Toepassingen van Hogesterktestaal (HSS)

Ing. Tim MEERT

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Introduction
ArcelorMittal Long Carbon Europe:
Overview of Product Range

Sections available in accordance with European, Russian, American, British and Japanese standards
HISTAR

High STrength Steels from ARcelorMittal
Quenching and Self-Tempering (QST)

- 850° C
- Self Tempering 600° C
- QST Water cooling
Comparison of rolling processes

**GRAIN**

- recrystallised austenite
- Non-recrystallised austenite
- Ferrite + Austenite
- Ferrite + Perlite
- Bainite
- Martensite

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>GRAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td></td>
</tr>
</tbody>
</table>

- Hot rolling
- TM rolling
- QST treatment

- Quenching
- Surface
- Inside

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Advantages of HISTAR steels
ETA: Full compliance with EN10025-4 (-> CE-mark) and EN1993 / EN1994

Comparison of yield strength between HISTAR and fine grain structural steels according to EN 10025-3/4:2004

<table>
<thead>
<tr>
<th>Min. Yield strength Reh [Mpa]</th>
<th>Material thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>300</td>
<td>10</td>
</tr>
<tr>
<td>350</td>
<td>20</td>
</tr>
<tr>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>450</td>
<td>40</td>
</tr>
<tr>
<td>500</td>
<td>50</td>
</tr>
</tbody>
</table>

- **HISTAR 460**: S460M/ML, S460N/NL
- **HISTAR 355**: S355M/ML, S355N/NL
Advantages of HISTAR steels

Influence on the slenderness of load carrying capacity of columns in HISTAR and conventional steels
Advantages of HISTAR steels

Weight Savings Using HISTAR460

- **Weight**
- **Cost**

- S355 HD400x677: 100% Weight and 68% Cost Savings
- HISTAR460 HD400x463: 32% Weight and Cost Savings

Effective length = 3.5 m

> 32% Weight and Cost Savings

NOTE: There is a 20-50% drop in price between the Jumbos and non-Jumbo sizes!
Advantages of HISTAR steels

Economical use of HISTAR steels compared to built up sections

<table>
<thead>
<tr>
<th>Steel grade Section</th>
<th>Fabrication costs</th>
<th>Weight per meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>HISTAR 460 HD 400 x 1086</td>
<td>125</td>
<td>1086</td>
</tr>
<tr>
<td>S 355 JR HD 400 x 990 + plates</td>
<td>35</td>
<td>90</td>
</tr>
<tr>
<td>S 355 Box column</td>
<td>115</td>
<td>130</td>
</tr>
</tbody>
</table>

Ultimate load (kN) and Weight (kg/m):

- HISTAR 460 HD 400 x 1086: 50544, 1086
- S 355 JR HD 400 x 990 + plates: 46568, 1320
- S 355 Box column: 47463, 1342

Buckling length: 4.5m
Advantages of HISTAR steels

PROJECT: Rheinenergiestadion (D)

Tender documents: welded beams

Proposal ArcelorMittal:

HD 400 x 287 / 382
HISTAR 355

16 % gain on weight
Economical advantages of HISTAR steels

Economical Use of HISTAR460 for Tension Members in Trusses

- 32% Weight & Cost Savings
- 52% Savings in Weld Material

S355 HD400x677

HISTAR460 HD400x463

* 32% Weight & Cost Savings
* 52% Savings in Weld Material
Economical advantages in fabrication

ADVANTAGE OF HISTAR460 -> S355

HD 400x463 (HISTAR460) [8h] -> HD 400x677 (S355) [13h]

$tw = 57.4\text{mm}$

$tw = 81.5\text{mm}$
Economical advantages in fabrication

Weldability and preheat temperatures (EN 1011-2)

Material thickness (mm)

<table>
<thead>
<tr>
<th>Yield strength Re (MPa)</th>
<th>Preheat-temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>235</td>
<td>0</td>
</tr>
<tr>
<td>275</td>
<td>0</td>
</tr>
<tr>
<td>355</td>
<td>12</td>
</tr>
<tr>
<td>420</td>
<td>12</td>
</tr>
<tr>
<td>460</td>
<td>12</td>
</tr>
<tr>
<td>500</td>
<td>12</td>
</tr>
</tbody>
</table>

