

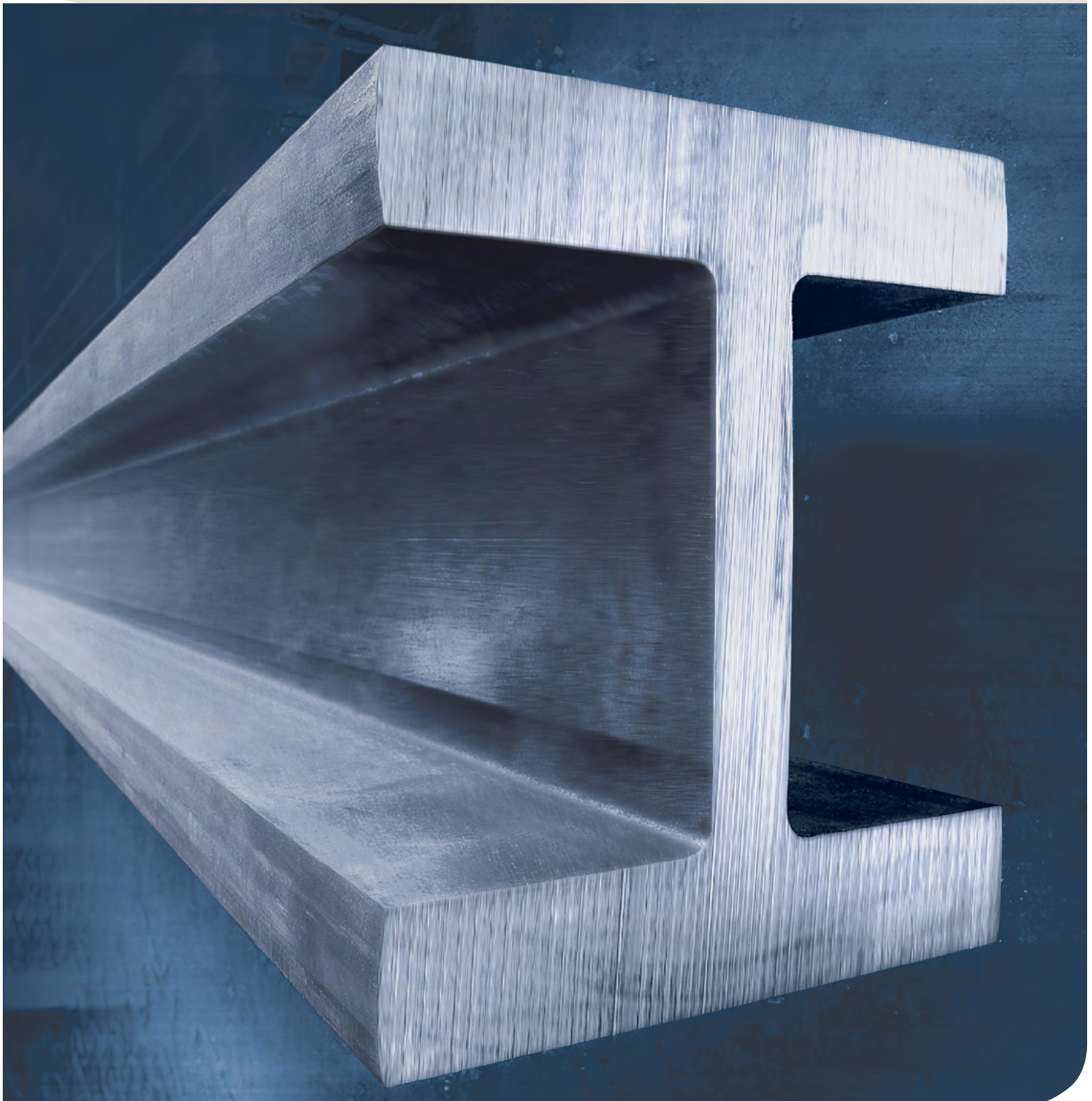
ArcelorMittal Europe – Long Products
Sections and Merchant Bars

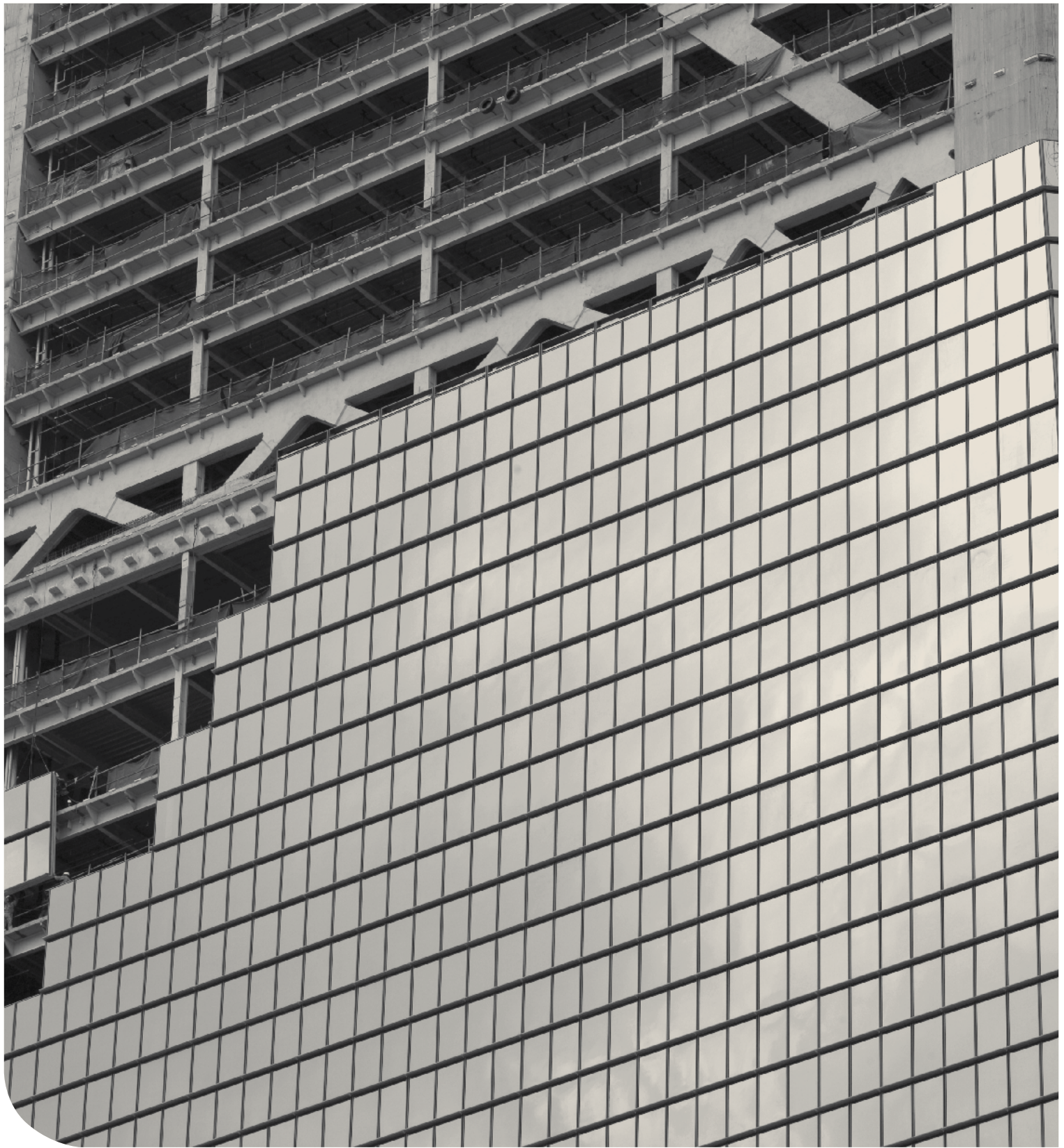


ArcelorMittal

HISTAR®

Innovative high strength steels
for economical steel structures





Innovative high strength steels for economical steel structures

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Hearst Tower, New York
United States



1. Introduction

With the development of the HISTAR® steels, ArcelorMittal has succeeded in creating structural steels combining high yield strength with excellent toughness at low temperatures and outstanding weldability. These material properties were considered incompatible until now.

This development was made possible by the innovative “in line” Quenching and Self-Tempering (QST) process, developed by ArcelorMittal Europe - Long Products in cooperation with the Centre de Recherches Métallurgiques in Liège.

The QST process enables the cost-effective production of high-strength steels. HISTAR® steels are delivered in accordance with the European Technical Approval ETA-10/0156. They are in full compliance with European and other national standards.

Hot rolled H-beams in HISTAR® grades enable the construction of innovative and competitive structures. Engineers take full advantage of the excellent HISTAR® properties when designing gravity columns of high-rise buildings, long span trusses and offshore structures. HISTAR® steels are recommended in any case of stress governed as well as seismic design.

HISTAR® steels are produced in the modern electric arc furnace (EAF) route, using 100% scrap as a raw material (upcycling). The EAF technology of steel production allows for significant reductions of noise, particle- and CO₂- emissions as well as water and primary energy consumption in the production process.

With HISTAR®, ArcelorMittal satisfies the needs of the designers for light and economical structures which fulfil at the same time the criteria of safety and sustainability.

**D2 Tower
Paris,
France**



2. Characteristics of HISTAR® steels

1. Product Description

HISTAR® steels are structural grades with a low alloy content, combining high strength, good toughness and superior weldability. HISTAR® grades are available with minimum yield strengths of 355 or 460 MPa.

When compared to standard structural steels, HISTAR® grades feature improved guaranteed mechanical characteristics over the whole range of product thicknesses (Figure 1). In order to best suit the different applications, HISTAR® grades are available with guaranteed toughnesses down to -20° C and down to -50° C.

HISTAR® steels are delivered in the thermo-mechanically rolled condition in accordance with the European Technical Approval ETA-10/0156. They comply with the requirements of the European standards EN 10025-4:2019 for weldable fine grain structural steels and EN 10225-2:2019 for weldable structural steels for fixed offshore structures. They also comply with other national standards like ASTM A 913/A 913 M and JIS G 3106. Table 1 shows a comparison, based on yield strength, between HISTAR® and other standard structural steel grades. HISTAR® grades are compatible with the requirements of the Eurocodes for the design of steel structures and composite steel-concrete structures.

The HISTAR® grades for offshore applications offer the following additional features:

- improved deformation properties in through thickness direction with respect to the resistance to lamellar tearing (Z qualities).
- notch impact properties in transverse direction.
- maximum ratio between yield strength and tensile strength.

Different HISTAR® grades are available in the market:

for general construction:

HISTAR® 355
fulfils the requirements of
1) ETA-10/0156 ($t \leq 140$ mm)
2) EN 10025-4:2019 for S355M

HISTAR® 355 L
fulfils the requirements of
1) ETA-10/0156 ($t \leq 125$ mm)
2) EN 10025-4:2019 for S355ML

HISTAR® 460
fulfils the requirements of
1) ETA-10/0156 ($t \leq 140$ mm)
2) EN 10025-4:2019 for S460M

HISTAR® 460 L
fulfils the requirements of
1) ETA-10/0156 ($t \leq 125$ mm)
2) EN 10025-4:2019 for S460ML

for offshore applications:

HISTAR® 355 TZ OS
fulfils the requirements of
EN 10225-2:2019 for S355 MLO

HISTAR® 355 TZK OS
fulfils the requirements of
EN 10225-2:2019 for S355 ML10

HISTAR® 460 TZ OS
fulfils the requirements of
EN 10225-2:2019 for S460 MLO

HISTAR® 460 TZK OS
fulfils the requirements of
EN 10225-2:2019 for S460 ML10

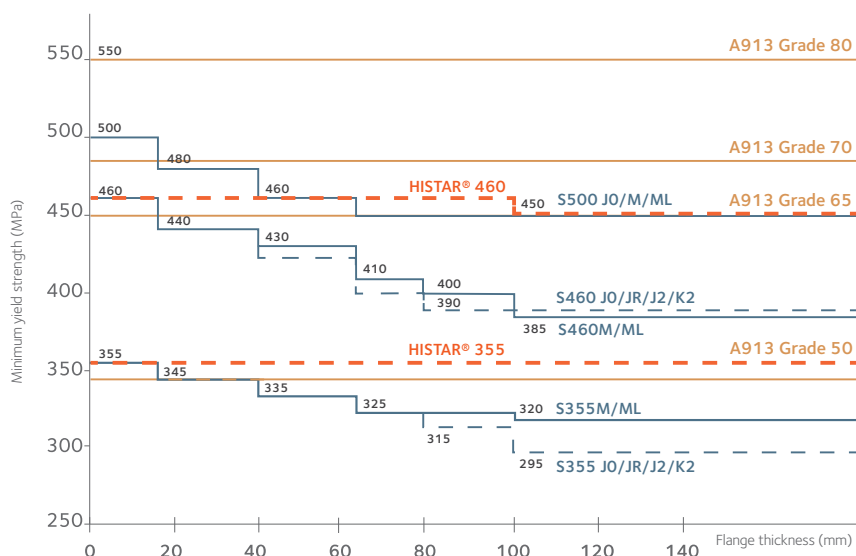


Figure 1 : Minimum yield strength according to material thickness for HISTAR® steels and European grades

Table 1: Comparison table for HISTAR® grades standards

HISTAR® Yield strength (MPa)	European and national standards					Previous standards				
	EN 10025-2: 2019	EN 10025-4: 2019	EN 10225-2: 2019	ASTM A 913	JIS G 3106:	NF A 35-504 NF A 36-201	NF A 35-501	DIN 17102	DIN 17100	BS 4360
355	S 355	S 355	S 355	Gr 50	SM 490 B/C/YB	E 355	E 36	St E 355	St 52-3	50 D
460	S 460	S 460	S 460	Gr 65	SM 570	E 460		St E 460		55 C
	S 500	S 500		Gr 70 Gr 80						



2. Chemical composition and mechanical properties

The chemical composition and the mechanical properties of the HISTAR® grades are given in Table 3 and 4 for general construction and in Table 5 and 6 for offshore applications. (pages 8-9)

3. Types of sections

HISTAR® grades are available in the following dimensions:

Table 2: Available sections (EN 10365)

Parallel flange beams	IPE 550 on request IPE 600 - IPE 750 UB 610 x 229 -> UB 1100 x 400
Wide flange beams	HE 260 - HE 280 on request HE 300 - HE 1000
Extra wide flange beams	HL 920 - HL 1100
Wide flange columns	HD 260 - HD 400 UC 254 x 254 -> UC 356 x 406
Wide flange bearing piles	HP 305 - HP 400 UBP 305 x 305 -> UBP 356 x 368

Equivalent shapes of ASTM A6 or other section series available. See [Sales Programme of ArcelorMittal Europe - Long Products](#), Sections and Merchant Bars for complete list and additional information.

The maximum flange thickness is:

- 140mm for HISTAR® 355 / 460
- 125mm for HISTAR® 355 L / 460 L
- 40mm for HISTAR® Offshore grades (sections with flange thickness > 40mm are subject to agreement).

