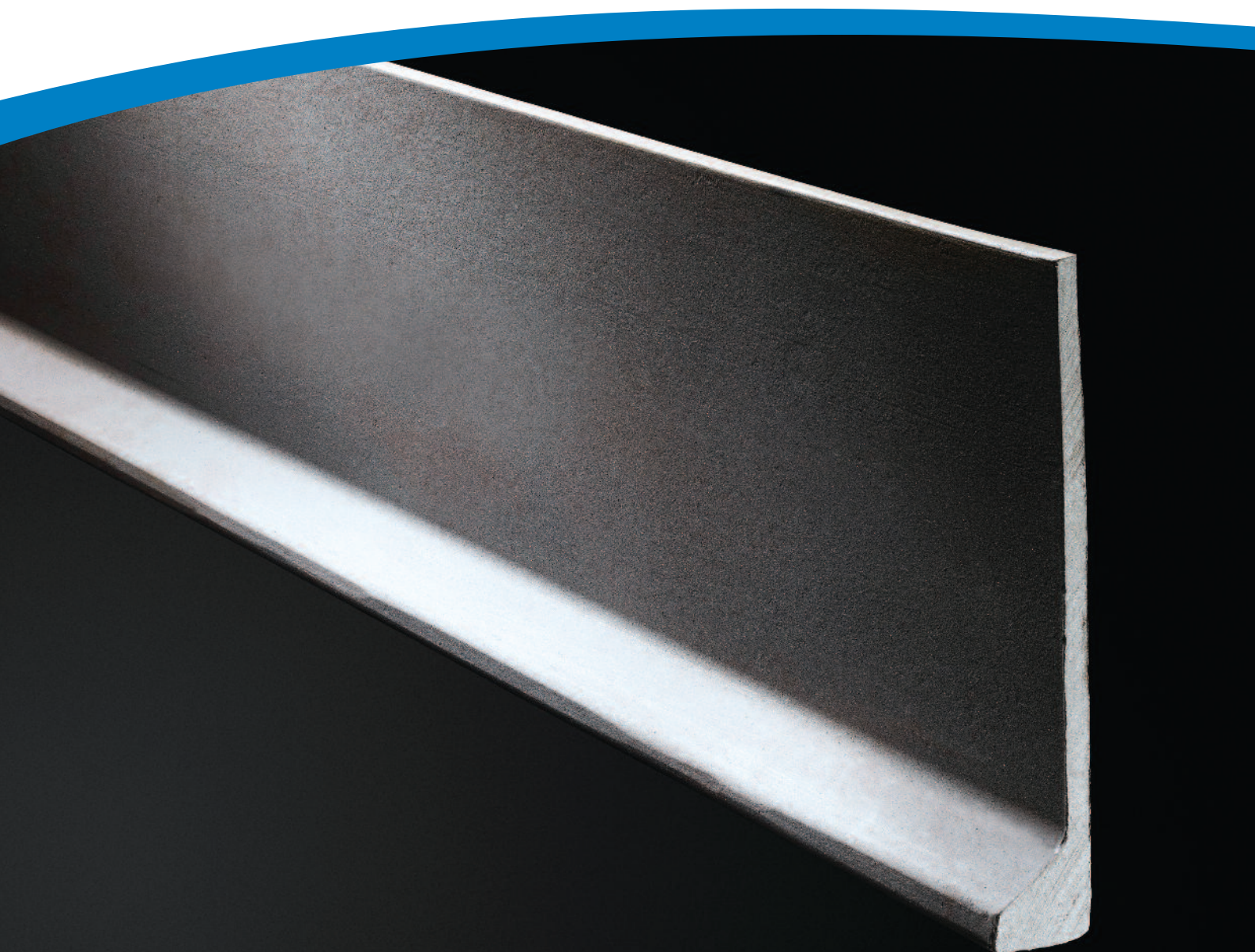


**TATA STEEL**



## **Bulb Flats**

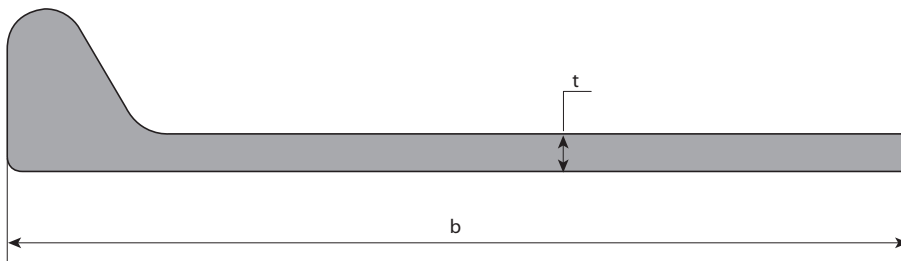




# Delivery conditions for shipbuilding steel

## 1.0 Dimensions

### 1.1 Width



Width b, (mm)	EN10067/ Tata Steel Standard	Tata Steel Special 1	Tata Steel Special 2
$\geq 160 \leq 180$	$\pm 2.0$ mm	$\pm 2.0$ mm	$\pm 1.5$ mm
$\geq 180 \leq 300$	$\pm 3.0$ mm	$\pm 2.2$ mm	$\pm 1.7$ mm
$\geq 300 \leq 430$	$\pm 4.0$ mm	$\pm 3.0$ mm	$\pm 2.0$ mm

Our special width tolerances are achieved through an offline 100% weld edge grinding process. This ensures clean flat edges for superior welding.

Even closer tolerances may be accepted after special agreement.

### 1.2 Thickness

Thickness tolerances for different widths ranges.

Width, b (mm)	EN10067/Tata Steel Standard	Tata Steel Special 1
