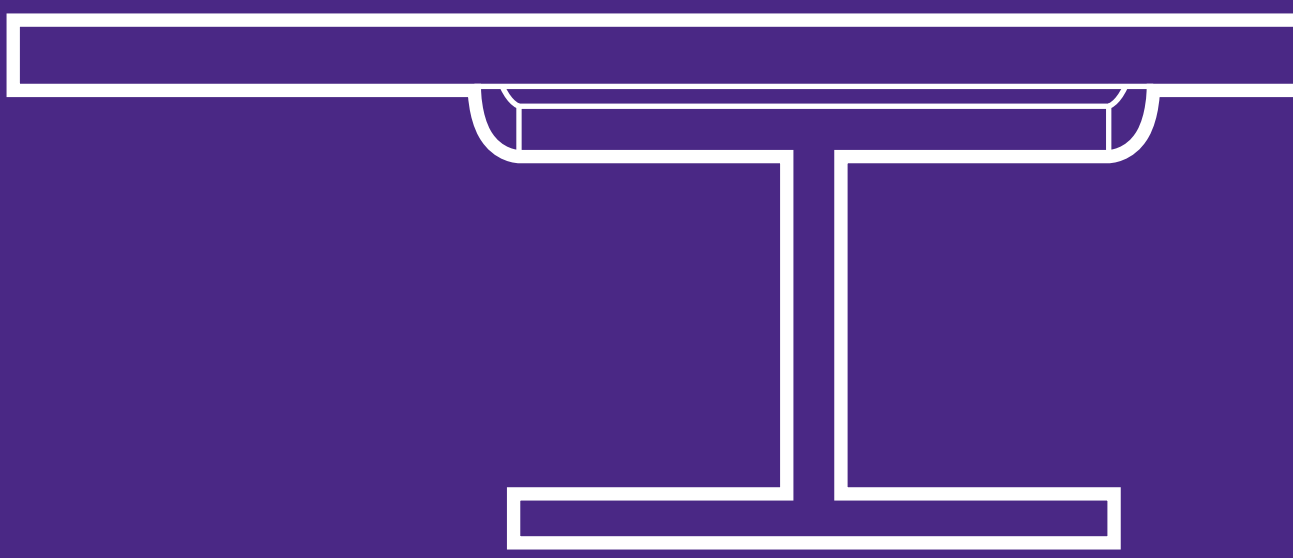
Corus Construction & Industrial

Steel sections for offshore structural applications



Corus is one of the world's leading metals companies with a great breadth of experience supplying steel to the offshore oil and gas industries, providing a full range of products and services for these applications.

This brochure details Corus' range of steel sections for offshore structural applications. Specifications and standards, typical properties achieved and fabrication procedures are described.

Specifications and standards

The following summaries of chemical and mechanical property requirements for typical offshore steel specifications are given as examples of conditions to be achieved.

British Standard BS 7191:1989 Grade 355

Chemical composition (ladle and product analysis / wt%) (1)

Grade	C max	Si	Mn max	P max	S max	Nb	V	Al max	Ti max	Cr max	Ni max	Mo max	Cu max	N max	CEV max
355D (Ladle only)	0.18	0.10/ 0.50	1.50	0.040	0.040	0.003/ 0.10	0.003/ 0.10	-	-	-	-	-	-	-	0.43
355EM	0.18	0.25/ 0.55	1.60	0.025	0.015	0.04 max	0.08 max	0.06(2)	0.02	0.25	0.30	0.08	0.35	0.014	0.43
355EMZ	0.18	0.25/ 0.55	1.60	0.025	0.008	0.04 max	0.08 max	0.06(2)	0.02	0.25	0.30	0.08	0.35	0.014	0.43

(1) Other restrictions apply beyond those shown. (2) Soluble Al to N ratio shall be a minimum of 2:1.