Table 3: Chemical composition of HISTAR® steel grades for general applications

Grades	Chemical composition														
	Ladle analysis ⁽⁴⁾ [%]														
	C max.	Mn max.	Si ⁽³⁾ max.	P max.	S max.	Al ⁽²⁾ min.	Cr ≤	Ni ≤	Mo ≤	Nb max.	Ti max.	V max.	CEV ⁽¹⁾ max. Nominal thickness [mm]		
	t ≤ 63			63 < t ≤ 125			125 < t ≤ 140								
HISTAR 355	0.12	1.60	0.50	0.030	0.030	0.02	0.30	0.30	0.20	0.05	0.05	0.10	0.39	0.39	0.39
HISTAR 355 L	0.12	1.60	0.50	0.030	0.025	0.02	0.30	0.30	0.20	0.05	0.05	0.10	0.39	0.39	-
HISTAR 460	0.12	1.70	0.60	0.030	0.030	0.02	0.30	0.70	0.20	0.05	0.05	0.12	0.41	0.43	0.43
HISTAR 460 L	0.12	1.70	0.60	0.030	0.025	0.02	0.30	0.70	0.20	0.05	0.05	0.12	0.41	0.43	-

(1) $CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15$

(2) If sufficient nitrogen binding elements are present, the minimum aluminium requirement does not apply.

(3) Upon agreement: Si = 0.14 - 0.25 % and P ≤ 0.035% max. for capability of forming a zinc layer during hot-dip galvanisation.

(4) Chemical elements not in present table are limited as per the provisions of ETA-10/0156.

Table 4: Mechanical properties of HISTAR® steel grades for general applications

Grades	Mechanical properties						
	Tensile test					Charpy V-notch impact test ⁽¹⁾	
	Min. yield strength R _e [MPa]			Tensile strength R _m	Minimum elongation A _{L₀=5.65√S₀}	Temperature	Min. absorbed energy
	Nominal thickness [mm]						
t ≤ 100	100 < t ≤ 125	125 < t ≤ 140	[MPa]	[%]	[°C]	[J]	
HISTAR 355	355	355	355	470 - 630	22	-20	40
HISTAR 355 L	355	355	-	470-630	22	-20	47
						-50	27
HISTAR 460	460	450	450	540-720	17	-20	40
HISTAR 460 L	460	450	-	540-720	17	-20	47
						-50	27

(1) Mean value of three tests for full size specimens with no single value less than 70 % of the guaranteed average value. The provisions according to EN 10025-1:2004 are applicable.

Table 5: Chemical composition of HISTAR® steel grades for offshore applications

Grades	Chemical composition									
	Ladle analysis [%]									
	C max.	Mn max.	Si ⁽³⁾ max.	P max.	S max.	Al ⁽²⁾ min.	Nb max.	Ti max.	V max.	CEV ⁽¹⁾ max.
HISTAR 355 TZ OFFSHORE	0.12	1.60	0.30	0.025	0.010	0.02	0.04	0.025	0.06	0.38
HISTAR 355 TZK OFFSHORE	0.12	1.60	0.30	0.020	0.007	0.02	0.04	0.025	0.06	0.38
HISTAR 460 TZ OFFSHORE	0.12	1.70	0.30	0.025	0.010	0.02	0.05	0.025	0.06	0.39
HISTAR 460 TZK OFFSHORE	0.12	1.70	0.30	0.020	0.007	0.02	0.05	0.025	0.06	0.39

(1) $CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15$

(2) When other N-binding elements are used, the minimum Al value does not apply.

(3) Upon agreement: Si = 0.14 – 0.25 % and P ≤ 0.035% max. for capability of forming a zinc layer during hot-dip galvanisation.

Table 6: Mechanical properties of HISTAR® steel grades for offshore applications

Grades	Mechanical properties							
	Tensile test					Through thickness tensile test ⁽¹⁾	Charpy V-notch impact test	
	Min. yield strength R_e [MPa]		Tensile strength R_m	Max. ratio	Minimum elongation A $L_0=5.65\sqrt{S_0}$	Min. reduction of area Z_z	Longitudinal direction	Transverse direction
	Nominal thickness (mm)		[MPa]	R_e/R_m	[%]	[%]		
	≤ 16	> 16 ≤ 40						
HISTAR 355 TZ OFFSHORE	355	355	460-620	0,87	22	25	-40° C KV ≥ 50 J	-
HISTAR 355 TZK OFFSHORE	355	355	460-620	0,87	22	35	-	-40° C KV ≥ 50 J
HISTAR 460 TZ OFFSHORE	460	460	530-720	0,90	17	25	-40° C KV ≥ 60 J	-
HISTAR 460 TZK OFFSHORE	460	460	530-720	0,90	17	35	-	-40° C KV ≥ 50 J

(1) Test upon agreement.

3. Weight reduction of steel structures through the use of HISTAR® steels

1. General

Due to the manufacturing process of quenching and self tempering (QST) HISTAR® steels deviate from EN 10025-4: 2019 with more severe requirements. The following rules and requirements are defined in the European Technical Approval ETA-10/0156 for HISTAR® steel grades. Hot rolled long steel products made of HISTAR® are intended for use in welded, bolted and riveted structures. Unless other specified, the fabrication and installation is carried out in accordance with EN 1090-2.

2. Design advantages

For thicknesses larger than 16mm the minimum yield strength R_{eH} and the ultimate strength R_m of HISTAR® steels are greater than those specified in EN 10025-4 (Figure 1). Lower imperfections of S460 high strength steels are reflected in EN 1993-1-1 in lower imperfection factors and more favorable buckling curves. The same applies to HISTAR® 460 (Design example and tables given in Chapter 4. Column design tables).

3. Advantages in fabrication

The chemical analysis (Table 3) of HISTAR® steels differs from the analysis specified in EN 10025-4. This results in a lower carbon equivalent value (CEV) and thus a better weldability of HISTAR® steels compared to conventional steel grades (Figure 8).

No or less preheating before welding is required for HISTAR® steel grades (Details given in Chapter 5. Fabrication guidelines). Additional rules for the design of fillet weld connections allow the use of more favorable correlation factors β_w for HISTAR® steels deviating from EN 1993-1-8:

Table 7: Correlation factor β_w

Steel grade	correlation factor β_w for fillet welds
HISTAR® 355/355L	0.85
HISTAR® 460/460L	0.80

4. Selection of steel subgrade

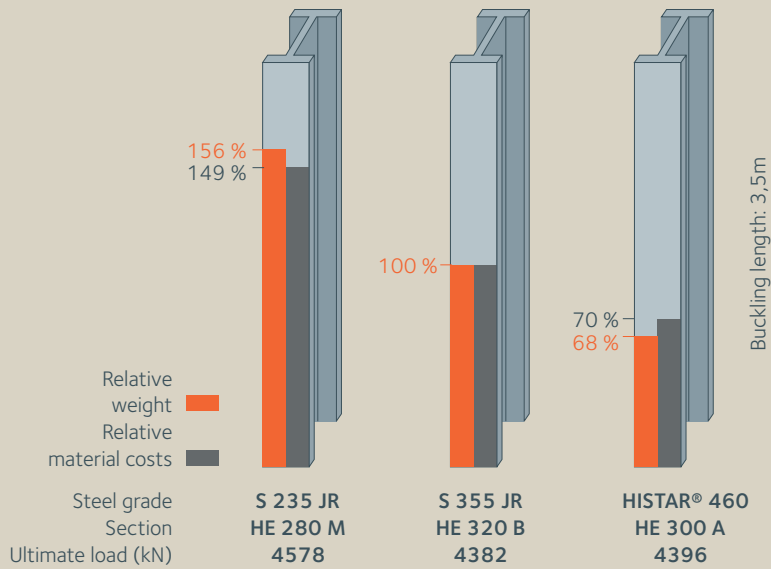
As for any steel, EN 1993-1-10 applies. HISTAR® steels have the same good toughness level than thermomechanical rolled steels according to EN 10025-4. Consequently the following steel grades have the same maximum permissible flange thickness according to EN 1993-1-10, Table 2.1, when applicable:
HISTAR® 355 and S355M (idem S355K2)
HISTAR® 355L and S355ML
HISTAR® 460 and S460M
HISTAR® 460L and S460ML

For elements not subjected to tension, welding or fatigue, the rules in EN 1993-1-10 can be conservative. In such cases, evaluation using fracture mechanics may be appropriate. According to EN 1993-1-10, as for any steel, fracture toughness needs not be specified for elements only in compression.

5. Application examples

Sections in HISTAR® steel grade have economical advantages to sections in conventional steel grades under compression, tension and bending. Complicated and expensive built-up sections can be substituted by economical hot rolled beams.

The reduced weight achieved with HISTAR® steels compared to conventional steels leads to reduced cost for material, finishing and assembly.



High strength HISTAR® grades allow, in comparison with conventional structural steels, to reduce the weight and material costs of steel structures, and to cut welding and assembly time (see Figures 2, 3 and 4).

Figure 2: Economical use of HISTAR® steel in columns

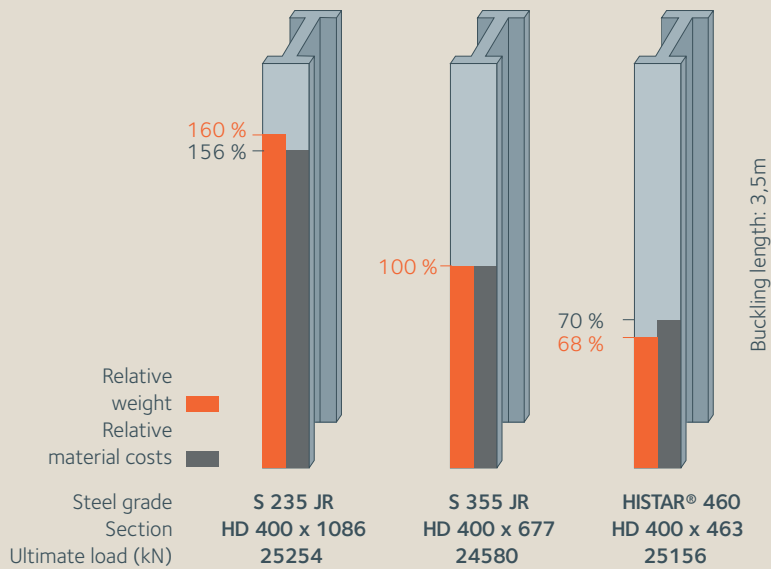


Figure 3: Economical use of HISTAR® steel in heavy columns

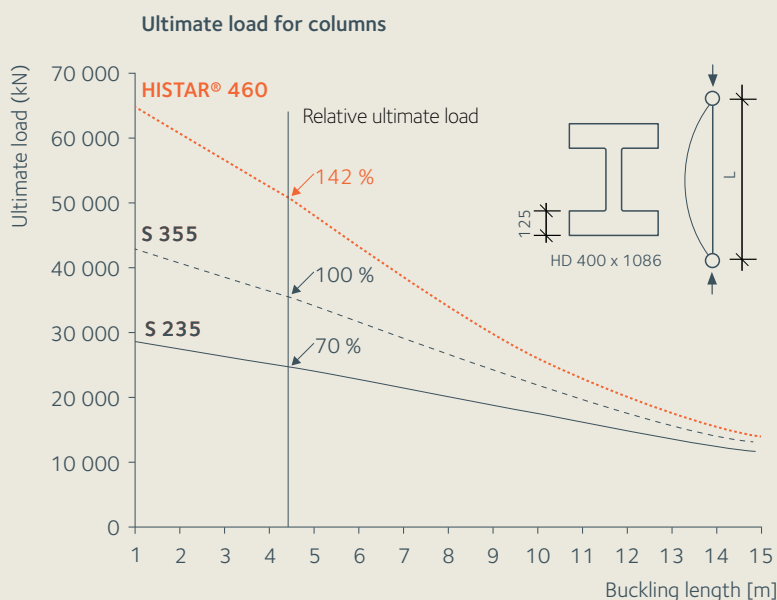
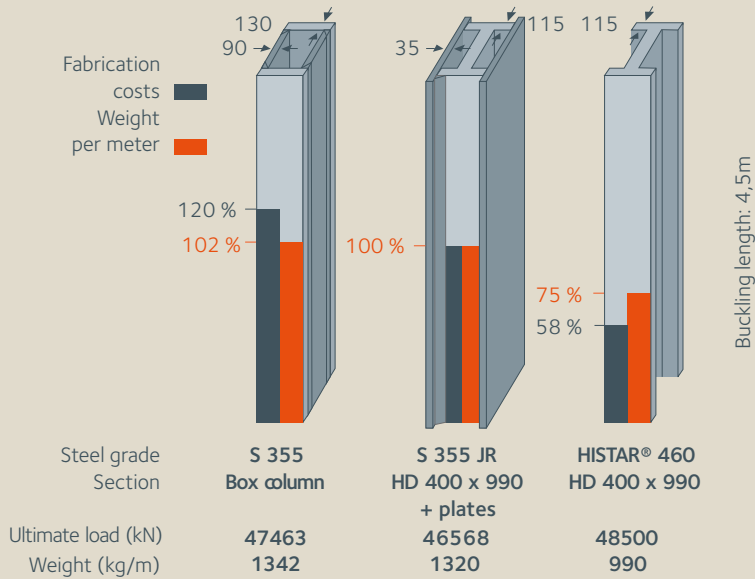
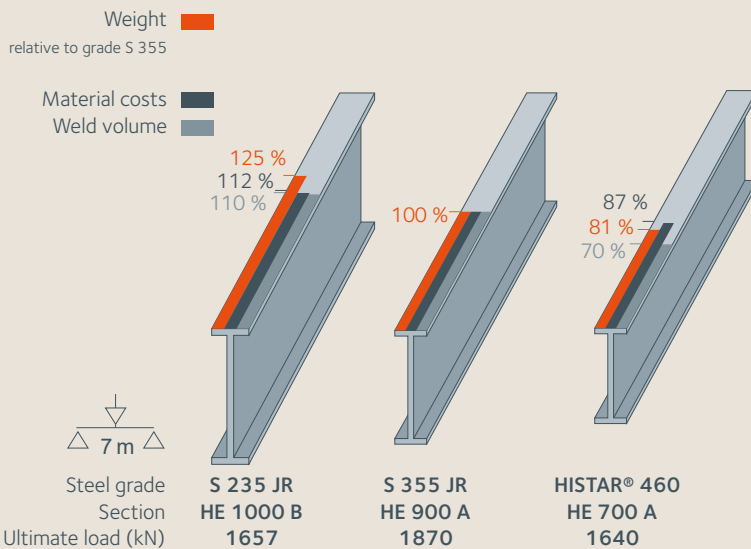


Figure 4: Influence of the slenderness on the load carrying capacity of the columns in HISTAR® and conventional steels



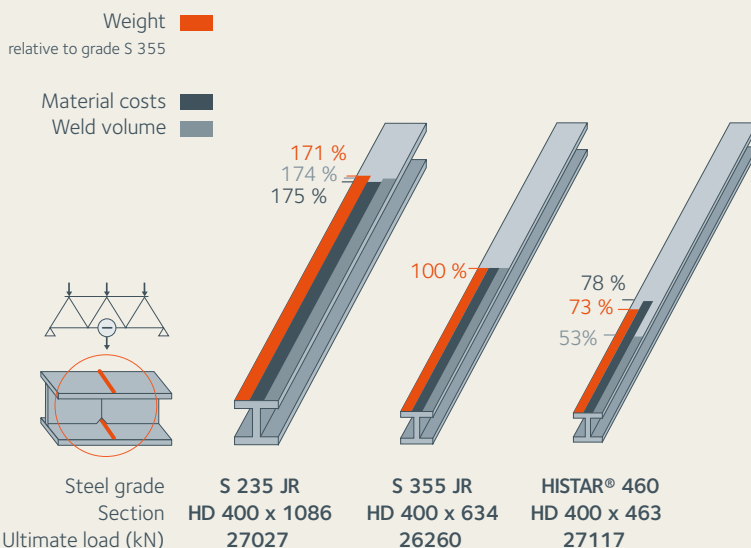
Due to the high yield strength of HISTAR® beams, it is possible to substitute complicated and expensive built-up sections by economical hot-rolled beams (see Figure 5).