$\geq 160 \leq 180$	-0.3 / + 1.0 mm	-0.2 / + 0.6 mm
$> 180 \leq 300$	-0.4 / + 1.0 mm	-0.3 / + 0.6 mm
$> 300 \leq 430$	-0.4 / + 1.2 mm	-0.3 / + 0.6 mm

### 1.3 Length

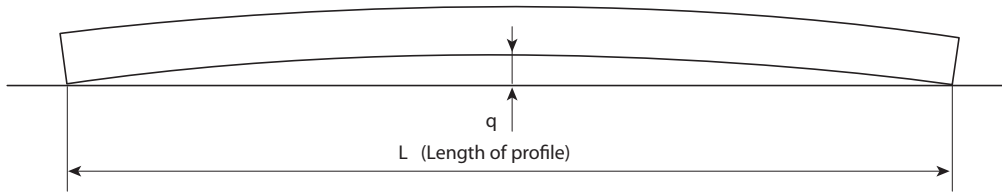
Closer tolerances may be achieved by special agreement.

Length, L	EN10067/Tata Steel Standard
All	-0 / + 100 mm

Individual lengths up to 16.5m maximum are available as a standard stackable length. Lengths outside this range may be available on request on a limited tonnage basis.

### 1.4 Straightness - Bow and Camber

As measured over the length of the bar.

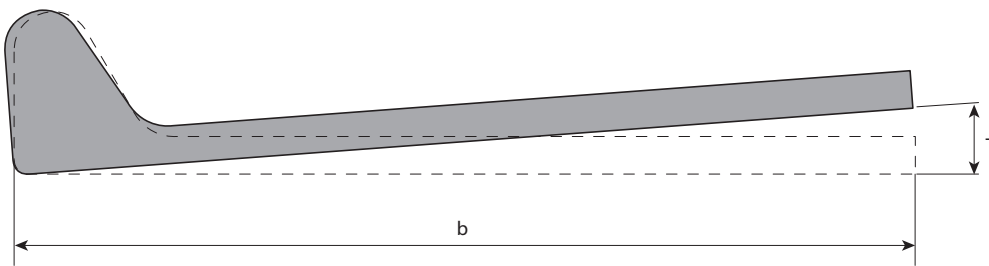


Length	EN10067/ Tata Steel Standard	Tata Steel Special 1	Tata Steel Special 2
L ≤ 18m	$q \leq 0.0035 \times L$	$q \leq 0.0025 \times L$	$q \leq 0.00125 \times L$

### 1.5 Torsion

The permissible degree of twist is given as the following calculation:

**Torsion,  $T = \text{width} \times \sin \text{tol degree}, \times \text{length}$**



Length	Tata Steel Standard	Tata Steel Special
All	0.5 °/m	0.35 °/m

### Typical worked example Tata Steel Standard

**Torsion:  $T = b \times \sin 0.5^\circ \times L$**

Width, b (mm)	Length, L				
	6 m	10 m	12 m	15 m	18 m
240	13	21	25	31	38

## Typical worked example Tata Steel Special

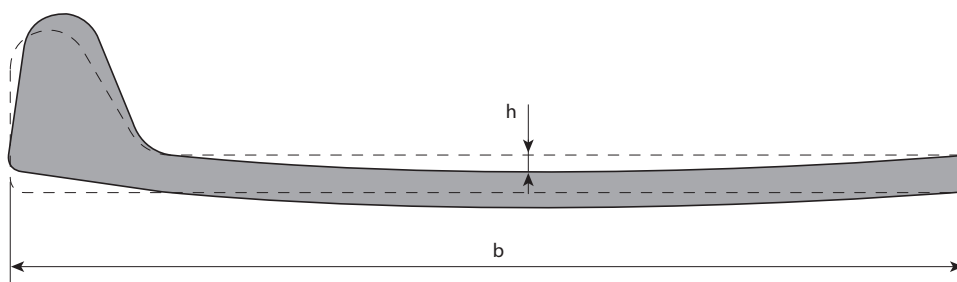
Torsion:  $T = b \times \sin 0.35^\circ \times L$

	Length, L				
	6 m	10 m	12 m	15 m	18 m
Width, b (mm)					
	Torsion, T				
240	9	15	18	22	26

### 1.6 Flatness

The plate flatness tolerance **h** is 0.3% of the bulb flat width **b** and is measured as shown below.

Plate flatness tolerance:  $h \leq 0.003 \times b$

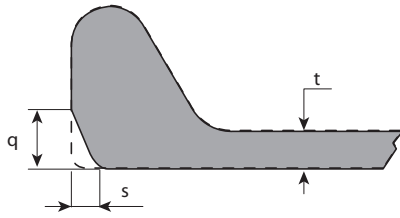


The bulb flatness tolerance of the heel is **n** measured as shown below with a 2mm maximum.

Bulb flatness tolerance:  $n \leq 2.0 \text{ mm}$



### 1.7 Shape



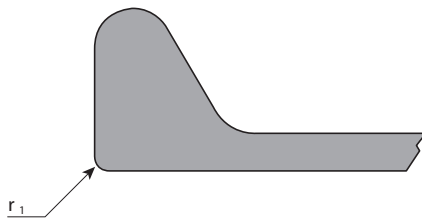
The dimensions s and q are measured as illustrated above.

#### Bulb head corner tolerances s

Thickness	Tolerance
$t \leq 9 \text{ mm}$	$s \leq 2.0 \text{ mm}$
$9 < t \leq 13 \text{ mm}$	$s \leq 3.0 \text{ mm}$
$t > 13 \text{ mm}$	$s \leq 4.0 \text{ mm}$

#### Bulb head corner tolerances q

Thickness	Tolerance
$t > 7 \text{ mm}$	$q \leq 0.75 S$

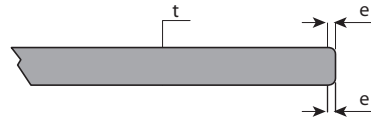


#### Bulb head corner tolerances radius r<sub>1</sub>

##### Radius of curvature of corners r<sub>1</sub> for thickness

Thickness	r <sub>1</sub> Maximum
$5 \leq t < 9$	2.0
$9 \leq t < 13$	3.0
$13 \leq t \leq 20$	4.0

The dimensions r<sub>1</sub> is measured as illustrated above.

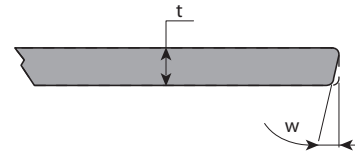


The dimension e is measured as illustrated above.

#### Web edge tolerances e

Thickness	EN10067 - Tata Steel Standard
$t \leq 9 \text{ mm}$	$e \leq 2.0 \text{ mm}$
$9 < t \leq 13 \text{ mm}$	$e \leq 3.0 \text{ mm}$
$t > 13 \text{ mm}$	$e \leq 4.0 \text{ mm}$

Tighter tolerances may be available on request through grinding of the web edge.