Mechanical properties

Grade	Minimum YS (MPa)			TS (MPa)	Min El ($5.65\sqrt{S_o}$) (%)	Min Ave Charpy V (J)			Z Properties	
	≤16mm	>16 ≤20mm	>20 ≤40mm			Orientation	-20ºC	-40ºC	Min Ave RA (%)	Min TS (MPa)
355D	355	345	-	490 - 640	20	Long	50	-	-	-
355EM	355	345	345	460 - 620	20	Long	-	50	-	-
355EMZ	355	345	345	460 - 620	20	Long	-	50	35(1)	368(1)

(1) Testing is not required for thicknesses below 25mm.

European Standard EN 10225: S355 Grades

Chemical composition (ladle and product analysis / wt%) (1)

Grade	C max	Si max	Mn	P max	S max	Nb max	V max	Al	Ti max	Cr max	Ni max	Mo max	Cu max	N max	CEV max
S355G1	0.20	0.50	0.90/ 1.65	0.035	0.030	0.05	0.12	0.02(2) min	0.030	0.30	0.50	0.10	0.35	0.015	0.43
S355G4 S355G4+M	0.16	0.50	1.60 max	0.035	0.030	0.05	0.10	0.02(2) min	0.050	-	0.30	0.20	0.35	0.015	0.43
S355G11 S355G11+M	0.14	0.55	1.65 max	0.025	0.015	0.04	0.06	0.015/ 0.055(2)	0.025	0.25	0.50	0.08	0.30	0.012	0.43
S355G12 S355G12+M	0.14	0.55	1.65 max	0.020	0.007	0.04	0.06	0.01/ 0.055(2)	0.025	0.25	0.50	0.08	0.30	0.012	0.43

(1) Other restrictions apply beyond those shown.
(2) Total Al to N ratio shall be a minimum of 2:1. When other N binding elements are used, the min Al and Al:N ratio do not apply.

Mechanical Properties

Grade	Minimum YS (MPa)				TS (MPa)	Max YS:TS Ratio	Min El ($5.65\sqrt{S_o}$) (%)	Min Ave Charpy V (J)			Z Properties	
	≤16mm	>16 ≤20mm	>20 ≤40mm	>40 ≤63mm				Orientation	-20ºC	-40ºC	Min Ave RA (%)	Min TS (MPa)
S355G1	355	345	345(1)	-	470 - 630	0.87	22	Long	50	-	-	-
S355G4 S355G4+M	355	345	345(1)	-	450 - 610	0.87	22	Long	50	-	-	-
S355G11 S355G11+M	355	345	345	335	460 - 620	0.87	22	Long	-	50(2)	-	-
S355G12 S355G12+M	355	345	345	335	460 - 620	0.87	22	Long Trans	- -	50(2) 50(3)	35(4)	368(4)

(1) ≤ 25 mm
(2) ≤ 25 mm, test at -20 °C
(3) Transverse impacts optional.
(4) Through thickness tensile testing optional

Comparison Table

BS 7191 Grade	Nearest Equivalent EN 10225 Grade
355D	S355G1, S355G4, S355G4+M
355EM	S355G11, S355G11+M
355EMZ	S355G12, S355G12+M

Competitive lead times

Corus produces structural sections from three rolling mills at Scunthorpe and Teesside in the UK. Regular rolling programmes at each of the mills ensure frequent availability of each section size.

Testing

Many offshore applications require special testing and inspection, and Corus has facilities for large scale testing of mechanical properties in-house. Testing requirements are in accordance with BS7191 and EN10225 at a minimum frequency of one set of tests per 40 tonnes, per cast (unless otherwise stated).

The following mechanical tests constitute one set:
1 tensile test (longitudinal) all grades
1 set of 3 Charpy V-notch impact tests (longitudinal)

The testing frequency increases to 1 set of 3 Charpy V-notch impact tests (longitudinal) per 5 tonnes for BS7191 Grades 355EM and EMZ.

Additional capabilities

For BS7191 Grade 355EMZ (option B.24) and EN10225 Grade G12+M (option 13), through thickness testing at a frequency of 1 per cast is carried out in accordance with EN10164 Quality Class Z35.

Non-destructive testing (NDT) facilities are available in house. When specified, testing is carried out by qualified Corus operators to guarantee internal soundness.