Figure 5: Economical use of a HISTAR® column compared to built-up sections



In case of bending, the required cross section and fabrication cost can be reduced by using beams in HISTAR® grades (see Figure 6).

Figure 6: Economical use of HISTAR® beams as girders



HISTAR® grades develop their full potential in the design of tension members in trusses. Here, they not only allow to save material costs by taking full advantage of the high yield strength but the reduction of the dead load of the truss also leads to the design of even thinner sections, resulting in additional savings in fabrication costs (see Figure 7).

Figure 7: Economical use of HISTAR® beams in truss applications

4. Column design tables

Table 8: Eurocode (EN 1993-1-1: 2005) design buckling resistance [kN] of major and minor axis of HD columns sections in HISTAR® 355.

Section designation	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)													
		2	3	4	5	6	7	8	9	10	11	12	13	14	
HD 400 x 1299	$N_{b,y,Rd}$	58700	58700	57800	56500	55100	53700	52200	50600	48800	46900	44800	42700	40400	
	$N_{b,z,Rd}$	58400	55300	52000	48600	45000	41100	37300	33400	29900	26600	23700	21100	18900	
HD 400 x 1202	$N_{b,y,Rd}$	54300	54300	53300	52100	50800	49400	48000	46400	44700	42800	40900	38800	36600	
	$N_{b,z,Rd}$	53900	51000	47900	44700	41300	37700	34000	30500	27200	24100	21500	19100	17100	
HD 400 x 1086	$N_{b,y,Rd}$	49200	49200	48300	47100	46000	44700	43400	41900	40400	38700	36900	35000	33000	
	$N_{b,z,Rd}$	48700	45900	43100	40100	36900	33500	30100	26900	23800	21100	18700	16600	14900	
HD 400 x 990	$N_{b,y,Rd}$	44800	44800	43900	42800	41700	40600	39300	37900	36500	34900	33200	31400	29500	
	$N_{b,z,Rd}$	44300	41700	39100	36300	33300	30200	27100	24100	21300	18800	16700	14800	13200	
HD 400 x 900	$N_{b,y,Rd}$	40800	40800	39900	38900	37800	36700	35500	34200	32800	31300	29700	28000	26300	
	$N_{b,z,Rd}$	40200	37900	35400	32800	30100	27200	24300	21600	19000	16800	14900	13200	11800	
HD 400 x 818	$N_{b,y,Rd}$	37000	37000	36100	35200	34200	33200	32100	30900	29500	28100	26600	25000	23400	
	$N_{b,z,Rd}$	36500	34300	32100	29700	27100	24400	21800	19300	17000	15000	13200	11700	10400	
HD 400 x 744	$N_{b,y,Rd}$	33700	33600	32700	31900	31000	30000	29000	27800	26600	25200	23800	22300	20900	
	$N_{b,z,Rd}$	33100	31100	29000	26800	24400	22000	19600	17300	15200	13400	11800	10500	9300	
HD 400 x 677	$N_{b,y,Rd}$	30700	30500	29800	29000	28100	27200	26200	25100	24000	22700	21400	20000	18600	
	$N_{b,z,Rd}$	30100	28300	26300	24300	22100	19800	17600	15500	13700	12000	10600	9360	8320	
HD 400 x 634	$N_{b,y,Rd}$	28700	28600	27800	27100	26300	25400	24500	23400	22300	21100	19800	18500	17200	
	$N_{b,z,Rd}$	28100	26400	24600	22600	20600	18400	16300	14400	12600	11100	9770	8640	7670	
HD 400 x 592	$N_{b,y,Rd}$	26800	26600	26000	25200	24500	23700	22800	21800	20700	19600	18400	17100	15900	
	$N_{b,z,Rd}$	26300	24600	22900	21100	19100	17100	15100	13300	11700	10200	9000	7950	7060	
HD 400 x 551	$N_{b,y,Rd}$	24900	24700	24100	23400	22700	21900	21000	20100	19100	18000	16900	15700	14500	
	$N_{b,z,Rd}$	24400	22800	21200	19500	17700	15800	14000	12200	10700	9400	8270	7300	6490	
HD 400 x 509	$N_{b,y,Rd}$	23000	22900	22300	21600	20900	20200	19400	18500	17600	16500	15500	14400	13300	
	$N_{b,z,Rd}$	22500	21100	19600	18000	16300	14500	12800	11200	9840	8620	7580	6690	5940	
HD 400 x 463	$N_{b,y,Rd}$	20900	20700	20200	19600	19000	18300	17500	16700	15800	14900	13900	12800	11900	
	$N_{b,z,Rd}$	20400	19100	17700	16300	14700	13100	11500	10100	8800	7700	6770	5970	5300	
HD 400 x 421	$N_{b,y,Rd}$	19100	18900	18400	17800	17200	16600	15900	15100	14300	13400	12500	11500	10600	
	$N_{b,z,Rd}$	18600	17400	16100	14800	13300	11800	10400	9100	7940	6940	6090	5380	4770	
HD 400 x 382	$N_{b,y,Rd}$	17300	17100	16600	16100	15600	15000	14300	13600	12900	12000	11200	10300	9500	
	$N_{b,z,Rd}$	16900	15800	14600	13300	12000	10700	9350	8160	7120	6220	5450	4810	4260	
HD 400 x 347	$N_{b,y,Rd}$	15700	15500	15100	14600	14100	13600	13000	12300	11600	10800	10000	9250	8490	
	$N_{b,z,Rd}$	15300	14300	13200	12100	10900	9620	8440	7360	6410	5600	4900	4320	3830	
HD 320 x 300	$N_{b,y,Rd}$	13600	13300	12800	12400	11900	11300	10700	9980	9250	8490	7740	7030	6380	
	$N_{b,z,Rd}$	12700	11500	10200	8840	7490	6270	5240	4410	3740	3200	2760	2400	2110	
HD 260 x 299	$N_{b,y,Rd}$	13500	13000	12500	11900	11300	10500	9740	8870	8000	7160	6390	5700	5100	
	$N_{b,z,Rd}$	12400	11000	9570	8040	6620	5420	4460	3710	3120	2660	2280	1980	1740	
HD 260 x 225	$N_{b,y,Rd}$	10100	9740	9330	8860	8330	7730	7070	6380	5700	5060	4490	3980	3550	
	$N_{b,z,Rd}$	9260	8210	7060	5870	4790	3900	3200	2650	2230	1890	1620	1410	1230	

More section designations are available on orangebook.arcelormittal.com

Table 9: Eurocode (EN 1993-1-1: 2005) design buckling resistance [kN] of major and minor axis of UC columns sections in HISTAR® 355.

Section designation	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
UC 356 x 406 x 1299	Nb,y,Rd	58700	58700	57800	56500	55100	53700	52200	50600	48800	46900	44800	42700	40400
	Nb,z,Rd	58400	55300	52000	48600	45000	41200	37300	33500	29900	26600	23700	21100	18900
UC 356 x 406 x 1202	Nb,y,Rd	54300	54300	53300	52100	50800	49400	48000	46400	44700	42800	40900	38800	36600
	Nb,z,Rd	53900	51000	47900	44700	41300	37700	34000	30500	27200	24100	21500	19100	17100
UC 356 x 406 x 1086	Nb,y,Rd	49200	49200	48300	47100	46000	44700	43400	41900	40400	38700	36900	35000	33000
	Nb,z,Rd	48700	45900	43100	40100	36900	33500	30100	26900	23800	21100	18700	16600	14900
UC 356 x 406 x 990	Nb,y,Rd	44800	44800	43900	42800	41700	40600	39300	37900	36500	34900	33200	31400	29500
	Nb,z,Rd	44300	41700	39100	36300	33300	30200	27100	24100	21300	18800	16700	14800	13200
UC 356 x 406 x 900	Nb,y,Rd	40800	40800	39900	38900	37800	36700	35500	34200	32800	31300	29700	28000	26300
	Nb,z,Rd	40200	37900	35400	32800	30100	27200	24300	21600	19000	16800	14900	13200	11800
UC 356 x 406 x 818	Nb,y,Rd	37000	37000	36100	35200	34200	33200	32100	30900	29500	28100	26600	25000	23400
	Nb,z,Rd	36500	34300	32100	29700	27100	24400	21800	19300	17000	15000	13200	11700	10400
UC 356 x 406 x 744	Nb,y,Rd	33700	33600	32700	31900	31000	30000	29000	27800	26600	25200	23800	22300	20900
	Nb,z,Rd	33100	31100	29000	26800	24400	22000	19600	17300	15200	13400	11800	10500	9300
UC 356 x 406 x 677	Nb,y,Rd	30700	30500	29800	29000	28100	27200	26200	25100	24000	22700	21400	20000	18600
	Nb,z,Rd	30100	28300	26300	24300	22100	19800	17600	15500	13700	12000	10600	9360	8320
UC 356 x 406 x 634	Nb,y,Rd	28700	28500	27800	27100	26300	25400	24500	23400	22300	21100	19800	18500	17200
	Nb,z,Rd	28100	26400	24600	22600	20500	18400	16300	14400	12600	11100	9750	8620	7660
UC 356 x 406 x 592	Nb,y,Rd	26800	26600	26000	25200	24500	23700	22800	21800	20700	19600	18400	17100	15900
	Nb,z,Rd	26300	24600	22900	21100	19100	17100	15100	13300	11700	10200	9000	7950	7060
UC 356 x 406 x 551	Nb,y,Rd	24900	24800	24100	23400	22700	21900	21100	20100	19100	18000	16900	15700	14600
	Nb,z,Rd	24400	22900	21200	19500	17700	15800	14000	12300	10700	9410	8280	7310	6490
UC 356 x 406 x 509	Nb,y,Rd	23000	22900	22300	21600	20900	20200	19400	18500	17600	16500	15500	14400	13300
	Nb,z,Rd	22500	21100	19600	18000	16300	14500	12800	11200	9840	8620	7580	6690	5940
UC 356 x 406 x 467	Nb,y,Rd	21100	20900	20400	19800	19100	18500	17700	16900	16000	15000	14000	13000	12000
	Nb,z,Rd	20600	19300	17900	16400	14800	13200	11600	10200	8910	7800	6850	6040	5360
UC 356 x 406 x 393	Nb,y,Rd	17800	17600	17100	16600	16000	15400	14800	14000	13300	12400	11500	10700	9820
	Nb,z,Rd	17300	16200	15000	13700	12400	11000	9640	8420	7340	6420	5630	4960	4400
UC 356 x 406 x 340	Nb,y,Rd	15400	15200	14800	14300	13800	13300	12700	12000	11300	10600	9830	9060	8320
	Nb,z,Rd	15000	14000	12900	11800	10600	9400	8240	7180	6250	5460	4780	4220	3740
UC 305 x 305 x 342	Nb,y,Rd	15500	15200	14700	14200	13600	13000	12200	11500	10600	9770	8920	8100	7350
	Nb,z,Rd	14600	13400	12000	10500	9010	7620	6420	5430	4620	3970	3430	2990	2630
UC 305 x 305 x 313	Nb,y,Rd	14200	13900	13400	12900	12400	11800	11100	10400	9610	8810	8030	7290	6600
	Nb,z,Rd	13300	12200	10900	9510	8130	6860	5780	4880	4150	3560	3080	2680	2360
UC 305 x 305 x 283	Nb,y,Rd	12800	12500	12100	11600	11100	10600	9970	9300	8580	7860	7140	6470	5850
	Nb,z,Rd	12000	11000	9800	8540	7290	6140	5160	4350	3700	3170	2740	2390	2100

More section designations are available on orangebook.arcelormittal.com

Calculation of the design buckling resistance of a compression member according to EN 1993-1-1: 2005 (Design governed by buckling about minor axis z-z)

Steel Column; buckling length $L_b = 4.00$ m
 HD 400 x 634, HISTAR® 460 ($f_y = 460$ MPa, $t_f \leq 100$ mm)
 $A = 808$ cm² $I_z = 98250$ cm⁴ $E = 210000$ MPa

Partial safety factor (EN 1993-1-1: 2005, 6.1): $\gamma_{M1} = 1.00$

$$\text{Elastic critical force: } N_{cr} = \frac{\pi^2 * E * I_z}{L_b^2}$$

Non dimensional slenderness for class 1, 2 and 3 sections (EN 1993-1-1: 2005 (6.49)):

$$\bar{\lambda} = \sqrt{\frac{A * f_y}{N_{cr}}} = \frac{L_b}{\pi} \sqrt{\frac{A * f_y}{I_z * E}} = \frac{400 \text{ cm}}{\pi} \sqrt{\frac{808 \text{ cm}^2 * 460 \text{ MPa}}{98250 \text{ cm}^4 * 210000 \text{ MPa}}} = 0.5404$$

Determination of the buckling curve (EN 1993-1-1: 2005, Table 6.1, Table 6.2):

Rolled I-Section, Buckling of the minor axis z-z, $h/b \leq 1.20$, $t_f \leq 100$ mm, S460:

- Table 6.2: Buckling curve a
- Table 6.1: Imperfection factor $\alpha = 0.21$

Buckling reduction factor χ (EN 1993-1-1: 2005 (6.49)) :

$$\phi = 0.50 * [1 + \alpha * (\bar{\lambda} - 0.20)] + \bar{\lambda}^2 = 0.50 * [1 + 0.21 * (0.5404 - 0.20)] + 0.5404^2 = 0.6818$$

$$\chi = \frac{1}{\phi + \sqrt{\phi^2 - \bar{\lambda}^2}} \leq 1.00 \quad \chi = \frac{1}{0.6818 + \sqrt{0.6818^2 - 0.5404^2}} = 0.911$$

Design buckling resistance of a compression member for class 1, 2 and 3 sections (EN 1993-1-1: 2005 (6.47)):

$$N_{b,z,Rd} = \frac{\chi * A * f_y}{\gamma_{M1}} \quad N_{b,z,Rd} = \frac{0.911 * 808 \text{ cm}^2 * 460 \text{ kN/cm}^2}{1.00} = 33900 \text{ kN}$$

Weight and cost reduction due to Design in HISTAR® 460:

HISTAR® 460	S 355
HD 400 x 634	HD 400 x 990
G = 634 kg/m	G = 990 kg/m
h x b = 474 x 424 mm	h x b = 550 x 448 mm
$t_f = 77.1$ mm; $t_w = 47.6$ mm	$t_f = 115$ mm; $t_w = 71.9$ mm
A = 808.0 cm ²	A = 1262 cm ²
$f_y = 460$ MPa (ETA-10/0156)	$f_y = 295$ Mpa
Buckling length $L_b = 4.00$ m	Buckling length = 4.0 m
$\lambda = 0.5404$	$\lambda = 0.4073$
Buckling curve a	Buckling curve c
X = 0.911	X = 0.893
$N_{b,Rd} = 33900$ kN	$N_{b,Rd} = 33200$ kN

Table 10: Eurocode (EN 1993-1-1: 2005) design buckling resistance [kN] of major and minor axis of HD columns sections in HISTAR® 460.