The dimension w is measured as illustrated above.

#### Web edge tolerances angle w

Thickness	Tolerance
$t \leq 9 \text{ mm}$	$w \leq 4^\circ$
$9 < t \leq 13 \text{ mm}$	$w \leq 4^\circ$
$t > 13 \text{ mm}$	$w \leq 4^\circ$

Tighter tolerance on web edge tolerance e and angle w may be available on request through offline grinding of the web edge.

Bulb flats are manufactured with rounded edges, eliminating the need for the labour-intensive and costly grinding process needed to meet new International Maritime Organisation guidelines.

## 2.0 Surface Condition

The surface requirements and repair conditions for shipbuilding profiles are in accordance with EN 10163-3:2004, subclass 3, class C. Maximum permissible depth of discontinuities and grinding allowance below minimum specified thickness are given in table below:

Nominal thickness of the Product, t	Maximum permissible depth of discontinuities (mm)
$3 \leq t < 6$	20% of t
$6 \leq t < 20$	1.2
$20 \leq t < 40$	1.7

## 3.0 Requirements for Blast-Cleaned and Primed Material

The material can be delivered in blast-cleaned and primed condition in accordance with EN10238:1996. The standard supply conditions are as follows:

Preparation grade:	Sa 2 ½
Surface roughness:	M (medium in acc. with ISO 8503-2)
Dry film thickness:	20 µm ± 5 µm
Types of primers:	To be agreed

## Steel types and grades

Special Profiles operations are in accordance with ISO9001:2008

The company also has approval of the world's leading classification societies such as: ABS, BV, CCS, DNV, GL, LRS, NKK, RINA, and RMRS.

Below is a list of sample grades we regularly produce.

Shipbuilding Steels		Structural Steels	
Strength	Grade	Euronorm	Grade
Normal	A, B	ASTM	A572 Gr50
	D		S235JR+AR
	E		S235J0+AR
High Strength	A32	EN10025-2	S235J2+AR
	D32		S275JR+AR
	E32		S275J0+AR
	A36		S275J2+AR
	D36		S355JR+AR
	E36		S355J0+AR
	A40		S355J2+AR
	D40		EN10025-4 S355M
E40	EN10225 G1*		
			G4

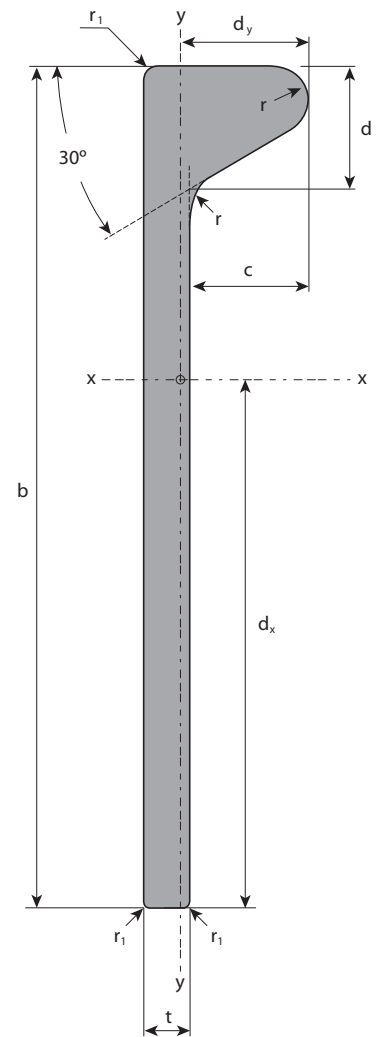
\* Excluding 100% inspection and individual bar marking.