The NDT facility can be incorporated into the 100% inspection process, an offline activity for checking the product conformity to the standard applied. This inspection service is operated in a dedicated bay by teams of experienced steel inspectors ensuring a high level of service and a quality product.

Total quality

Corus products will be delivered in the as-rolled condition, in accordance with EN10021. Surface requirements meet EN10163 parts 1 and 3, and rolling tolerances comply with European Specifications, e.g. EN10034 for beams and columns.

All products have a Corus bar-coded label which shows the customer order and product details. The product can be hard-stamped, colour-coded and stencilled as specified within the BS7191 and EN10225 standard or as agreed with the customer. All products carry the Corus brand, the mill of origin and reference back to cast level.

Accredited Quality Assurance - every rolling mill and steelworks involved in the supply of structural sections operates quality management systems complying with ISO9001. Moreover, every site has been approved by Lloyds Register Quality Assurance (LRQA), a nationally accredited independent third party approval body, as well as many other leading National and International QA organisations.

Certification

Corus certification is in accordance with EN10204. Test certificates are normally supplied to Type 3.1.B. If third party inspection is required, inspectorate-endorsed certificates to Type 3.1.C will be supplied. Certificates are available in English, French and German.

Chemical composition

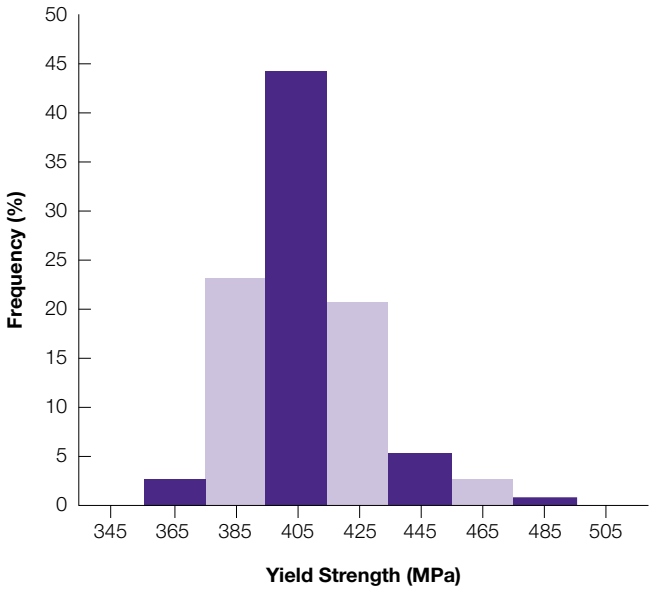
Structural sections are based on a low sulphur, low nitrogen, silicon killed, aluminium fine grained chemistry with a low carbon equivalent value (CEV).

Mechanical properties

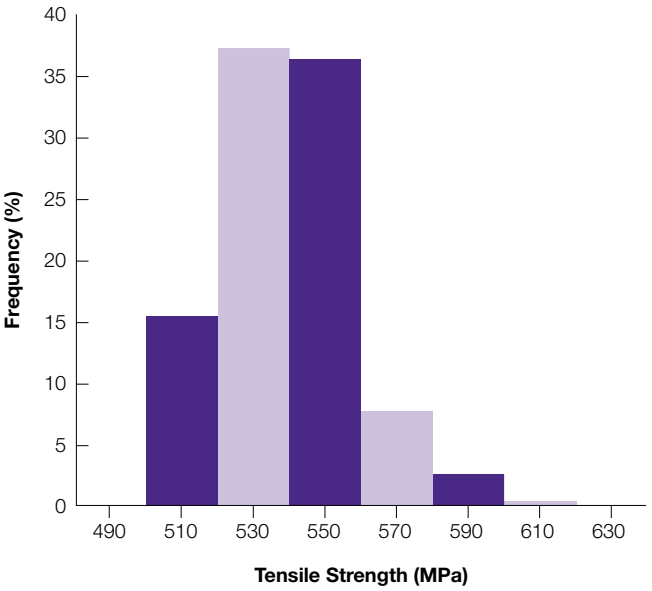
Below are typical examples of mechanical properties measured across the full range of beams and columns produced for offshore structural applications (conforming to BS7191:1989 Grade 355 EMZ).