Section designation	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)													
		2	3	4	5	6	7	8	9	10	11	12	13	14	
HD 400 x 1299	$N_{b,y,Rd}$	74300	74100	73000	71800	70500	69000	67400	65500	63300	60800	57900	54700	51200	
	$N_{b,z,Rd}$	73300	70000	66500	62400	57700	52400	46700	41200	36000	31500	27600	24300	21500	
HD 400 x 1202	$N_{b,y,Rd}$	68900	68700	67600	66400	65100	63700	62100	60300	58100	55600	52800	49600	46300	
	$N_{b,z,Rd}$	67800	64800	61400	57500	53000	48000	42700	37500	32700	28600	25000	21900	19400	
HD 400 x 1086	$N_{b,y,Rd}$	62400	62200	61200	60100	59000	57700	56200	54500	52600	50300	47700	44800	41700	
	$N_{b,z,Rd}$	61300	58500	55300	51600	47300	42600	37600	32800	28500	24800	21700	19000	16800	
HD 400 x 990	$N_{b,y,Rd}$	56800	56600	55600	54600	53600	52300	50900	49300	47400	45200	42700	40000	37100	
	$N_{b,z,Rd}$	55800	53100	50100	46700	42700	38300	33700	29300	25500	22100	19300	16900	14900	
HD 400 x 900	$N_{b,y,Rd}$	51700	51400	50600	49600	48600	47400	46100	44500	42700	40600	38200	35600	32900	
	$N_{b,z,Rd}$	50700	48200	45500	42300	38500	34400	30200	26200	22700	19700	17100	15000	13200	
HD 400 x 818	$N_{b,y,Rd}$	48000	47700	46800	45900	44900	43800	42400	40900	39000	36900	34500	32000	29400	
	$N_{b,z,Rd}$	47300	45800	44000	41700	38600	34700	30400	26200	22400	19200	16600	14400	12600	
HD 400 x 744	$N_{b,y,Rd}$	43600	43300	42500	41600	40700	39600	38300	36900	35100	33100	30800	28400	26100	
	$N_{b,z,Rd}$	43000	41600	39900	37700	34800	31200	27200	23300	19900	17100	14700	12800	11200	
HD 400 x 677	$N_{b,y,Rd}$	39700	39400	38600	37800	37000	35900	34700	33300	31600	29700	27500	25300	23100	
	$N_{b,z,Rd}$	39100	37800	36300	34200	31500	28200	24500	20900	17800	15300	13100	11400	9970	
HD 400 x 634	$N_{b,y,Rd}$	37200	36800	36100	35400	34500	33500	32400	31000	29400	27500	25500	23400	21300	
	$N_{b,z,Rd}$	36600	35400	33900	31900	29300	26100	22600	19300	16500	14100	12100	10500	9180	
HD 400 x 592	$N_{b,y,Rd}$	34700	34400	33700	33000	32200	31300	30100	28800	27300	25500	23500	21600	19600	
	$N_{b,z,Rd}$	34200	33000	31600	29700	27300	24200	20900	17800	15200	12900	11100	9650	8440	
HD 400 x 551	$N_{b,y,Rd}$	32300	31900	31300	30600	29800	28900	27900	26600	25100	23400	21600	19700	17900	
	$N_{b,z,Rd}$	31700	30600	29300	27500	25200	22300	19300	16400	13900	11900	10200	8840	7730	
HD 400 x 509	$N_{b,y,Rd}$	29900	29500	28900	28300	27600	26700	25700	24500	23100	21500	19700	18000	16300	
	$N_{b,z,Rd}$	29300	28300	27100	25400	23200	20500	17700	15000	12700	10900	9340	8090	7070	
HD 400 x 463	$N_{b,y,Rd}$	27100	26800	26200	25600	25000	24200	23200	22100	20700	19200	17600	16000	14500	
	$N_{b,z,Rd}$	26600	25700	24500	23000	21000	18500	15800	13400	11400	9690	8320	7210	6300	
HD 400 x 421	$N_{b,y,Rd}$	24700	24400	23900	23300	22700	21900	21000	20000	18700	17300	15800	14300	12900	
	$N_{b,z,Rd}$	24300	23400	22300	20900	19000	16700	14300	12100	10200	8700	7470	6470	5650	
HD 400 x 382	$N_{b,y,Rd}$	22400	22100	21600	21100	20500	19800	19000	18000	16800	15500	14100	12800	11500	
	$N_{b,z,Rd}$	22000	21200	20200	18900	17100	15000	12800	10800	9150	7790	6680	5780	5050	
HD 400 x 347	$N_{b,y,Rd}$	20300	20000	19600	19100	18600	17900	17100	16200	15100	13900	12600	11400	10300	
	$N_{b,z,Rd}$	19900	19200	18300	17100	15500	13500	11500	9730	8220	6990	6000	5190	4530	
HD 400 x 314	$N_{b,y,Rd}$	18400	18100	17700	17300	16700	16100	15400	14500	13500	12400	11200	10100	9110	
	$N_{b,z,Rd}$	18000	17300	16500	15400	13900	12100	10300	8660	7310	6210	5330	4610	4020	
HD 400 x 287	$N_{b,y,Rd}$	16800	16600	16200	15800	15300	14800	14100	13300	12300	11300	10200	9210	8270	
	$N_{b,z,Rd}$	16500	15900	15100	14100	12700	11100	9380	7900	6660	5660	4850	4200	3660	
HD 400 x 262	$N_{b,y,Rd}$	15400	15100	14800	14400	14000	13500	12800	12100	11200	10200	9240	8310	7450	
	$N_{b,z,Rd}$	15100	14500	13800	12800	11600	10000	8500	7150	6030	5120	4390	3800	3310	
HD 400 x 237	$N_{b,y,Rd}$	13800	13600	13300	13000	12600	12100	11500	10800	9970	9090	8200	7360	6600	
	$N_{b,z,Rd}$	13600	13000	12400	11500	10300	8950	7570	6360	5350	4550	3890	3370	2940	
HD 400 x 216	$N_{b,y,Rd}$	12700	12500	12200	11900	11500	11000	10500	9830	9070	8260	7450	6680	5980	
	$N_{b,z,Rd}$	12400	11900	11300	10500	9440	8170	6900	5790	4880	4140	3550	3070	2680	

Table 10 (continued): Eurocode (EN 1993-1-1: 2005) design buckling resistance [kN] of major and minor axis of HD columns sections in HISTAR® 460.

Section designation	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
HD 400 x 187	$N_{b,y,Rd}$	10900	10700	10500	10200	9880	9480	9000	8420	7760	7050	6340	5680	5080
	$N_{b,z,Rd}$	10700	10300	9750	9040	8090	6970	5880	4920	4140	3510	3010	2600	2270
HD 360 x 196	$N_{b,y,Rd}$	11500	11300	11000	10800	10400	10000	9490	8880	8190	7440	6700	6000	5360
	$N_{b,z,Rd}$	11200	10800	10100	9290	8180	6930	5770	4790	4010	3390	2900	2500	2180
HD 360 x 179	$N_{b,y,Rd}$	10500	10300	10100	9800	9490	9100	8640	8070	7430	6750	6070	5430	4850
	$N_{b,z,Rd}$	10200	9800	9240	8460	7430	6290	5230	4340	3640	3070	2630	2270	1970
HD 360 x 162	$N_{b,y,Rd}$	9490	9310	9100	8850	8570	8220	7790	7280	6690	6070	5460	4880	4360
	$N_{b,z,Rd}$	9240	8850	8340	7630	6690	5660	4700	3900	3270	2760	2360	2040	1770
HD 360 x 147	$N_{b,y,Rd}$	8640	8480	8280	8060	7790	7470	7070	6600	6060	5490	4920	4400	3930
	$N_{b,z,Rd}$	8420	8060	7590	6930	6070	5120	4250	3520	2950	2490	2130	1840	1600
HD 360 x 134	$N_{b,y,Rd}$	7850	7700	7510	7310	7060	6760	6400	5960	5470	4950	4430	3960	3530
	$N_{b,z,Rd}$	7640	7310	6880	6280	5490	4630	3840	3180	2660	2250	1920	1660	1440
HD 320 x 300	$N_{b,y,Rd}$	17600	17200	16800	16300	15700	15000	14100	13000	11800	10600	9480	8420	7490
	$N_{b,z,Rd}$	16900	15900	14500	12600	10300	8270	6660	5430	4490	3770	3200	2760	2390
HD 320 x 245	$N_{b,y,Rd}$	14300	14000	13700	13200	12700	12100	11400	10500	9470	8470	7520	6670	5920
	$N_{b,z,Rd}$	13800	13000	11800	10200	8310	6650	5350	4360	3600	3020	2570	2210	1920
HD 320 x 198	$N_{b,y,Rd}$	11600	11300	11000	10700	10200	9690	9020	8250	7410	6580	5820	5140	4550
	$N_{b,z,Rd}$	11100	10400	9460	8080	6550	5210	4180	3400	2810	2360	2000	1720	1490
HD 320 x 158	$N_{b,y,Rd}$	9230	9010	8760	8460	8100	7650	7090	6450	5760	5100	4490	3960	3500
	$N_{b,z,Rd}$	8850	8300	7480	6350	5110	4060	3250	2640	2180	1830	1550	1330	1160
HD 320 x 127	$N_{b,y,Rd}$	7390	7210	7010	6770	6470	6090	5630	5090	4540	4000	3520	3100	2740
	$N_{b,z,Rd}$	7080	6630	5960	5020	4020	3180	2540	2060	1700	1430	1210	1040	904
HD 320 x 97,6	$N_{b,y,Rd}$	5700	5550	5390	5200	4960	4650	4280	3860	3420	3010	2640	2320	2050
	$N_{b,z,Rd}$	5460	5100	4570	3830	3060	2410	1930	1560	1290	1080	917	788	684
HD 260 x 299	$N_{b,y,Rd}$	17400	16900	16400	15700	14900	13900	12600	11300	9880	8620	7520	6590	5800
	$N_{b,z,Rd}$	16600	15400	13700	11200	8840	6930	5510	4460	3670	3070	2610	2240	1940
HD 260 x 225	$N_{b,y,Rd}$	13100	12700	12300	11700	11000	10100	9100	7990	6940	6010	5220	4550	4000
	$N_{b,z,Rd}$	12500	11500	10100	8160	6350	4950	3920	3170	2610	2180	1850	1590	1380
HD 260 x 172	$N_{b,y,Rd}$	9990	9690	9340	8900	8320	7590	6740	5860	5060	4360	3770	3290	2880
	$N_{b,z,Rd}$	9540	8800	7650	6160	4780	3710	2940	2370	1950	1630	1380	1190	1030
HD 260 x 142	$N_{b,y,Rd}$	8190	7940	7630	7250	6740	6100	5370	4640	3980	3420	2960	2570	2250
	$N_{b,z,Rd}$	7810	7180	6190	4930	3800	2940	2330	1880	1540	1290	1090	938	814
HD 260 x 114	$N_{b,y,Rd}$	6610	6400	6150	5820	5390	4850	4240	3650	3120	2680	2310	2010	1760
	$N_{b,z,Rd}$	6300	5770	4940	3910	3000	2320	1830	1470	1210	1010	858	736	638

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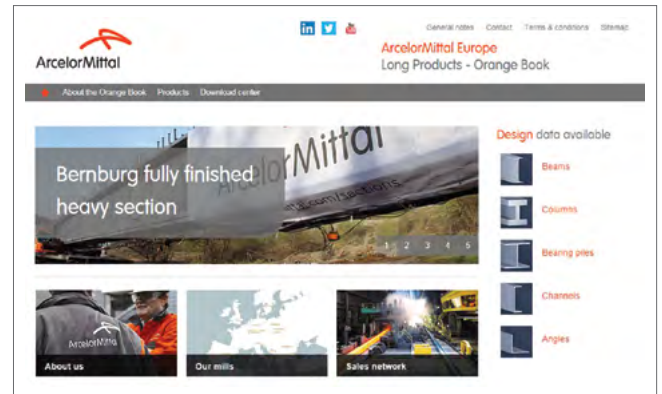


Table 11: Eurocode (EN 1993-1-1: 2005) design buckling resistances [kN] of major and minor axis of UC columns sections in HISTAR® 460.