## Dimensions and Properties

Section Description	Section Description					Mass per metre G kg/m	Area of section F cm <sup>2</sup>	Surface area per metre U m <sup>2</sup> /m	Distance to Centre of Gravity		Second Moment of Area	
	b mm	t mm	c mm	d mm	r mm				dx mm	dy mm	I <sub>x</sub> cm <sup>4</sup>	I <sub>y</sub> cm <sup>4</sup>
160x7	160	7.0	22.0	22.2	6.0	11.44	14.58	0.365	96.7	6.5	371.10	5.85
160x8	160	8.0	22.0	22.2	6.0	12.70	16.18	0.367	95.1	6.8	409.27	6.54
160x9	160	9.0	22.0	22.2	6.0	13.95	17.78	0.370	93.7	7.1	446.70	7.31
160x10	160	10.0	22.0	22.2	6.0	15.19	19.34	0.371	92.6	7.5	481.31	8.15
160x11	160	11.0	22.0	22.2	6.0	16.44	20.94	0.373	91.7	7.9	517.81	9.09
160x11.5	160	11.5	22.0	22.2	6.0	17.07	21.74	0.374	91.3	8.1	535.93	9.60
180x8	180	8.0	25.0	25.5	7.0	14.78	18.83	0.412	109.0	7.4	606.55	9.89
180x9	180	9.0	25.0	25.5	7.0	16.20	20.63	0.414	107.4	7.7	661.09	10.92
180x10	180	10.0	25.0	25.5	7.0	17.59	22.40	0.416	106.0	8.1	711.72	12.03
180x11	180	11.0	25.0	25.5	7.0	19.00	24.20	0.418	104.8	8.4	764.60	13.25
180x11.5	180	11.5	25.0	25.5	7.0	19.70	25.10	0.419	104.3	8.6	790.81	13.90
200x8.5	200	8.5	28.0	28.8	8.0	17.77	22.63	0.458	122.2	8.2	901.07	15.06
200x9	200	9.0	28.0	28.8	8.0	18.55	23.63	0.459	121.3	8.4	939.14	15.75
200x10	200	10.0	28.0	28.8	8.0	20.10	25.60	0.460	119.7	8.7	1010.47	17.18
200x11	200	11.0	28.0	28.8	8.0	21.67	27.60	0.463	118.3	9.0	1084.33	18.75
200x11.5	200	11.5	28.0	28.8	8.0	22.45	28.60	0.464	117.6	9.2	1120.89	19.57
200x12	200	12.0	28.0	28.8	8.0	23.24	29.60	0.465	117.0	9.4	1157.23	20.43
220x9	220	9.0	31.0	32.1	9.0	21.02	26.78	0.504	135.5	9.1	1290.48	22.01
220x10	220	10.0	31.0	32.1	9.0	22.72	28.94	0.505	133.7	9.3	1387.89	23.86
220x11	220	11.0	31.0	32.1	9.0	24.45	31.14	0.507	132.0	9.7	1488.07	25.83
220x11.5	220	11.5	31.0	32.1	9.0	25.31	32.24	0.509	131.2	9.8	1537.57	26.87
220x12	220	12.0	31.0	32.1	9.0	26.17	33.34	0.510	130.5	10.0	1586.73	27.94
230x11	230	11.0	32.5	33.75	9.5	25.88	32.97	0.530	138.9	10.0	1724.98	30.05
240x9.5	240	9.5	34.0	35.4	10.0	24.51	31.23	0.549	148.9	9.9	1787.40	31.12
240x10	240	10.0	34.0	35.4	10.0	25.46	32.43	0.550	147.9	10.0	1854.67	32.30
240x10.5	240	10.5	34.0	35.4	10.0	26.40	33.63	0.551	146.9	10.2	1921.25	33.52
240x11	240	11.0	34.0	35.4	10.0	27.34	34.83	0.552	145.9	10.3	1987.20	34.78
240x11.5	240	11.5	34.0	35.4	10.0	28.28	36.03	0.554	145.1	10.5	2052.60	36.06
240x12	240	12.0	34.0	35.4	10.0	29.22	37.23	0.555	144.3	10.6	2117.50	37.39
260x10	260	10.0	37.0	38.7	11.0	28.30	36.05	0.595	162.3	10.7	2421.72	42.80
260x11	260	11.0	37.0	38.7	11.0	30.34	38.65	0.597	160.1	11.0	2593.45	45.86
260x12	260	12.0	37.0	38.7	11.0	32.38	41.25	0.600	158.2	11.3	2762.00	49.07