No preheating for HISTAR steels if:
- Re < 460 MPa: $H_2 < 10$ ml/100g
- Re ≥ 460 MPa: $H_2 < 5$ ml/100g

Welding energy: $E ≥ 10$ kJ/cm

CE (%) = C + $\frac{Mn}{6}$ + $\frac{(Cr + Mo + V)}{5}$ + $\frac{(Cu + Ni)}{15}$
Summary HISTAR460

- Weight savings (material) 10 to 30% with associated cost savings of 10 to 50%
- Fabrication savings 5 to 30%
- Miscellaneous savings: erection, transportation, foundations, … 0 to 20%

Total Savings = 15% to 35%
Economical aspects of high strength steels
Advantages of HISTAR steels

77 Hudson at Colgate Center, Jersey City

Columns in ASTM A913 Grade 65 (HISTAR460) instead of Grade 50 (S355)

- 32 floors
- Area = 100,000 m²
- Floor height = 4.4 m
- Temporary loads = 15.7 kPa
- Frame: 9 x 9m and 9 x 15m

Total weight of columns

<table>
<thead>
<tr>
<th>Grade 50</th>
<th>Grade 65</th>
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</thead>
<tbody>
<tr>
<td>W 14 x 730</td>
<td>W 14 x 665</td>
</tr>
<tr>
<td>W 14 x 665</td>
<td>W 14 x 605</td>
</tr>
<tr>
<td>W 14 x 605</td>
<td>W 14 x 500</td>
</tr>
<tr>
<td>W 14 x 550</td>
<td>W 14 x 426</td>
</tr>
<tr>
<td>W 14 x 500</td>
<td>W 14 x 398</td>
</tr>
<tr>
<td>W 14 x 455</td>
<td>W 14 x 398</td>
</tr>
<tr>
<td>W 14 x 426</td>
<td>W 14 x 370</td>
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<tr>
<td>W 14 x 398</td>
<td>W 14 x 342</td>
</tr>
<tr>
<td>W 14 x 370</td>
<td>W 14 x 342</td>
</tr>
<tr>
<td>W 14 x 342</td>
<td>W 14 x 283</td>
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<tr>
<td>W 14 x 311</td>
<td>W 14 x 257</td>
</tr>
<tr>
<td>W 14 x 283</td>
<td>W 14 x 233</td>
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<tr>
<td>W 14 x 257</td>
<td>W 14 x 211</td>
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<tr>
<td>W 14 x 233</td>
<td>W 14 x 193</td>
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<td>W 14 x 211</td>
<td>W 14 x 176</td>
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<td>W 14 x 193</td>
<td>W 14 x 159</td>
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<td>W 14 x 176</td>
<td>W 14 x 145</td>
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<td>W 14 x 159</td>
<td>W 14 x 132</td>
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<td>W 14 x 145</td>
<td>W 14 x 120</td>
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<tr>
<td>W 14 x 132</td>
<td>W 14 x 109</td>
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<tr>
<td>W 14 x 120</td>
<td>W 14 x 99</td>
</tr>
<tr>
<td>W 14 x 109</td>
<td>-</td>
</tr>
</tbody>
</table>

Weight saving: 17%
Advantages of HISTAR steels

Mapfre Tower
Barcelona (E)

Hotel Olympica
Barcelona (E)
Economical advantages in column design

MAPFRE TOWER
Column design

Buckling length: 3.3 m
Total column weight
S 355: 25.3 t
S 460: 19.3 t

24% weight reduction thanks to the use of HISTAR 460 steel
Typical application: Deep foundations
Typical applications: deep foundations

HP sections

HP bearing piles or sheet piles for deep foundations

Sheet Piles

<table>
<thead>
<tr>
<th>Z-Section</th>
<th>U-Section</th>
<th>Combi-wall HZM/AZ</th>
<th>Flat Sheet Pile A5500</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Z-Section Image" /></td>
<td><img src="image2.png" alt="U-Section Image" /></td>
<td><img src="image3.png" alt="Combi-wall HZM/AZ Image" /></td>
<td><img src="image4.png" alt="Flat Sheet Pile A5500 Image" /></td>
</tr>
</tbody>
</table>