Section designation	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
UC 356 x 406 x 1299	$N_{b,y,Rd}$	74500	74400	73200	72000	70700	69200	67600	65700	63500	60900	58000	54800	51300
	$N_{b,z,Rd}$	73500	70200	66600	62500	57800	52500	46800	41200	36100	31500	27600	24300	21500
UC 356 x 406 x 1202	$N_{b,y,Rd}$	68900	68700	67600	66400	65200	63800	62200	60300	58100	55600	52800	49600	46300
	$N_{b,z,Rd}$	67900	64800	61400	57600	53100	48000	42700	37500	32700	28500	25000	21900	19400
UC 356 x 406 x 1086	$N_{b,y,Rd}$	62400	62200	61200	60100	59000	57700	56200	54500	52500	50300	47600	44800	41700
	$N_{b,z,Rd}$	61300	58400	55300	51600	47300	42600	37600	32800	28500	24800	21700	19000	16800
UC 356 x 406 x 990	$N_{b,y,Rd}$	56800	56600	55700	54700	53600	52300	50900	49300	47400	45200	42700	40000	37100
	$N_{b,z,Rd}$	55800	53100	50200	46700	42700	38300	33700	29300	25400	22100	19300	16900	14900
UC 356 x 406 x 900	$N_{b,y,Rd}$	51700	51400	50600	49600	48600	47400	46100	44500	42700	40600	38200	35600	32900
	$N_{b,z,Rd}$	50700	48200	45500	42300	38600	34400	30200	26200	22700	19700	17100	15000	13200
UC 356 x 406 x 818	$N_{b,y,Rd}$	48000	47700	46800	45900	44900	43800	42400	40900	39000	36900	34500	32000	29400
	$N_{b,z,Rd}$	47300	45800	44000	41700	38600	34700	30400	26200	22400	19200	16600	14400	12600
UC 356 x 406 x 744	$N_{b,y,Rd}$	43600	43300	42500	41600	40700	39600	38300	36900	35100	33100	30800	28400	26100
	$N_{b,z,Rd}$	43000	41600	39900	37700	34800	31200	27200	23300	19900	17100	14700	12800	11200
UC 356 x 406 x 677	$N_{b,y,Rd}$	39700	39400	38600	37800	36900	35900	34700	33300	31600	29700	27500	25300	23100
	$N_{b,z,Rd}$	39100	37800	36300	34200	31500	28200	24500	20900	17800	15300	13100	11400	9970
UC 356 x 406 x 634	$N_{b,y,Rd}$	37100	36800	36100	35400	34500	33500	32400	31000	29400	27500	25500	23400	21400
	$N_{b,z,Rd}$	36600	35300	33800	31900	29300	26100	22600	19300	16400	14000	12100	10500	9160
UC 356 x 406 x 592	$N_{b,y,Rd}$	34700	34400	33700	33000	32200	31200	30100	28800	27300	25500	23500	21600	19600
	$N_{b,z,Rd}$	34200	33000	31600	29700	27300	24200	20900	17800	15200	12900	11100	9650	8440
UC 356 x 406 x 551	$N_{b,y,Rd}$	32300	31900	31300	30600	29900	29000	27900	26600	25100	23400	21600	19700	17900
	$N_{b,z,Rd}$	31800	30700	29300	27600	25200	22400	19300	16400	13900	11900	10200	8860	7740
UC 356 x 406 x 509	$N_{b,y,Rd}$	29900	29500	28900	28300	27600	26700	25700	24500	23100	21400	19700	18000	16300
	$N_{b,z,Rd}$	29300	28300	27100	25400	23200	20500	17700	15000	12700	10900	9340	8090	7070
UC 356 x 406 x 467	$N_{b,y,Rd}$	27400	27000	26500	25900	25200	24400	23500	22300	21000	19500	17800	16200	14700
	$N_{b,z,Rd}$	26900	25900	24800	23200	21200	18700	16000	13600	11500	9800	8420	7300	6370
UC 356 x 406 x 393	$N_{b,y,Rd}$	23000	22700	22200	21700	21100	20400	19600	18500	17300	16000	14600	13200	11900
	$N_{b,z,Rd}$	22600	21800	20800	19400	17600	15500	13200	11200	9440	8040	6900	5970	5220
UC 356 x 406 x 340	$N_{b,y,Rd}$	19900	19600	19200	18700	18200	17600	16800	15900	14800	13600	12400	11200	10100
	$N_{b,z,Rd}$	19500	18800	17900	16700	15100	13200	11300	9490	8010	6820	5850	5060	4420
UC 356 x 406 x 287	$N_{b,y,Rd}$	16100	15900	15500	15200	14700	14200	13600	12900	12000	11000	10100	9090	8190
	$N_{b,z,Rd}$	15800	15200	14500	13600	12300	10800	9220	7790	6590	5610	4810	4170	3640
UC 356 x 406 x 235	$N_{b,y,Rd}$	13200	13000	12700	12400	12000	11600	11000	10400	9680	8880	8060	7260	6530
	$N_{b,z,Rd}$	12900	12400	11800	11100	10000	8760	7460	6290	5320	4520	3880	3360	2930

More section designations are available on orangebook.arcelormittal.com

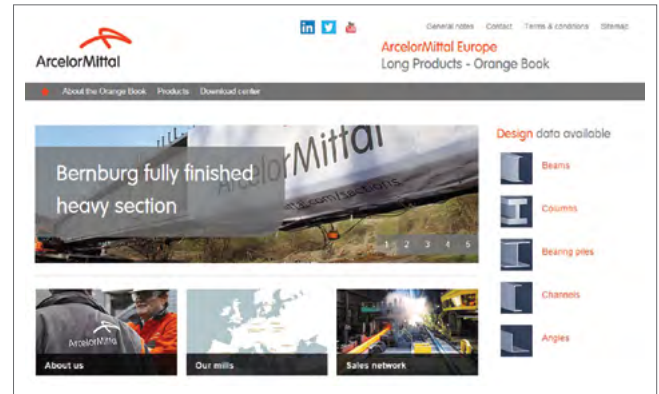


Table 11 (continued): Eurocode (EN 1993-1-1: 2005) design buckling resistances [kN] of major and minor axis of UC columns sections in HISTAR® 460.

Section designation	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
UC 356 x 368 x 202	$N_{b,y,Rd}$	11300	11100	10900	10600	10300	9910	9450	8890	8250	7540	6830	6140	5510
	$N_{b,z,Rd}$	11100	10600	10000	9260	8220	7040	5900	4920	4130	3500	2990	2590	2250
UC 356 x 368 x 177	$N_{b,y,Rd}$	9920	9760	9540	9300	9010	8670	8250	7750	7180	6550	5920	5320	4770
	$N_{b,z,Rd}$	9690	9300	8790	8090	7170	6120	5120	4270	3580	3030	2600	2240	1950
UC 356 x 368 x 153	$N_{b,y,Rd}$	8570	8420	8240	8020	7770	7470	7110	6670	6160	5610	5060	4540	4070
	$N_{b,z,Rd}$	8360	8020	7580	6970	6170	5260	4390	3660	3070	2600	2220	1920	1670
UC 356 x 368 x 129	$N_{b,y,Rd}$	7230	7100	6940	6760	6540	6280	5970	5590	5160	4690	4220	3780	3390
	$N_{b,z,Rd}$	7050	6760	6380	5860	5180	4400	3670	3050	2560	2160	1850	1600	1390
UC 305 x 305 x 342	$N_{b,y,Rd}$	20100	19700	19200	18600	18000	17200	16200	15000	13600	12300	10900	9720	8650
	$N_{b,z,Rd}$	19400	18400	17000	15000	12500	10200	8260	6760	5610	4720	4020	3460	3010
UC 305 x 305 x 313	$N_{b,y,Rd}$	18400	18000	17500	17000	16400	15600	14700	13500	12300	11000	9810	8710	7740
	$N_{b,z,Rd}$	17700	16800	15400	13500	11300	9150	7410	6060	5020	4220	3590	3090	2690
UC 305 x 305 x 283	$N_{b,y,Rd}$	16600	16200	15800	15300	14700	14000	13100	12100	10900	9790	8690	7710	6840
	$N_{b,z,Rd}$	16000	15100	13900	12200	10100	8170	6600	5400	4470	3760	3200	2750	2390
UC 305 x 305 x 240	$N_{b,y,Rd}$	13500	13100	12800	12400	12000	11400	10700	9830	8900	7960	7070	6270	5570
	$N_{b,z,Rd}$	13000	12300	11300	9930	8270	6700	5430	4440	3680	3090	2630	2260	1970
UC 305 x 305 x 198	$N_{b,y,Rd}$	11100	10800	10600	10200	9820	9320	8700	7980	7190	6400	5670	5020	4450
	$N_{b,z,Rd}$	10700	10100	9280	8100	6720	5420	4380	3580	2960	2490	2120	1820	1580
UC 305 x 305 x 158	$N_{b,y,Rd}$	8840	8630	8400	8120	7780	7360	6840	6230	5580	4950	4370	3860	3410
	$N_{b,z,Rd}$	8510	8040	7350	6370	5240	4210	3390	2770	2290	1920	1640	1410	1220
UC 305 x 305 x 137	$N_{b,y,Rd}$	7650	7470	7260	7020	6720	6340	5880	5340	4770	4220	3720	3280	2900
	$N_{b,z,Rd}$	7370	6950	6340	5480	4490	3600	2890	2360	1950	1640	1390	1200	1040
UC 305 x 305 x 118	$N_{b,y,Rd}$	6590	6420	6240	6030	5760	5430	5020	4550	4060	3580	3150	2780	2450
	$N_{b,z,Rd}$	6340	5970	5440	4680	3820	3060	2460	2000	1660	1390	1180	1020	883
UC 305 x 305 x 97	$N_{b,y,Rd}$	5650	5500	5340	5140	4900	4590	4210	3780	3340	2930	2570	2260	1990
	$N_{b,z,Rd}$	5430	5090	4600	3900	3140	2500	2000	1620	1340	1120	955	821	713
UC 254 x 254 x 167	$N_{b,y,Rd}$	9270	9000	8680	8290	7770	7120	6350	5550	4800	4150	3600	3140	2750
	$N_{b,z,Rd}$	8860	8180	7140	5780	4490	3500	2770	2240	1840	1540	1310	1120	973
UC 254 x 254 x 132	$N_{b,y,Rd}$	7310	7090	6830	6500	6070	5520	4890	4240	3660	3150	2720	2370	2080
	$N_{b,z,Rd}$	6980	6420	5570	4460	3450	2680	2120	1710	1410	1180	997	856	742
UC 254 x 254 x 107	$N_{b,y,Rd}$	5920	5740	5520	5240	4870	4400	3870	3340	2870	2460	2130	1850	1620
	$N_{b,z,Rd}$	5650	5190	4470	3550	2730	2120	1670	1350	1110	927	786	675	585

More section designations are available on orangebook.arcelormittal.com

Table 12: Eurocode (EN 1993-1-1: 2005) design buckling resistance [kN] of major and minor axis of HD Box columns sections in HISTAR® 460.

	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
Box HD 400 x 634	N _{b,y,Rd}	74 204	70653	66891	62958	58793	54402	49863	45315	40913	36791	33029	29661	26680
	N _{b,z,Rd}	74 204	72557	69487	66346	63079	59652	56064	52348	48568	44813	41170	37715	34499
Box HD 400 x 677	N _{b,y,Rd}	79 291	77676	71647	67498	63109	58480	53688	48873	44196	39799	35773	32157	28948
	N _{b,z,Rd}	79 291	75620	74446	71145	67720	64129	60370	56471	52497	48533	44671	40993	37554
Box HD 400 x 744	N _{b,y,Rd}	85178	81587	77451	73146	68603	63811	58832	53793	48855	44165	39829	35902	32393
	N _{b,z,Rd}	85178	83767	80409	76990	73450	69748	65875	61851	57729	53584	49521	45609	41920
Box HD 400 x 818	N _{b,y,Rd}	93706	90006	85548	80920	76043	70900	65545	60105	54740	49613	44844	40499	36598
	N _{b,z,Rd}	93706	92414	88808	85146	81363	77415	73287	68992	64581	60130	55729	51469	47424
Box HD 400 x 900	N _{b,y,Rd}	103232	99424	94614	89629	84385	78857	73093	67213	61384	55779	50532	45724	41386
	N _{b,z,Rd}	103232	102099	98225	94300	90255	86042	81641	77059	72341	67558	62803	58169	53738
Box HD 400 x 990	N _{b,y,Rd}	113385	109542	104380	99046	93446	87546	81384	75074	68783	62690	56945	51645	46836
	N _{b,z,Rd}	113385	112462	108314	104121	99810	95331	90656	85788	80764	75652	70541	65527	60700
Box HD 400 x 1086	N _{b,y,Rd}	124529	120647	115100	109381	103390	97082	90487	83712	76923	70305	64023	58193	52872
	N _{b,z,Rd}	124529	123878	119443	114970	110384	105629	100673	95513	90178	84729	79253	73847	68605
Box HD 400 x 1202	N _{b,y,Rd}	137443	133346	127291	121056	114530	107663	100480	93090	85665	78408	71494	65056	59165
	N _{b,z,Rd}	137443	137162	132412	127633	122746	117693	112435	106963	101297	95491	89624	83795	78099
Box HD 400 x 1299	N _{b,y,Rd}	148230	144267	137898	131358	124528	117350	109837	102084	94254	86547	79151	72214	65824
	N _{b,z,Rd}	148230	148230	143333	138320	133207	127930	122449	116749	110842	104775	98620	92471	86427

Table 13: Eurocode (EN 1993-1-1: 2005) design buckling resistance [kN] of major and minor axis of Cruciform sections in HISTAR® 460.

	Axis	Compression resistance $N_{b,y,Rd}$ $N_{b,z,Rd}$ (kN) for buckling lengths (m)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
Cruciform HL 1100 x 607	N _{b,y,Rd}	71039	71039	71039	70020	68374	66721	65046	63342	61598	59807	57967	56077	54139
	N _{b,z,Rd}	71039	71039	71039	70221	68615	67004	65375	63719	62027	60292	58511	56682	54806
Cruciform HL 1000 x 642	N _{b,y,Rd}	75125	75125	75125	73441	71578	69699	67788	65835	63828	61762	59635	57450	55214
	N _{b,z,Rd}	75125	75125	75125	73708	71899	70078	68229	66343	64408	62419	60373	58270	56116
Cruciform HL 920 x 656	N _{b,y,Rd}	76752	76752	76752	74586	72590	70571	68513	66402	64227	61986	59677	57306	54887
	N _{b,z,Rd}	76752	76752	76752	74891	72958	71008	69022	66991	64901	62750	60534	58258	55931
Cruciform HL 920 x 725	N _{b,y,Rd}	84801	84801	84801	82472	80280	78064	75805	73489	71105	68647	66116	63517	60863
	N _{b,z,Rd}	84801	84801	84801	82846	80731	78598	76429	74210	71929	69581	67164	64681	62141
Cruciform HL 1000 x 748	N _{b,y,Rd}	87605	87605	87605	85771	83624	81461	79264	77019	74713	72342	69901	67393	64826
	N _{b,z,Rd}	87605	87605	87605	86129	84054	81969	79854	77698	75489	73220	70886	68488	66031
Cruciform HL 920 x 787	N _{b,y,Rd}	92071	92071	92071	89638	87278	84893	82464	79975	77413	74773	72054	69262	66410
	N _{b,z,Rd}	92071	92071	92071	90069	87798	85508	83181	80803	78360	75846	73258	70600	67878
Cruciform HL 1000 x 883	N _{b,y,Rd}	103402	103402	103402	101400	98899	96381	93826	91216	88540	85787	82955	80045	77065
	N _{b,z,Rd}	103402	103402	103402	101891	99489	97076	94634	92146	89599	86986	84299	81540	78711
Cruciform HL 920 x 970	N _{b,y,Rd}	111159	111159	111159	108615	105847	103055	100215	97311	94327	91255	88092	84843	81519
	N _{b,z,Rd}	111159	111159	111159	109238	106597	103940	101246	98498	95683	92790	89814	86757	83625
Cruciform HL 1000 x 976	N _{b,y,Rd}	111735	111735	111735	109818	107165	104498	101793	99035	96208	93304	90317	87248	84104
	N _{b,z,Rd}	111735	111735	111735	110389	107851	105305	102730	100111	97434	94689	91870	88975	86007
Cruciform HL 920 x 1077	N _{b,y,Rd}	123331	123331	123331	120665	117625	114562	111448	108266	104997	101634	98172	94616	90975
	N _{b,z,Rd}	123331	123331	123331	121410	118522	115618	112677	109681	106612	103461	100222	96894	93483
Cruciform HL 920 x 1194	N _{b,y,Rd}	136816	136816	136816	134043	130710	127351	123940	120457	116881	113204	109419	105531	101549
	N _{b,z,Rd}	136816	136816	136816	134941	131789	128622	125418	122156	118819	115395	111878	108264	104559
Cruciform HL 920 x 1269	N _{b,y,Rd}	145357	145357	145357	142531	139014	135471	131876	128205	124438	120566	116581	112487	108294
	N _{b,z,Rd}	145357	145357	145357	143525	140208	136878	133510	130084	126580	122987	119297	115506	111620
Cruciform HL 920 x 1377	N _{b,y,Rd}	157652	157652	157652	154264	150383	146471	142495	138432	134260	129966	125547	121007	116359
	N _{b,z,Rd}	157652	157652	157652	155601	151990	148364	144697	140965	137148	133233	129211	125080	120845

More section designations are available on orangebook.arcelormittal.com

5. Fabrication guidelines

1. General

The general recommendations given in this chapter shall be observed to ensure the successful fabrication, welding, and heat treatment of the fine-grained high-strength HISTAR® 355 and HISTAR® 460 steels for structural and offshore applications.