260x13	260	13.0	37.0	38.7	11.0	34.43	43.85	0.602	156.5	11.6	2927.94	52.45
280x10.5	280	10.5	40.0	42.0	12.0	32.36	41.22	0.641	175.7	11.6	3210.10	57.50
280x11	280	11.0	40.0	42.0	12.0	33.46	42.62	0.642	174.5	11.7	3318.79	59.39
280x12	280	12.0	40.0	42.0	12.0	35.66	45.42	0.645	172.4	11.9	3532.99	63.29
280x13	280	13.0	40.0	42.0	12.0	37.86	48.22	0.647	170.5	12.2	3743.56	67.37
300x11	300	11.0	43.0	45.3	13.0	36.69	46.73	0.687	189.1	12.4	4175.43	75.68
300x12	300	12.0	43.0	45.3	13.0	39.04	49.73	0.690	186.7	12.7	4443.49	80.39
300x13	300	13.0	43.0	45.3	13.0	41.40	52.73	0.692	184.6	12.9	4706.64	85.27
320x11.5	320	11.5	46.0	48.6	14.0	41.28	52.59	0.733	202.5	13.3	5342.16	97.86
320x12	320	12.0	46.0	48.6	14.0	42.54	54.19	0.735	201.3	13.4	5506.76	100.69
320x12.5	320	12.5	46.0	48.6	14.0	43.79	55.79	0.736	200.1	13.5	5669.75	103.58
320x13	320	13.0	46.0	48.6	14.0	45.05	57.39	0.737	199.0	13.6	5831.26	106.51
320x13.5	320	13.5	46.0	48.6	14.0	46.27	58.94	0.737	198.0	13.7	5977.59	109.44
320x14	320	14.0	46.0	48.6	14.0	47.53	60.54	0.738	197.0	13.9	6136.58	112.48
340x12	340	12.0	49.0	52.0	15.0	46.15	58.78	0.780	216.0	14.1	6736.30	124.57
340x12.5	340	12.5	49.0	52.0	15.0	47.48	60.48	0.781	214.7	14.2	6934.97	127.98
340x13	340	13.0	49.0	52.0	15.0	48.81	62.18	0.782	213.5	14.3	7131.73	131.44
340x14	340	14.0	49.0	52.0	15.0	51.45	65.54	0.784	211.3	14.6	7504.42	138.47
340x15	340	15.0	49.0	52.0	15.0	54.12	68.94	0.786	209.2	14.8	7886.99	145.80
370x12.5	370	12.5	53.5	56.9	16.5	53.22	67.79	0.848	236.9	15.4	9184.55	172.23
370x13	370	13.0	53.5	56.9	16.5	54.67	69.64	0.850	235.5	15.5	9444.05	176.62
370x14	370	14.0	53.5	56.9	16.5	57.54	73.30	0.851	233.0	15.7	9936.79	185.49
370x15	370	15.0	53.5	56.9	16.5	60.44	77.00	0.854	230.7	15.9	10440.07	194.68
370x16	370	16.0	53.5	56.9	16.5	63.35	80.70	0.857	228.6	16.1	10935.90	204.14
400x13	400	13.0	58.0	61.9	18.0	60.78	77.43	0.918	257.9	16.6	12234.74	232.34
400x14	400	14.0	58.0	61.9	18.0	63.88	81.38	0.919	255.1	16.8	12872.91	243.41
400x15	400	15.0	58.0	61.9	18.0	67.02	85.38	0.922	252.5	17.0	13521.89	254.79
400x16	400	16.0	58.0	61.9	18.0	70.16	89.38	0.925	250.2	17.2	14160.53	266.45
430x14	430	14.0	62.5	66.8	19.5	70.48	89.78	0.987	277.5	18.0	16366.61	313.68
430x15	430	15.0	62.5	66.8	19.5	73.85	94.08	0.990	274.6	18.1	17189.22	327.65
430x17	430	17.0	62.5	66.8	19.5	80.60	102.68	0.995	269.6	18.5	18794.22	356.44
430x18	430	18.0	62.5	66.8	19.5	83.98	106.98	0.998	267.4	18.8	19579.84	371.35
430x19	430	19.0	62.5	66.8	19.5	87.36	111.28	1.001	265.4	19.0	20355.95	386.65
430x20	430	20.0	62.5	66.8	19.5	90.73	115.58	1.004	263.5	19.3	21123.62	402.40