These histograms illustrate the spread of values that may be expected in the production of large tonnages of beams and columns rolled from a number of casts of steel. Corus' Technical staff will be happy to discuss the benefits shown in this data with reference to your particular requirements. See the back cover for contact details.

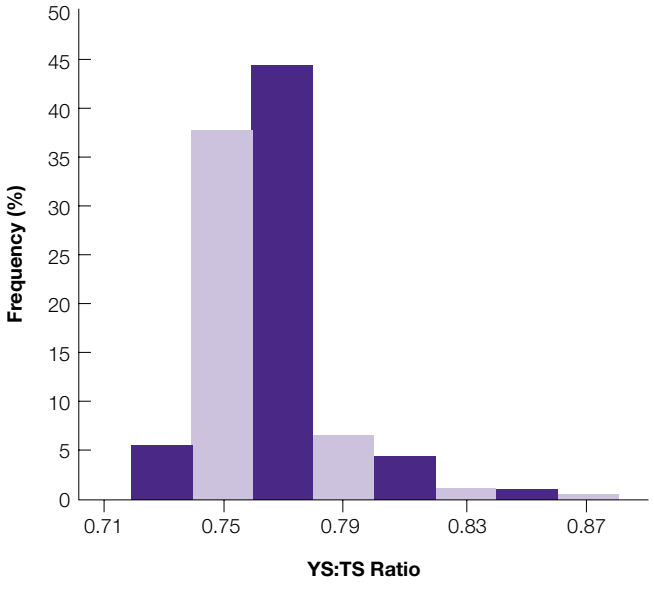
Yield stress



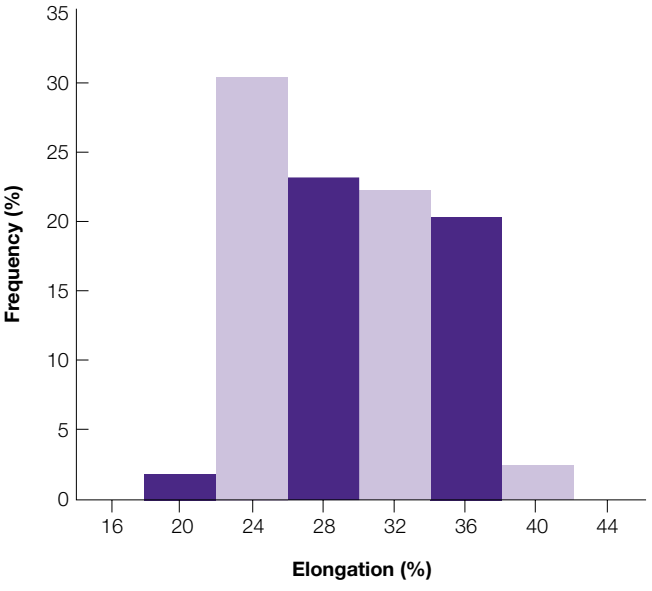
Tensile strength



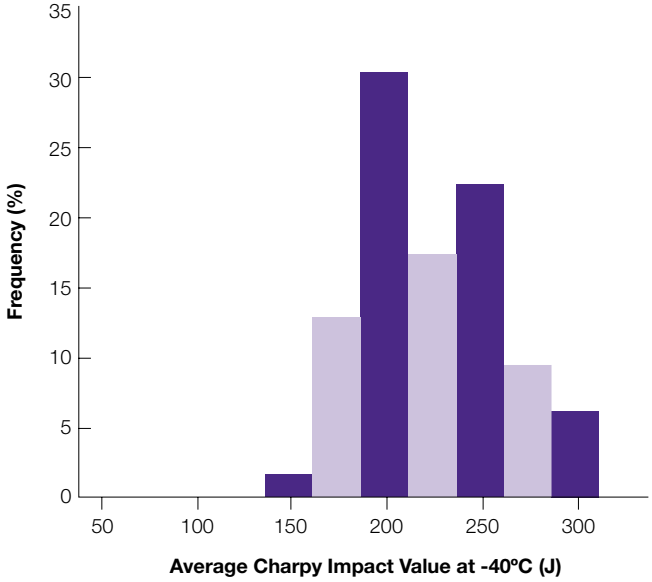
Yield to tensile ratio



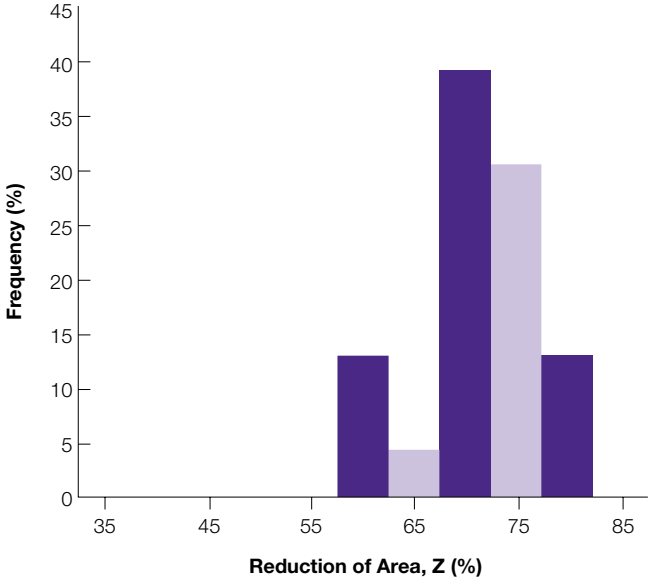
Elongation



Average longitudinal Charpy impact value at -40ºC



Through thickness tensile ductility



High strength steels

Corus would be happy to discuss any requirements for higher strength steels, from the S420 series and above, and any particular requirements for weldability, toughness and mechanical properties. Corus' experience in the manufacture of high strength/high toughness grades is well proven together with an extensive knowledge of the demands of the offshore market. Please use the contact details on the back cover.

Corus can also utilise the facilities of world class R&D teams to further develop steels to meet your requirements.

Size availability

Corus supplies a full range of steel products for offshore applications. Beams, columns, joists, channels and angles are available in all the BS7191 grades and the EN10225 S355 grades, in both metric and imperial denominations. Corus supplies BS, ASTM and Euronorm sizes in flange thicknesses up to 40mm. For sections greater than 40mm, please refer to Corus sales offices.