In addition to these guidelines, consideration must be made to the local code requirement. In particular, the fabrication should be carried out in accordance with EN 1090-2 and EN 1011-2.

These recommendations do not exempt from the application of generally accepted engineering practices.

For aspects not covered within these guidelines, it is recommended to ask the advice of the Technical Advisory of ArcelorMittal Europe Long Products.

2. Machining

HISTAR® 355/460 beams can be machined under the same conditions as structural steels featuring the same level of tensile strength. Tool wear from drilling and cutting of beams in HISTAR® grades is similar to the one of beams in structural grades of the same level of strength.

3. Thermal cutting

HISTAR® 355/460 beams can be cut, using a thermal process normally applied to structural steels featuring the same level of tensile strength. Typically no preheating is required when torch cutting is performed at ambient temperatures > 0° C.

As for any steel, it is recommended to preheat the surroundings of the area to be flame cut to 50 °C if the product is wet or if the temperature is below 0 °C.

As for any steel, in addition, it is recommended that thermally cut beam copes and weld access holes of hot rolled shapes with a flange thickness exceeding 50mm be preheated to a temperature of no less than 65 °C.

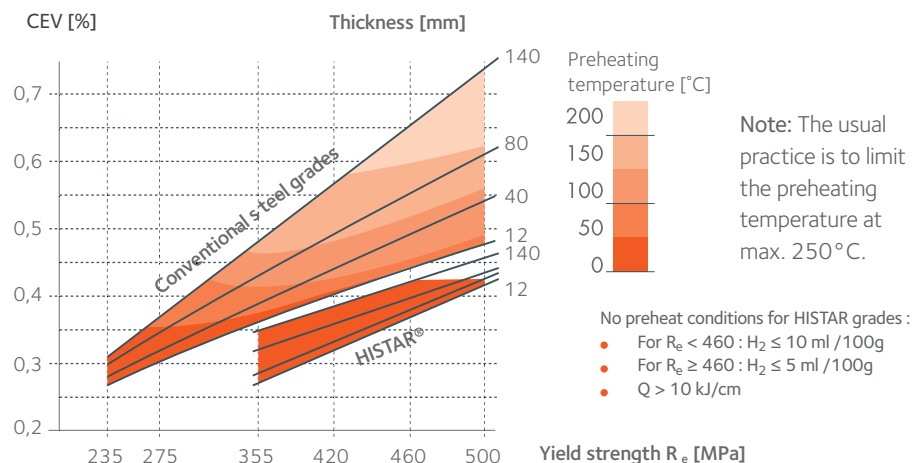
If specified, the thermally cut surfaces of beam copes and weld access holes should be ground to bright metal and inspected by either magnetic particle or dye penetrant methods.

4. Welding

HISTAR® steels offer a good weldability for manual and automatic processes, provided the general rules for welding are respected. Shielded Metal Arc Welding (SMAW) or Manual Metal Arc (MMA) welding, Gas Metal Arc Welding (MIG/MAG), Flux-Cored Arc Welding (FCAW), and Submerged Arc Welding (SAW) are processes successfully used to weld HISTAR® 355 and 460 grades.

Flame cut groove surfaces have to be descaled by grinding before welding. HISTAR® 355 / 460 and conventional structural grades can be combined by welding. For these cases the welding conditions of the conventional grade have to be integrated in the welding procedure.

Figure 8: Preheating temperatures for conventional structural steel grades and HISTAR grades (acc. to EN 1011-2:2001/method A)



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



Diandong Powerplant, P.R China



4.1 Preheat temperatures

The preheat temperature for avoiding coldcracking represents the lowest temperature before starting the first run and below which the weld region shall not fall during welding.

Thanks to the low carbon equivalent values of the HISTAR® grades (see figure 8), it is generally not necessary to preheat, as long as:

- the heat input ranges Q (according to EN 1011-1) between 10 and 60 kJ/cm
- the temperature of the product is $> 0^{\circ}\text{C}$
- electrodes with low hydrogen content and low carbon equivalent are used.

Shanghai World Finance Center, P.R. China

Table 14: Preheating requirements for HISTAR 460 acc. to EN 1011-2/method A

Combined thickness [mm]	Hydrogen content of welding consumables [ml/100 g]			
	5-10		≤ 5	
≤50 > 50	Heat input [kJ/cm]		Heat input [kJ/cm]	
	10-15	15-60	10-15	15-60
	No preheat 100°C	No preheat No preheat	No preheat No preheat	No preheat No preheat

HISTAR® 460 may also be welded with consumables containing hydrogen levels between 5 and 10 ml/100g. In this case, a slight preheating is advised when combined with thick sections at a low range of heat input.

Table 14 indicates the preheating requirements applicable for the HISTAR® 460 grade in function of the thickness, heat input and hydrogen content of the weld consumables.

Some preheating may be required for ambient temperatures < 0° C, electrodes with high hydrogen content, high restraint conditions or low heat input welds (such as repair welds, tack welds or single pass welds on thick material). In case of special applications, the fabricator may apply a more conservative preheating procedure. In any case, preheating is not detrimental to the quality of the HISTAR® grades if the cooling time from 800°C to 500°C is less than 25s. This condition is satisfied with the usual welding energies and preheating temperature. Otherwise the HISTAR® producer should be asked for advice.

As for any steel, EN 1090-2 7.5.3 specifies that surfaces to be welded shall be maintained dry and free from condensation. If temperature of material to be welded is below 5°C suitable heating may be necessary.

4.2 Welding consumables

The filler metal has to be selected in order to ensure the intended mechanical properties of the weld joint. The consumable should be chosen according to the following criteria: The mechanical properties of the weld metal shall comply with the requirements of the HISTAR® grade, in particular the impact energy,

- matching or slight “overmatching” of the tensile properties in comparison with the base metal is common welding practice,
- in order to use the “no preheat” procedure, the diffusible hydrogen content in the deposited weld metal must be low, i.e. H₂ ≤ 10ml/100g for HISTAR® 355 and H₂ ≤ 5ml/100g for HISTAR® 460,
- basic covered electrodes and fluxes are to be dried before use for 2 hours at 300° C and stored at 150° C in a drying oven and/or a quiver. When using dry electrodes, only the storage at 150°C is required. Excessive roughness shall be removed by machining or grinding. The recommendations of the manufacturer shall be followed,
- The conditions of the welding consumable manufacturer apply,
- as for the welding of conventional structural steels, electrodes containing nickel are recommended in case of high toughness requirements at low temperature (e.g. bridges, offshore).

Table 15 summarises the information allowing a suitable choice of the welding consumables: tensile and impact properties of the HISTAR® grades as well as the standards for the classification of the welding consumables for the various welding processes. Typical examples for choosing the welding consumables are included in the table. Other choices may also be adequate. Advice on commercial designations is available upon request and may be provided by the welding consumable producers.

The hydrogen content of the weld consumables is indicated in the standard designation as H5 or H10 respectively for contents lower than 5 or 10 ml/100g. No hydrogen is present in the weld consumables for the flux free welding processes (GMAW, MAG).

4.3 Weld bevel preparation

The bevel preparation can be done by oxycutting, milling, plasma or waterjet cutting. Bevels for V or half V joints are possible without restriction. For other bevel types (K or X joints) in material thicknesses greater than 63 mm, it is recommended to locate the weld root at about a third up to a quarter of the material thickness.

As for any steel, prior to the welding, the bevelled surface should be free from grease, humidity, rust, coating, etc. Excessive roughness shall be removed by machining or grinding.

5. Stress relieving

A stress relief post weld heat treatment (PWHT) may be necessary when the layout of the structure and/or the expected stress condition after welding requires a reduction of the residual stresses. Stress relieving of HISTAR® steel grades is performed at temperatures between 530°C and 580°C. The holding time should be 2 minutes per mm of product thickness, but not less than 30 minutes and not more than 90 minutes.

6. Flame straightening

Flame straightening is defined as a fast and local heating in order to eliminate deformations or to give to a structural member a required shape. HISTAR® 355/460 grades can be flame straightened following the procedures usually applied to fine grain steels. The flame straightening temperature may go up to 650°C in case of a local full section heating. For local superficial heating, the flame straightening temperature may go up to 900°C. Further guidance concerning flame straightening is given in CEN/TR 10347:2006. In order to improve the efficiency of the flame straightening process, restrain forces should be applied to the structural element through calibrated jacks or other suitable devices. In the areas to be flame straightened, the stresses from the restraining forces shall be less than the yield stress of the steel at elevated temperature.

7. Hot forming

The operations of hot forming and normalising at temperatures higher than those of the stress relieving treatment are not suited for the HISTAR® steels.

8. Cold forming

The cold forming behaviour of the HISTAR® steels is comparable to the one of conventional structural steels of the same range of tensile strength. The usual cold deformation rules apply. In particular, it is recommended to control and limit the degree of cold deformation. Cold forming modifies the mechanical properties of steel; they should remain compatible with the intended use of the structure.

9. Galvanising

HISTAR® grades are delivered with a silicon content ranging between 0.14 % and 0.25 % and are as such capable of forming a zinc layer during hot dip galvanising. Fabrication recommendations for steel elements to be galvanized must be followed. More detailed information on this topic are given in the brochure "Corrosion protection of rolled steel sections using hot dip galvanisation" (available upon request).

10. Beam Finishing

To save time and costs to the customer, the structural shapes from ArcelorMittal can be delivered with processing like cold sawing, drilling, coping, straightening, cambering, weldedge bevelling, welding, and surface coating.

Table 15: Choice of the welding consumables metals following the European classification

Grade	Tensile test			Notch impact test		Welding process (EN ISO 4063:2010)			
						SMAW (111)	MAG (135) GMAW (13)	FCAW (136)	SAW (121)
HISTAR®	R _e min [MPa]	R _m [MPa]	A _{5,d} min [%]	Temperature [°C]	Energy min. [J]	Standard (Designation)	Standard (Designation)	Standard (Designation)	Standard (Designation)
355	355	470-630	22	-20	40	EN ISO 2560-A (E 42 3 *** H5)	EN ISO 14341-A (G 42 3 ***)	EN ISO 17632-A (T 42 3 *** H10)	EN ISO 14174 EN ISO 14171
355 L	355	470-630	22	-50	27	EN ISO 2560-A (E 42 5 *** H5)	EN ISO 14341-A (G 42 5 ***)	EN ISO 17632-A (T 42 5 *** H5)	EN ISO 14174 EN ISO 14171
355 TZK- OS	355	460-620	22	-40	50				
460	460	540-720	17	-20	40	EN ISO 2560-A (E 46 3 *** H5)	EN ISO 14341-A (G 46 3 ***)	EN ISO 17632-A (T 46 3 *** H5)	EN ISO 14174 EN ISO 14171
460 L	460	540-720	17	-50	27	EN ISO 2560-A (E 46 5 *** H5)	EN ISO 14341-A (G 46 5 ***)	EN ISO 17632-A (T 46 5 *** H5)	EN ISO 14174 EN ISO 14171
460 TZK- OS	460	540-720	17	-40	60				

6. Technical delivery conditions



1. Rolling tolerances

Tolerances on dimensions and weight of beams in HISTAR® grades and in structural steels are identical. They are given in the sales catalogue "Beams, Channels and Merchant Bars".

2. Mechanical testing

For the structural HISTAR® grades, tensile test and Charpy V-notch impact test are performed in accordance with EN 10025-1:2004. Supplementary tests are possible upon agreement at an extra.

The frequency of mechanical testing for the HISTAR® Offshore grades is in accordance with EN 10225-2:2019, i.e. once per 40 t or part thereof. The following tests are performed: one tensile test and one set of three Charpy V-Notch impact tests. Position and orientation of samples for these tests are in accordance with EN 10225-2:2019. Supplementary tests such as through thickness tensile tests according to EN 10164:2018 and impact tests in transverse direction can be performed upon agreement at an extra.

If other tests, such as weldability evaluation tests, are requested, this has to be agreed upon.

3. Ultrasonic testing

Ultrasonic testing is carried out upon agreement at an extra. The procedure for this test must be agreed between the purchaser and the manufacturer.

In case of order following EN 10164:2018, ultrasonic testing is performed in accordance with EN 10306:2014 class 2.3.

4. Certification

The type of certification shall be specified at the time of order.

5. Surface conditioning

HISTAR® beams are delivered in standard ex-mill condition with surface quality in accordance with EN 10163-3:2004, Class C, Subclass 1. Other conditions are possible upon agreement.

Material can be supplied shot-blasted with or without coating upon agreement at an extra. Procedures have to be agreed upon between the purchaser and the manufacturer. Shot-blasted material with or without coating can be supplied with surface condition in accordance with EN 10163-3:2004, Class D, upon agreement at an extra.

The Skyscraper Center
The Global Tall Building Database of the CTBUH

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ArcelorMittal
Acquired Arcelor (2006)
Acquired Mittal Steel (2006)
Parent company of Acindar S.A.

Click a company above to see buildings specifically involving that company. The building list below shows buildings involving ArcelorMittal, Arcelor, Mittal Steel, Acindar S.A., Aeralia, Arbed, Usinor, International Steel Group, Ispat International N.Y.

Buildings

Note: All listed data for proposed or under construction buildings is based on the most reliable information currently available. This data is thus subject to change until the building has completed and all information can be confirmed and ratified by the CTBUH.

