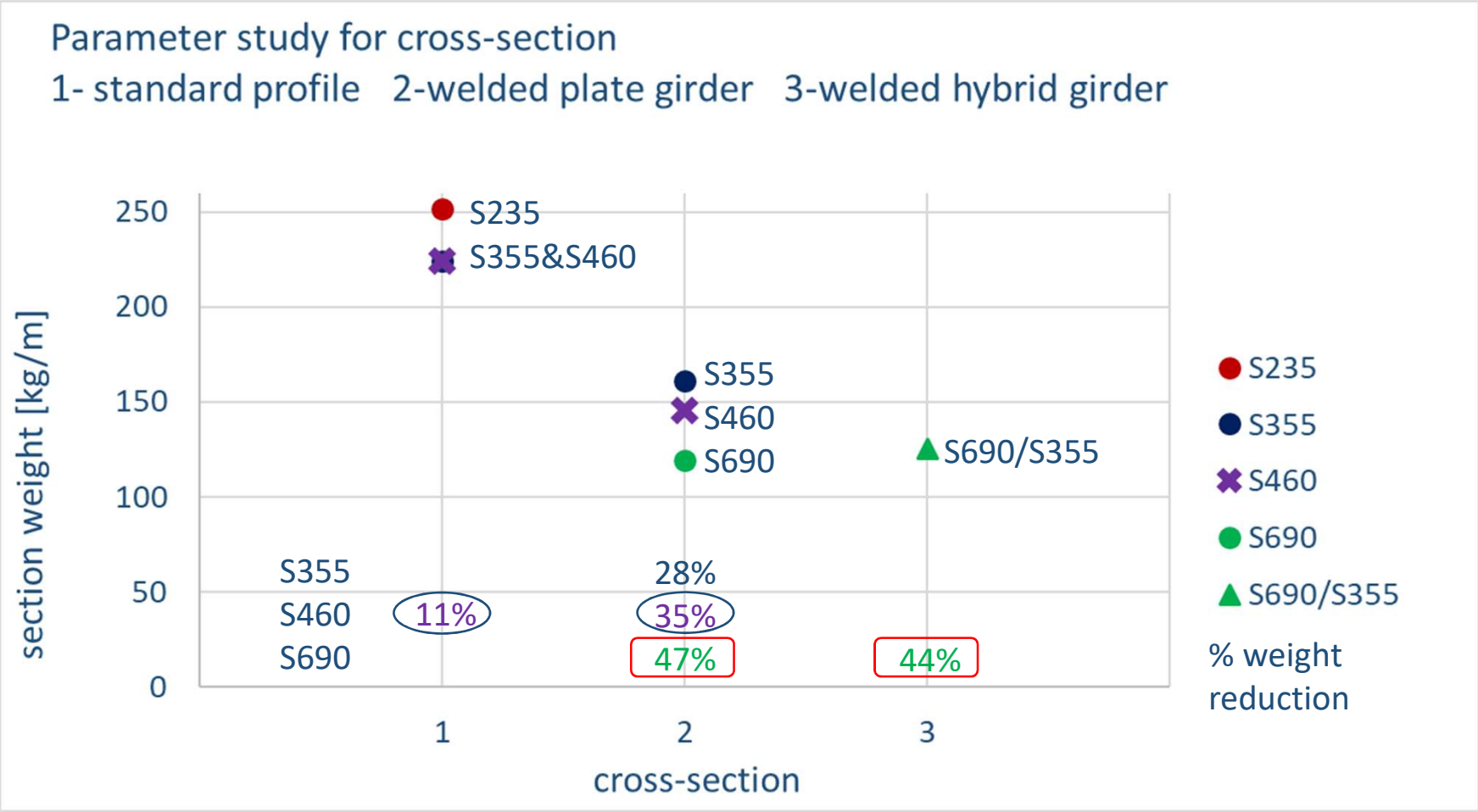


Welded hybrid girder



B. General Parametric Study

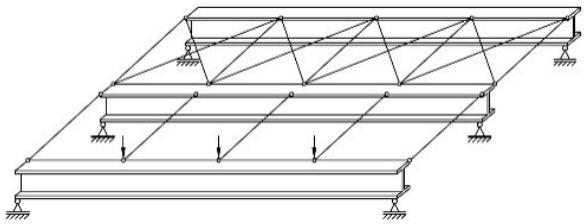
Example: Beam with large span (L=20m)

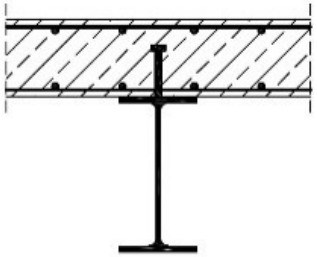


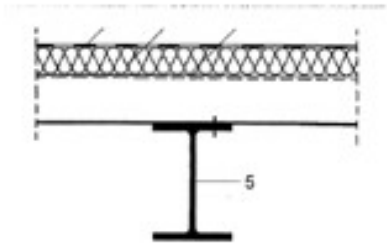
Constructive measures for using HSS

Lateral-torsional buckling:

- Lateral constraints on the upper flange are recommended

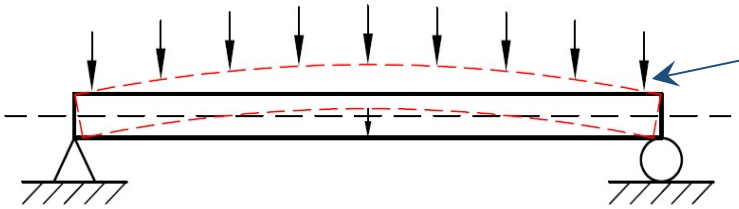






Deflection limit:

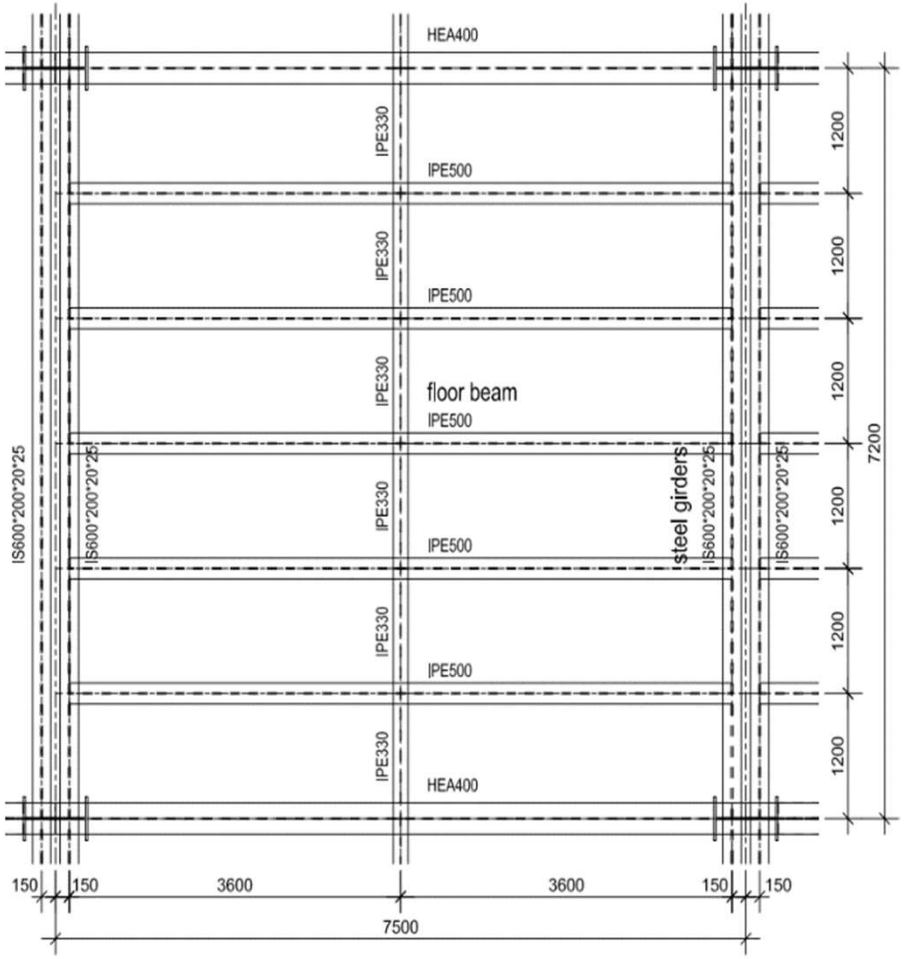
Deflection limit has to be reduced - for example precamber the beam to balance the dead loads - deflection limit only for the imposed loads



precamber of the beam

For more information see SCI P432

C. Case Study



floor system: 7.2m x 7.5m

Main Girder: welded profiles
IS 600x200x20x25 with S355
Secondary beam:
IPE 500 with S235
Loads:
dead load: 9 kN/m²
live load: 10 kN/m²

C. Case Study

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Steel Grade	Section Height	Top flange Width	Bottom flange Width	Web Thickness	Top flange Thickness	Bottom flange Thickness	Section Weight	Comparison Steel Weight	Comparison with sym. Profile
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[kg/m]		
S355	600	200	100	CL 1 - 8	CL 1 - 22	None - 25	88.9	100%	73%
S460/S355	600	200	100	CL 2 - 8	CL 1 - 18	None - 22	80.7	91%	71%
S460	600	200	100	CL 2 - 8	CL 1 - 18	None - 18	77.8	88%	69%

Comparative studies for steel main girder with unsymmetrical welded profile

Steel Grade	Profile	Section Weight [kg/m]	Comparison
S235	IPE500	90.7	100%
S355	IPE450	77.6	86%
S460	IPE400	66.3	73%

Optimization of steel Secondary beam

D. Recommendations for HSS Beams

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Conclusions

- Especially for large spans and high loadings, welded plate sections with HSS are highly effective
- More benefits for welded profiles than standard profiles with HSS
- Larger girder heights + smaller plate thicknesses are effective geometries
- Hybrid sections with lower strength of the web are very effective
- Generally lateral constraints on the upper flange are recommended
- Deflection limit has to be reduced
  i.e., considering precamber of the beam for dead loads

Further Support

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