Corus also provides section sizes, weights and profiles in addition to those listed, including asymmetric beams. Sales office staff will be happy to provide any further information required.

Easy to weld sections

Corus' structural sections have low CEV values and are easy to weld. As with all steel types, the selection of weld procedure must take into account a number of factors linked to the properties of the structural sections. The toughness of the HAZ must be kept above critical values to eliminate the risk of brittle failure in service. Methods of evaluating the effects of the weld thermal cycle on HAZ hardness and toughness are included in welding standards such as BS EN1011-2:2001. Data on HAZ toughness (based on Charpy - V impact and Crack Tip Opening Displacement laboratory tests) can be obtained from Corus on request. Corus welding metallurgists are available to discuss any queries on specific applications involving weld procedures not covered by BS EN1011 which replaces BS5135:1994. See the back cover for contact details.

British universal beams
127 x 76 mm - 914 x 419 mm

American wide flange sections
W6 x 15 lb/ft - W40 x 327 lb/ft

British universal columns
152 x 152 mm - 356 x 406 mm

Equal angles
90 x 90 mm - 200 x 200 mm

Universal bearing piles
203 x 203 mm - 356 x 368 mm

Unequal angles
100 x 65 mm - 200 x 150mm

Euronorm I beam
IPE 100 mm - 750 mm

Joists
76 x 76 mm - 254 x 203 mm

Euronorm H beam
HE 100 mm - 1000 mm

Parallel flange channels
100 x 50 mm - 430 x 100 mm

www.corusgroup.com

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