Completed Architecturally Topped Out Structurally Topped Out Under Construction On Hold Never Completed Proposed Vision Demolished

Search:

Previous 1 2 3 Next

#	Building Name	City	Height (m)	Height (ft)	Floors	Completed	Material	Use
1	Burj Khalifa	Dubai (AE)	828	2,717	163	2010	steel/concrete	office / residential / hotel
2	One World Trade Center	New York City (US)	541.3	1,776	94	2014	composite	office
3	Pentominium Tower	Dubai (AE)	516	1,693	122	-	steel/concrete	residential
4	Shanghai World Financial Center	Shanghai (CN)	492	1,614	101	2008	composite	hotel / office

7. Reference projects

More on ArcelorMittal can be found on the Skyscraper Center:
<http://www.skyscrapercenter.com/company/7007>

Projects Europe	Location
REMBRANDT TOWER	AMSTERDAM, NL
SPORTPALEIS	ANTWERPEN, BE
HAVENHUIS	ANTWERPEN, BE
TORRE MAPFRE	BARCELONA, ES
HAUPTBAHNHOF	BERLIN, DE
VELODROM	BERLIN, DE
COLMORE ROW	BIRMINGHAM, GB
POSTTOWER	BONN, DE
MESSEHALLEN	BREMEN, DE
BELGACOM TOWER	BRUSSELS, BE
ESPACE LEOPOLD	BRUSSELS, BE
SALLE MULTISPORT	DUNKERQUE, FR
ST. JAMES	EDINBURGH, GB
VARIOUS BEARING PILE PROJECTS	EUROPE
VARIOUS PARKING PROJECTS	EUROPE
THE SQUAIRE	FRANKFURT, DE
VOIRON	GRENOBLE, FR
CENTRE DE RETRAITEMENTS DES DECHETS	ISSY LES MOULINEAUX, FR
DIAMOND OF ISTANBUL	ISTANBUL, TR
FENERBAHCE BASKETBALL ARENA	ISTANBUL, TR
HILTON DOUBLETREE HOTEL	ISTANBUL, TR
SABIHA GOKCEN HANGARS	ISTANBUL, TR
TARABYA HOTEL	ISTANBUL, TR
ZORLU TOWER	ISTANBUL, TR
RHEINENERGIE STADION	KÖLN, DE
1 BANK STREET	LONDON, GB
THE PINNACLE	LONDON, GB
100 BISHOPSGATE	LONDON, GB
25 CHURCHILL PLACE	LONDON, GB
EDWARDIAN HOTEL	LONDON, GB
THAMES TOWER / NINE ELMS	LONDON, GB
THE 22 BISHOPSGATE	LONDON, GB
CAR PARK AT FOOTBALL STADIUM	LUXEMBOURG, LU
TORRE BANKIA	MADRID, ES
PUERTE EUROPA	MADRID, ES
TORRE CRISTAL	MADRID, ES
TORRE REPSOL	MADRID, ES
THE FACTORY	MANCHESTER, GB
MANCHESTER CITY MINI STADIUM	MANCHESTER, GB
DESIO TOWER	MILANO, IT

Projects Europe	Location
DIAMOND TOWER LE VARESE	MILANO, IT
GIAX TOWER	MILANO, IT
HOTEL DE VILLE	MONTPELLIER, FR
SALLE DE SPECTACLE	MONTPELLIER, FR
NABEREZHNYAYA TOWER	MOSCOW, RU
EMBANKMENT TOWER	MOSCOW, RU
EURASIA TOWER	MOSCOW, RU
FEDERATION COMPLEX	MOSCOW, RU
AKRO PLASTIC	NIEDERZISSEN, DE
VARIOUS OFF-SHORE PLATFORMS	NORTH SEA, UK+N
ARENA 92	PARIS, FR
IMMEUBLE BASALTE	PARIS, FR
TOUR D2	PARIS, FR
STADE DE LA ROUTE DE LORIENT	RENNES, FR
EUROPEAN PATENT OFFICE	RIJSWIJK, NL
NEW ORLEANS TOWER	ROTTERDAM, NL
LAKHTA CENTER	ST. PETERSBURG, RU
STADSKANTOOR	UTRECHT, NL
DAEWOO TOWER	WARSAW, PL

Bridges	Location
OA1-OA2-OA3 RING ROAD	ARLES, FR
LIAISON MICHEVILLE	BELVAL, LU
OA5 - OA6 / RAILWAY LINE	BETTEMBOURG, LU
PUENTE CAMÚ - LA VEGA BRIDGE	DOM.REP., DR
A16 MOTORWAY 20 OVERPASSES	FRANCE, FR
DANNERALLEE	HAMBURG, DE
ISTANBUL LRT BRIDGES	ISTANBUL, TR
S-16/S-51 EXPRESS ROAD	OLSZTYN, PL
A-1 HIGHWAY TASK D	RADOMSKO PL
DP-1256R	RZUCHOW PL
SAN DIEGO AIRPORT PEDESTRIAN BRIDGE	SAN DIEGO, CA
VIA RAPIDA BRIDGE	TEGUCIGALPA, HN
TENAY BRIDGE	TENAY, FR
E-4 / CENTRALNA MAGISTRALA KOLEJOWA (CMK)	ZAWIERCIE, PL

Projects Asia	Location
ASTANA ARENA	ASTANA, KZ
NEW POLY PLAZA	BEIJING, CN
J57 MINI SKY CITY	CHANGSHA, CN
QUATAR INTERNATIONAL AIRPORT	DOHA, QA
ROYAL ATLANTIS	DUBAI, AE
EMIRATES ENGINEERING CENTRE & MAINTENANCE HALLS	DUBAI, AE
EMIRATES TOWERS	DUBAI, AE
PENTOMINIUM TOWER	DUBAI, AE
VIETIN BANK BUSINESS CENTRE	HANOI, VN
LANDMARK 81	HO CHI MINH CITY, VN
EXHIBITION STATION & WESTERN APPROACH TUNNEL	HONG KONG, CN
VARIOUS BEARING PILES	HONG KONG, CN
IMPERIUM TOWER	MANILA, PH
DAIEC CONVENTION CENTRE	MUMBAI, IN
TRUMP TOWER	MUMBAI, IN
CMA TOWER	RIYADH, SA
SHANGHAI WORLD FINANCIAL CENTER	SHANGHAI, CN
CHANGI AIRPORT	SINGAPORE, SG
DUO RESIDENCES	SINGAPORE, SG
SINGAPORE STATE COURT	SINGAPORE, SG
BLAST DOOR FOR NEW HIGH COURT	SINGAPORE, SG
EREN PAPER FACTORY	TEKIRDAG, TR
DIANDONG POWER PLANT	YUNNAN, CN
LANXI POWER PLANT	ZHEJIANG, CN

Projects Australia	Location
ILUKA	GOLD COAST, AU
SOUTHERN CROSS	MELBOURNE, AU
SOUTHERN CROSS II	MELBOURNE, AU

Projects America	Location
ATRIO TOWER	BOGOTA, CO
BOILER STRUCTURE	MEXICO, MX
POWER PLANT EMPALME II	SONORA, MX
TRINIDAD MANSION	TRINIDAD, TT

Projects US & Canada	Location
BROWARD COUNTY CIVIC	ARENA MIAMI, FL
AT&T STADIUM	ARLINGTON, TX
AUSTIN CONVENTION CENTER	AUSTIN, TX
BALTIMORE CONVENTION CENTER	BALTIMORE, MD
US CENSUS BUILDING	BIRMINGHAM, AL
111 HUNTINGTON AVENUE	BOSTON, MA
1-7 DALTON HOTEL & RESIDENCES	BOSTON, MA
33 ARCH STREET	BOSTON, MA
BOSTON ARTERY	BOSTON, MA
TD GARDEN	BOSTON, MA
HARVARD UNIVERSITY	BOSTON, MA
MANULIFE TOWER	BOSTON, MA
ONE GATEWAY	BOSTON, MA
PIER 4 OFFICE BUILDING	BOSTON, MA
ST. JAMES PROJECT	BOSTON, MA
WESTIN HQ HOTEL AT THE BCEC	BOSTON, MA
THE BOW	CALGARY, AB
EIGHTH AVENUE PLACE	CALGARY, AB
BROOKFIELD PLACE	CALGARY, AB
MANULIFE TOWER	CALGARY, AB
PENNY LANE	CALGARY, AB
525 UNIVERSITY AVENUE	TORONTO, ON
TIME WARNER CABLE ARENA	CHARLOTTE, NC
300 NORTH LASALLE	CHICAGO, IL
111 SOUTH WACKER	CHICAGO, IL
150 NORTH RIVERSIDE	CHICAGO, IL
151 NORTH FRANKLIN	CHICAGO, IL
155 NORTH WACKER	CHICAGO, IL
ANN & ROBERT H. LURIE CHILDREN'S HOSPITAL	CHICAGO, IL
MOMO	CHICAGO, IL
LOUIS A. SIMPSON AND KIMBERLY K. QUERREY BIOMEDICAL RESEARCH CENTER	CHICAGO, IL
ONE SOUTH DEARBORN	CHICAGO, IL
PRENTICE WOMEN'S HOSPITAL	CHICAGO, IL
CENTER FOR CARE AND DISCOVERY, UNIVERSITY OF CHICAGO MEDICINE	CHICAGO, IL
PROSPERA CENTRE	CHILLIWACK, BC
KREMCO - OFFSHORE PLATFORMS	CLEARFIELD, UT
CORONA CITY HALL	CORONA, CA
SOUTH PLACER JUSTICE CENTER	ROSEVILLE, CA
CIVIC CENTER PLAZA	WALNUT CREEK, CA
APPLE PARK	CUPERTINO, CA
MALKER HALL, U OF CALIFORNIA	DAVIS, CA
TRICO STEEL MILL	DECATUR, AL
FREDERIC C. HAMILTON BUILDING	DENVER, CO
COLORADO CONVENTION CENTER	DENVER, CO
KRAUSE GATEWAY CENTRE	DES MOINES, IA
NORTHWEST AIRLINE HANGAR	DETROIT, MI
PRESSAGE FACTORY	EDMONTON, AB
CHIRON LIFE SCIENCES BUILDING	EMERYVILLE, CA
MCCORMICK PLACE EXP.	EMERYVILLE, CA
BOIENG 777 ASSEMBLY BUILDING	EVERETT, WA
ALERUS CENTER	GRAND FORKS, ND
TOWER AT CCCC	FRESNO, CA
CARDINALS STADIUM	GLENDALE, AZ
GLENDALE PLAZE	GLENDALE, AZ
DEVOS PLACE	GRAND RAPIDS, MI
GLIDER OFFSHORE	GULF OF MEXICO
URSA OFFSHORE	GULF OF MEXICO
HARTFORD 21/ TOWN SQUARE	HARTFORD, CT
INGLEWOOD STADIUM	HOUSTON, TX
NRG STADIUM (HOUSTON TEXANS)	HOUSTON, TX

Projects US & Canada	Location
LUCAS OIL STADIUM (INDIANAPOLIS COLTS)	INDIANAPOLIS, IN
COSMOPOLITAN	LAS VEGAS, NV
FOUNTAINBLEAU CASINO	LAS VEGAS, NV
LAS VEGAS CLUB TOWER	LAS VEGAS, NV
MGM CASINO HOTEL	LAS VEGAS, NV
THE PALAZZO	LAS VEGAS, NV
RED ROCK CASINO	LAS VEGAS, NV
LIVERMORE CIVIC CENTER LIBRARY	LIVERMORE, CA
ONE LONDON PLACE	LONDON, ON
1220 FOUNDATION TOWER HOSPITAL	LOS ANGELES, CA
2000 AVENUE OF THE STARS	LOS ANGELES, CA
CALTRANS DISTRICT 7 HQ	LOS ANGELES, CA
CHASE CENTER BASKETBALL ARENA FOR THE GOLDEN STATE WARRIORS	LOS ANGELES, CA
LOMA LINDA HOSPITAL / MEDICAL CENTER	LOS ANGELES, CA
MENLO GATEWAY OG.	LOS ANGELES, CA
NETHERCUTT CAR MUSEUM	LOS ANGELES, CA
UCLA, CNSI COURT OF SCIENCES BUILDING	LOS ANGELES, CA
WEST ANGELES CATHEDRAL	LOS ANGELES, CA
JEWISH HOSPITAL (SMARTBEAM)	LOUISVILLE, KY
ST. FRANCIS HOSPITAL	LYNWOOD, CA
TORRE REFORMA 509	MEXICO, ME
BRICKELL CITY CENTER	MIAMI, FL
MARLINS PARK	MIAMI, FL
ADRIENNE ARSHT CENTER FOR THE PERFORMING ARTS	MIAMI, FL
MILLER PARK	MILWAUKEE, WI
WISCONSIN ENTERTAINMENT AND SPORTS CENTER	MILWAUKEE, WI
NORTHWESTERN MUTUAL TOWER AND COMMONS	MILWAUKEE, WI
GUTHRIE THEATER	MINNEAPOLIS, MN
MINNEAPOLIS CONVENTION CENTER	MINNEAPOLIS, MN
U.S. BANK STADIUM (MINNEAPOLIS VIKINGS)	MINNEAPOLIS, MN
AIOC BUILDING	MONTREAL, QC
EL CAMINO HOSPITAL	MOUNTAIN VIEW, CA
HUDSON YARDS	NEW YORK, NY
217 WEST 57TH STREET*	NEW YORK, NY
ONE WORLD TRADE CENTER	NEW YORK, NY
THREE WORLD TRADE CENTER	NEW YORK, NY
FOUR WORLD TRADE CENTER	NEW YORK, NY
250 WEST 55TH STREET	NEW YORK, NY
300 MADISON AVENUE	NEW YORK, NY
425 PARK AVENUE	NEW YORK, NY
BARUCH COLOGE	NEW YORK, NY
BROOKLYN RENAISSANCE	NEW YORK, NY
4 TIMES SQUARE	NEW YORK, NY
5 TIMES SQUARE	NEW YORK, NY
HEARST TOWER	NEW YORK, NY
JAVITS CENTRE	NEW YORK, NY
MORGAN STANLEY DEAN WITTER PLAZA	NEW YORK, NY
PALLADIUM ATHLETIC FACILITY	NEW YORK, NY
ONE MANHATTAN WEST	NEW YORK, NY
RANDOM HOUSE TOWER	NEW YORK, NY
RIVER AIR	NEW YORK, NY
SLOAN-KETTERING HOSPITAL	NEW YORK, NY
STANDARD HOTEL	NEW YORK, NY
WORLD TRADE CENTER TRANSPORTATION HUB	NEW YORK, NY
FOUR WORLD TRADE CENTER	NEW YORK, NY
KAISER HOSPITAL	OAKLAND, CA