Elastic Modulus		Radius of Gyration		Warping Constant	Torsional Constant
Zx cm <sup>3</sup>	Zy cm <sup>3</sup>	rx cm	ry cm	H cm <sup>6</sup> /10 <sup>3</sup>	J cm <sup>4</sup>
38.4	9.0	5.05	0.63	1.11	3.65
43.0	9.7	5.03	0.64	1.15	4.57
47.7	10.3	5.01	0.64	1.19	5.73
52.0	10.9	4.99	0.65	1.22	7.12
56.5	11.5	4.97	0.66	1.26	8.86
58.7	11.9	4.96	0.66	1.29	9.85
55.6	13.3	5.67	0.72	2.41	6.24
61.6	14.1	5.66	0.73	2.47	7.57
67.1	14.9	5.64	0.73	2.52	9.15
72.9	15.7	5.62	0.74	2.60	11.13
75.8	16.1	5.61	0.74	2.64	12.26
73.7	18.3	6.31	0.82	4.71	9.20
77.4	18.8	6.30	0.82	4.76	10.00
84.4	19.8	6.28	0.82	4.83	11.78
91.7	20.8	6.27	0.82	4.95	14.01
95.3	21.3	6.26	0.83	5.02	15.28
98.9	21.8	6.25	0.83	5.09	16.65
95.2	24.3	6.94	0.91	8.61	13.17
103.8	25.5	6.92	0.91	8.72	15.16
112.7	26.8	6.91	0.91	8.90	17.65
117.2	27.4	6.91	0.91	8.99	19.06
121.6	28.0	6.90	0.92	9.10	20.60
124.2	30.1	7.23	0.95	11.69	19.81
120.0	31.4	7.57	1.00	14.83	18.25
125.4	32.2	7.56	1.00	14.94	19.46
130.8	33.0	7.56	1.00	15.06	20.78
136.2	33.8	7.55	1.00	15.19	22.22
141.5	34.5	7.55	1.00	15.33	23.79
146.8	35.2	7.54	1.00	15.48	25.49
149.2	39.9	8.20	1.09	24.54	24.85
162.0	41.8	8.19	1.09	24.87	27.91
174.6	43.6	8.18	1.09	25.25	31.50
187.0	45.3	8.17	1.09	25.69	35.69
182.7	49.7	8.82	1.18	39.05	33.16
190.2	50.8	8.82	1.18	39.27	34.90
205.0	53.0	8.82	1.18	39.77	38.84
219.6	55.1	8.81	1.18	40.34	43.42
220.8	60.9	9.45	1.27	60.10	43.42
238.0	63.5	9.45	1.27	60.72	47.73
254.9	66.1	9.45	1.27	61.45	52.71
263.8	73.7	10.08	1.36	89.86	55.95
273.6	75.3	10.08	1.36	90.25	58.38
283.4	76.8	10.08	1.36	90.68	60.99
293.1	78.3	10.08	1.36	91.15	63.79
301.9	79.7	10.07	1.36	91.35	66.51
311.5	81.1	10.07	1.36	91.89	69.71
311.9	88.2	10.70	1.46	131.02	71.06
323.1	89.9	10.71	1.45	131.53	73.88
334.1	91.7	10.71	1.45	132.09	76.91
355.2	95.0	10.70	1.45	132.97	83.29
377.0	98.3	10.70	1.45	134.41	90.88
387.8	112.1	11.64	1.59	221.07	97.62
401.0	114.2	11.64	1.59	221.76	101.01
426.5	118.5	11.64	1.59	222.83	108.11
452.5	122.6	11.64	1.59	224.72	116.55
478.4	126.6	11.64	1.59	226.88	126.04
474.5	139.7	12.57	1.73	357.80	131.25
504.7	145.0	12.58	1.73	358.96	139.13
535.5	150.1	12.58	1.73	361.32	148.48
566.1	154.9	12.59	1.73	364.08	158.97
589.9	174.7	13.50	1.87	559.02	177.41
626.0	180.8	13.52	1.87	561.76	187.72
697.1	192.5	13.53	1.86	569.01	212.09
732.2	197.9	13.53	1.86	573.41	226.30
767.0	203.4	13.52	1.86	578.26	241.98
801.6	208.6	13.52	1.87	583.53	259.20





[www.tatasteel.com](http://www.tatasteel.com)

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