A29 - Le Havre-Amiens (F)
Viaduc de Mirville
Typical application: Industrial buildings
Typical applications: industrial buildings
Typical applications: industrial buildings

Fabrication hall/Warehouse Liebherr (D)
5000T HE/HL 1100
Typical application: High-rise buildings
Under construction:

Height 92 m – 22 floors - +/- 65000m²

+ Design: Kraaivanger architecten
+ Engineering office: Zonneveld Ingenieurs
+ General contractor: Boele&van Eesteren and G&S Bouw
+ Steel fabricator: ASK Romein – Oostingh Staalbouw

+/- 8000T sections delivered of which all columns were HD-beams in HISTAR460 (+/ 5000T)
STADSKANTOOR UTRECHT

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STADSKANTOOR ROTTERDAM: ‘Timmerhuis’

Under construction:

46000m² of offices, commercial and residential areas

+ Design: OMA
+ Engineering office: ABT
+ General contractor: Heijmans groep
+ Steel fabricator: CSM

+/- 2000T sections in HISTAR355
Desio Tower in Milano, ITALY
HD400 columns in Histar 460
TORRE DIAMANTE – MILAN

Torre Diamante

Height 130 m – 30 floors

Architect: Kohn Pedersen Fox – USA
Fabricator: Stahlbau Pichler – Italy

700t HD column sections in S460M made in Luxembourg out of 100% Western European recycled steel scrap

LEED Gold certificate
Freedom Tower - Manhattan

Architect:
David Childs SOM

Structural Engineer:
WSP Cantor Seinuk

1776 ft, 69 Office Floors, 105 Floors total

Concrete Core with a perimeter of steel columns (total of 80,000 tons of steel)

Approx. 8,100 MT Jumbos in A913 Gr.65
Hearst Tower - New York

“Vertical extension” of existing 1928 Art-Deco style building.

Architect: Sir Norman Foster

3000 T Histar Sections
Burj Khalifa - Dubai

Total height 828m
2700 t of jumbo sections for structure above 600m
Steel fabricator: Eversendai - Dubai
Structural engineer: Skidmore Owings & Merrill - USA
TOUR D2 – PARIS

Under construction:
Height 120 m – 35 floors
Fabricator: Iemants - Belgium

HD column sections in HISTAR460
Typical application: Stadia / Trusses
Many advantages in use ....

H-Section is an OPEN profile
⇒ SIMPLE to connect to other members

Simplified execution of truss nodes:
Flange to flange connection

\[ h_i \]

Selection of sections from one range ⇒ identical distance between the flanges
Simple truss connections
Trusses with Jumbo Shapes from ArcelorMittal

Velodrome - Berlin (D)
Trusses with Jumbo Shapes from ArcelorMittal

Truss nodes:
Excellent weldability is not only wishful but an absolute must
Astana Arena, Kazakhstan

- total steel tonnage for upper tribune and retractable roof: ~10 000 t
- 2 main trusses with span 124.4m: 950t each in HISTAR460
New Engineering Center of Emirates Airlines - Dubai
7 hangars 110 x 110 m for maintenance works of Airbus 380
~8000 t of H-beams in S355 and HISTAR 460

80 m wing span
26 m tail height

Typical applications: trusses
Typical application: Car parks
Car parks
Car parks
Typical application: Bridges
Road and railway bridges

Typical spans: 10 - 45m
Composite Bridges

- Comparison for a bridge with a span of 17 m and 2 traffic lanes

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>S235</th>
<th>S355</th>
<th>S460M</th>
<th>S460M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>HE 1000 M</td>
<td>HE 700 M</td>
<td>HE 700 B</td>
<td>HE 550 M</td>
</tr>
<tr>
<td>Construction depth</td>
<td>1.38 m</td>
<td>1.09 m</td>
<td>1.08 m</td>
<td>0.95 m</td>
</tr>
<tr>
<td>Steel weight</td>
<td>+ 16 %</td>
<td>reference</td>
<td>- 20 %</td>
<td>- 8 %</td>
</tr>
</tbody>
</table>
STAY IN TOUCH!

→ Download technical documentation and software for structural design

Visit: www.arcelormittal.com/sections

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