Projects US & Canada	Location
POTLACH	NEW ORLEANS, LA
CANADIAN TIRE CENTRE (OTTAWA SENATORS)	OTTAWA, ON
CIRA CENTRE	PHILADELPHIA, PA
CHASE FIELD (ARIZONA DIAMONDBACKS)	PHOENIX, AZ
PHOENIX CONVENTION CENTER	PHOENIX, AZ
ARIZONA CARDINALS NFL STADIUM	PHOENIX, AZ
PHELPS DODGE TOWER	PHOENIX, AZ
POMONA SCIENCE BUILDING	POMONA, CA
PROVIDENCE NORTH PAVILION	PORTLAND, OR
MODA CENTER (PORTLAND TRAILBLAZERS)	PORTLAND, OR
PROVIDENCE PLACE	PROVIDENCE, RI
RALEIGH CONVENTION CENTER	RALEIGH, NC
TEXAS STATION (TRUSS)	RENO, NV
VIRGINIA BEACH CONVENTION CENTER	RICHMOND, VA
MAYO CLINIC	ROCHESTER, MN
SHERATON GRAND BALLROOM	SACRAMENTO, CA
INTERMOUNTAIN MEDICAL CENTER (IMC)	SALT LAKE CITY, UT
LDS ASSEMBLY BUILDING	SALT LAKE CITY, UT
850 CHERRY AVENUE	SAN BRUNO, CA
ADVANCED EQUITIES PLAZA	SAN DIEGO, CA
BROADWAY 655	SAN DIEGO, CA
CALTRANS BUILDING	SAN DIEGO, CA
181 FREEMONT	SAN FRANCISCO, CA
555 MISSION STREET	SAN FRANCISCO, CA
199 FREEMONT STREET	SAN FRANCISCO, CA
MOSCONE CENTER	SAN FRANCISCO, CA
SALESFORCE TOWER	SAN FRANCISCO, CA
ADOBE SYSTEMS HD - PHASE II	SAN JOSE, CA
MAYAGUEZ SHOPPING CENTER	SAN JUAN, PR
VISA BUILDING	SAN MATEO, CA
KAISER HOSPITAL	SANTA CLARA, CA
WATER TOWER	SANTA MONICA, CA
ST. JOHNS HOSPITAL	SANTA MONICA, CA
RUSSEL INVESTMENTS CENTER	SEATTLE, WA
5TH AND COLUMBIA	SEATTLE, WA
HYATT REGENCY SEATTLE	SEATTLE, WA
MARINERS STADIUM PRACTICE FIELD	SEATTLE, WA
NEW PACIFIC NW BASEBALL PARK	SEATTLE, WA
WASHINGTON MUTUAL HQ - SEATTLE ART MUSEUM	SEATTLE, WA
TESLA GIGAFACTORY	SPARKS, NV
TRANS WORLD DOME	ST. LOUIS, MO
NATIONWIDE ARENA	ST. PAUL, MN
LUCILE PACKERD CHILDREN'S HOSPITAL / STANFORD UNIVERSITY MEDICAL CENTRE	STANFORD, CA
BROOKFIELD PLACE*	TORONTO, ON
AIR CANADA CENTRE	TORONTO, ON
BAY ADELAIDE CENTER TOWERS EAST & WEST	TORONTO, ON
THE BRITT	TORONTO, ON
TORONTO CONVENTION CENTER	TORONTO, ON
GM PLACE (GRIZZLIES & CANUCKS)	VANCOUVER, BC
BUENA VENTURA MALL	VENTURE, CA
SAVE-ON-FOODS MEMORIAL CENTRE	VICTORIA, BC
WASHINGTON CONVENTION CENTER WASHINGTON, DC	WASHINGTON, DC
PRESBYTERIAN HOSPITAL FOUNDATION TOWER	WHITTIER, CA
HART CENTER EXP. & REN. - COLLEGE OF THE HOLY CROSS	WORCESTER, MA

8. Hot rolled sections in sustainable construction

The preservation of natural resources in our industrialised societies has become a priority in the creation of the built environment. Consequently, the industrialised building concepts have to comply with changing economical parameters like the incorporation of life cycle analyses in the design of buildings, as well as with technological changes for considering at an equal level sustainability goals with respect to the environment and society.

These sustainability goals are in nature:

- ecological
- economical
- socio-cultural
- technical oriented
- process oriented

They are interdependent as well as ambivalent, providing a coherent response to complex questions and ensuring the future generations a pleasant built environment.

Sustainable construction using hot-rolled steel sections is fully consistent with the various aspects of the sustainability goals.

- Ecological aspects of sustainability

The main ecological goals aim at using construction materials that are safe from health and environmental points of view, at reducing structures waste when dismantling buildings at the end of their service life, and at preserving as best possible the energy content in the construction materials, thus maintaining their ideal efficiency. Here, structural steels offer high material efficiency and rolled sections constitute the most recycled construction material in the world. In the modern electric arc furnace (EAF) route, steel is produced using 100%

scrap as a raw material (upcycling). Also, used steel elements can be deployed for further use in renovation and refurbishment of existing buildings. In addition, the EAF technology of steel allows for significant reductions of noise, particle- and CO₂- emissions as well as water and primary energy consumption in the production mills.

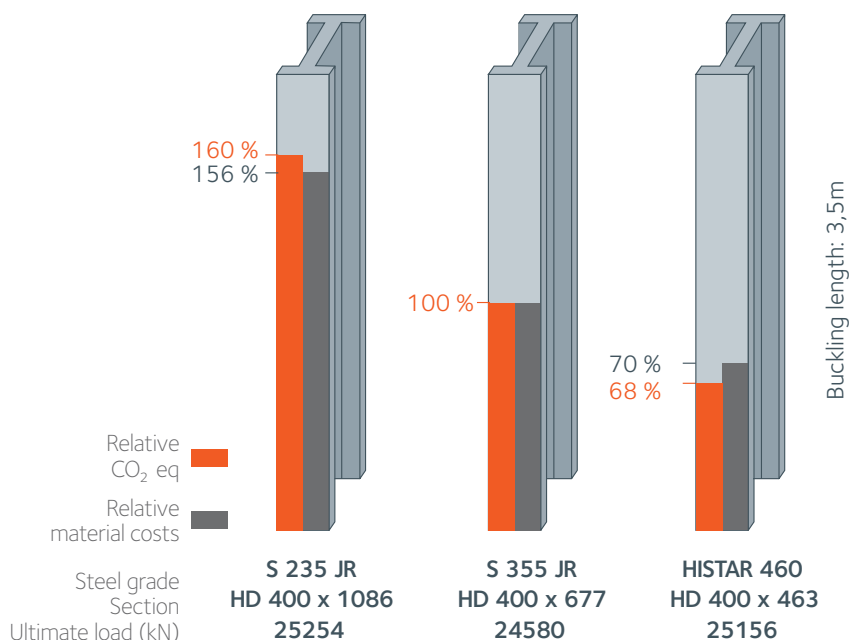
- Economical aspects of sustainability

Beside being interested in the reduction of investment costs, investors are also concerned about the optimisation of operational costs and the achievement the longest possible service life in combination with high flexibility in use of the building. Rolled sections in structural steel allow architects and designers to easily fulfill the

requirements of investors by combining high quality, functionality, aesthetics, lowweight and short construction time. Slender superstructures can be designed which decrease construction height and foundation works leading to a further decrease of material, fabrication, transport and construction costs. Short construction times and therefore reduced traffic disturbance save user costs during construction. Tenders including the lifecycle costs prove the competitiveness and sustainability of steel and composite structures. Recovered steel can be recycled indefinitely.

Assuming an appropriate design, whole structures or their individual steel elements can be re-used after dismantling of the original building and offer so significant economical life-cycle potential.

Figure 9: CO₂ reduction of HISTAR® steels in heavy columns



- Socio-cultural aspects of sustainability

This aspect allows the architect to reconcile his own aesthetic demands for a building with the social expectations of its surrounding environment. Again, thanks to the prefabrication construction system, rolled steel sections provide the user with transparent and lean structures combined with robustness and safety. Local inhabitants and their social environment remain clean in uncontaminated surroundings as steel in structures does not release any harmful substances into the environment.

- Technical aspects of sustainability

Structures made of rolled beams have the advantage of being able to resist high level utilization and are adaptable to changes in use. These robust construction solutions are capable of coping well with variations in use during service life without damage or loss of functionality.

- Process aspects of sustainability

Steel constructions offer many advantages through their flexibility, lightness and cost effectiveness. Rolled beams are used as primary bearing elements. They are industrially produced to a high quality, offer good availability in a full range of sizes and steel grades, including HISTAR®. Fabricated in specialized workshops the end product is delivered to site ready for erection. Quality control has already been carried out at the production.

Smaller construction sites and plant equipment are therefore needed whilst minimal noise and dust disturbance on site are characteristics for steel construction. Structures using hot rolled sections reduce erection times. Hence, transportation cost and pollution as well as accident potential is reduced. Choosing HISTAR® steels and using their full potential, leads to create the best conditions for a contemporary, economical, ecological and consistent sustainable construction.

In design and service life, the slenderness of both columns and beams is a major advantage for steel construction.

- HISTAR® Environmental Product Declaration EPD-ARM-20170033 IBD1-EN

An Environmental Product Declaration is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products. EPDs are more and more required by companies working in and supplying to the construction industry, as they provide transparency to the public regarding the environmental performance of construction products and are used in building certification schemes such as BREEAM and LEED, and national regulation regarding sustainable construction.

HISTAR® EPD-ARM-20170033 IBD1-EN is based on a “cradle-to-gate with options” Life Cycle Assessment (LCA) performed in accordance with ISO 14040/44 and EN15804. The EPD is based on data collection at the manufacturing site including all used and registered materials and energy as well as measured on-site emissions. The EPD includes the following lifecycle stages:

- Structural steel production (Module A1-A3 according to EN15804);
- Sorting and shredding of after-use steel, non-recovered scrap due to sorting efficiency (Module C3);
- End-of-Life scenarios, including reuse and recycling (Module D).

HISTAR® steels are contributing to a major reduction in greenhouse gases by making it possible to use lighter structures with reduced carbon footprint. Substituting HISTAR® for common steel achieves CO₂ reductions of about 30% in steel columns and about 20% in beams.

9. Frequently asked questions

What is HISTAR®?

HISTAR® is the trademark of high-strength low-alloy steel shapes from ArcelorMittal produced by a thermomechanical rolling in combination with a quenching and self-tempering process. European Technical Assessment ETA 10/0156 is the European product standard specification to which HISTAR® steel conforms.

What is the availability of HISTAR® grades?

The product is available in HISTAR® 355, HISTAR® 355L, HISTAR® 460, HISTAR® 460L. Estimated delivery time (in mainland Europe) is 2-3 weeks after rolling.

What shapes are available in HISTAR®?

Kindly refer to table 2 (page 7).

If I order the HISTAR® specification, does the production process lengthen the lead time?

No. Shapes produced in HISTAR® have the same availability as any other steel grades. The quenching and self-tempering process used to produce HISTAR® shapes is an in-line process, meaning the steel will not leave the production line to receive the treatment. As a result, it is an inherently efficient, performance enhancing treatment method and will not affect the delivery time for the material.

Is there a premium for HISTAR® Steel?

There is no premium. Our HISTAR® steels are priced the same as other structural steel of comparable yield strengths and toughness S355 or S460. In fact, the reduced weight and weld cost achieved with HISTAR® steel leads to reduced cost of material, finishing and assembly.

What lengths are available for HISTAR®?

Standard delivered lengths range from 9 to 18 m. Other lengths are available upon agreement. For bridge girders special lengths up to 40 m are achievable.

What are the design rules for columns, beams and connections in HISTAR®?

Kindly refer to chapters 3 and 4.

How does the toughness of HISTAR® grades compare to other hot-rolled steel grades?

Kindly refer to chapter 3.4.

What Charpy V-Notch toughness requirements does HISTAR® meet?

Kindly refer to tables 4 and 6.

What is the ductility of HISTAR®?

Kindly refer to tables 4 and 6.

How do the residual stresses in HISTAR® compare to other materials after rolling?

There will be little to no difference between the residual stresses of a particular shape in HISTAR® and the same shape in a steel grade with comparable yield strength.

How does the fatigue behaviour of HISTAR® compare to other steel grades?

As for any other structural steels, HISTAR® shapes can be designed according to EN 1993-1-9.

How does the fire resistance of HISTAR® compare to other steel grades?

The fire resistance of HISTAR® steels is the same as for any other structural steels. HISTAR® shapes can be designed according to standard codes EN 1993-1-2 and EN 1994-1-2.

How does the corrosion resistance of HISTAR® compare to other steel grades?

The corrosion resistance of HISTAR® shapes is the same as that of other structural steel grades.

Can HISTAR® be galvanised?

Kindly refer to chapter 5.9.

How can HISTAR® be used in seismic application?

As for other structural steels for seismic application, HISTAR® shapes should be designed acc. to EN 1998-1. High-rise buildings in earthquake-prone areas all around the world have been successfully designed and built with HISTAR®.

How do I weld HISTAR® material?

Kindly refer to chapter 5.4.

What electrodes should be used when welding HISTAR® shapes?

Kindly refer to chapter 5.4.2 and table 15.

Can HISTAR® be welded in combination to other grades?

Yes. When welding HISTAR® to other structural grades, preheating may be needed for the other structural grades. Usual preheating, if required, has no detrimental effect on HISTAR®.

Is thermal cutting of HISTAR® shapes permitted?

Kindly refer to chapter 5.3.

Can stress relieving treatments be performed on HISTAR® steel?

Kindly refer to chapter 5.5.

What can I expect when machining and cutting shapes in HISTAR®?

Kindly refer to chapter 5.2 and 5.3.

What are the environmental features of HISTAR®?

Kindly refer to chapter 8.

An environmental Product Declaration (EPD) of HISTAR® is available on sections.arcelormittal.com

Shapes in HISTAR® steel are 100% produced from steel scrap. After use or reuse, as for any other steel shapes, shapes in HISTAR® have a recovery rate of about 98% – according to European Commission Technical Steel Research – considering recycling and reuse of the material.

Where can I find additional technical information on HISTAR® products?

Our specialists are ready to support your projects all over the world. Feel free to consult our technical advisory or your nearest sales contact:

E: sections.sales@arcelormittal.com

T: +352 5313 - 3010

sections.arcelormittal.com

Emirates Tower One, Dubai
United Arab Emirates





13. Our support to your project

- Technical support

We help you in designing and developing innovative solutions to take the best advantage of our steel.

We are happy to provide free technical advice and to answer your questions about the use of sections and merchant bars. This technical advice covers the design of structural elements, construction details, surface protection, fire safety, metallurgy and welding.

Our specialists are ready to support your initiatives anywhere in the world and to provide tailor made services to help you get better result faster with our steel.

sections.sales@arcelormittal.com

- Finishing

As a complement to the technical capacities of our partners, we are equipped with high-performance finishing tools and offer a wide range of services, such as: drilling, flame cutting, T cut-outs, notching, cambering, curving, straightening, cold sawing to exact length, welding and fitting of studs, shot and sand blasting, surface treatment.

Resources:

software and technical documentation :
sections.arcelormittal.com

examples of our full range of products for the construction market (structures, façades, roofing, etc.):
constructalia.arcelormittal.com

- Our expertise

ArcelorMittal, the world's leading steel and mining company, has continuously brought, with the support of its R&D teams, innovation to the construction business. In that matter, ArcelorMittal has decided to look at the construction in a different way, by considering the building as part of its environment and through its entire lifecycle. This new approach is called **Steligen**®.

In Europe, to help project stakeholders (architects, real estate companies, engineer), ArcelorMittal has developed a network of Steligen® Construction Engineers applying a science-based methodology, which considers buildings holistically and demonstrate the benefits of best-in-class products in terms of economics, flexibility, sustainability and creativity.

Contact us for technical support:

For European market:

steligen.engineering@arcelormittal.com

For other markets:

sections.sales@arcelormittal.com

More info about Steligen® :

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