 PETROBRAS	TECHNICAL SPECIFICATION		Nº: I-ET-3010.00-1400-140-P4X-001
	CLIENT:		SHEET: 1 of 46
	JOB:		
	AREA:		ESUP
	TITLE: STRUCTURE PLATES AND PROFILES CATALOGUE		INTERNAL
MICROSOFT WORD / V. 2019 / I-ET-3010.00-1400-140-P4X-001_G			

INDEX OF REVISION

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL
A	TUBULAR, T / WT AND I/H SECTIONS INCLUDED ON TABLES 2, 26, 27 AND 31
B	I/H, TUBULAR AND T/WT SECTIONS UPDATED
C	ANNEX INCLUDED - REVISED ACCORDING CLARIFICATION NOTICE DUE TO BIDDERS QUESTIONS
D	PLATE THICKNESSES AND I/H, T / WT AND TUBULAR SECTIONS UPDATED
E	I/H, ANGLE BAR, TUBULAR AND T/WT SECTIONS UPDATED
F	ANNEX INCLUDED
G	PLATES THICKNESSES AND I/H SECTIONS UPDATED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	AUG/21/19	MAY/31/19	JUL/17/20	SEP/18/20	MAR/15/21	OCT/19/22	APR/18/23	SEP/19/23	
EXECUTION	BGWA	BGWA	BGWA	BGWA	BGWA	E2A7	E2A7	BGWA	
CHECK	B38L	B38L	B38L	E2AP	B3NE	B3NE	B3NE	EI91	
APPROVAL	SG04	SG04	SG04	CYEL	CYEL	CYEL	CYEL	CYEL	

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1. MAIN OBJECTIVE

This document aims to list and organize the structural steel plates and profiles based on standards, supplier catalogs and past projects to be used in the design of steel structures of floating or fixed platform's topside.

In the listed tables are presented some information of the sections that are usually required for structural dimensioning and material list such as dimensions, geometric properties, unit weight and painting area.


For structural profiles, the tables presented are oriented according to the type of section and standard nomenclature reported in the reference catalogs, if any, and cover the following sections:

- I. I / H profile
 - a. I / H welded (BR sections)
 - b. W / HP
- II. Angle bar
- III. Channel bar
- IV. Tubular profile
- V. T / WT profile
- VI. Square bar
- VII. Flat bar
- VIII. Round bar

Finally, standardized nomenclatures are presented for use in structural analysis software, following requirements compatible with the computational language and restrictions of the commonly used softwares.

2. REFERENCES

- [1] ABNT NBR 15980:2020 – Perfis laminados de aço para uso estrutural – Dimensões e tolerâncias
- [2] Catálogo Barras e perfis Gerdau
- [3] Catálogo Perfis Estruturais Gerdau - Tabela de bitolas
- [4] Catálogo Tubos Estruturais Vallourec – Seção Circular, Quadrada e Retangular

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3. GLOSSARY

- **Angle bar**

Rolled bar with a cross section in the form of a L;

- **Channel bar**

Rolled bar with a cross section in the form of an U;

- **Flange**

Horizontal elements which compose a structural section and are responsible for resist most of the bending moment experienced by a linear structural element;

- **Flat bar**

Rolled bar with rectangular cross section;

- **HP profile**

H profile with double-symmetry and parallels flanges with the same thickness of the web element;

- **Rolling**

Metal forming process in which metal stock is passed through one or more pairs of rolls to reduce the thickness and to make the thickness uniform;

- **Round bar**

Rolled bar with circular cross section;

- **Square bar**

Rolled bar with square cross section;

- **T profile**

Monosymmetry profile composed by one flange and one web;

- **W profile**

I and H profiles with double-symmetry and parallels flanges in which are thicker than web element;

- **Web**

Vertical element which compose a structural section and is responsible for mainly resists shear forces;

- **Welded I/H profile**

Structural element composed by three steel shapes joined through electric arc welding, forming approximately an I or H;

- **WT profile**

T profile obtained from the mid-depth cut of W or HP sections;

- **Symbols**


b_f / b – flange width

C_w – warping constant

d – section diameter or height

H – flexural constant

I_x – moment of inertia of the section about its major axis

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I_y – moment of inertia of the section about its minor axis
 J – torsional moment of inertia
 Q – first moment of area
 Q_f – first moment of area at point of intersection between web and flange
 Q_w – first moment of area at mid-depth of the section
 R_0 – polar radius of gyration
 R_p – radius of gyration about the principal axis
 R_x – radius of gyration about the major axis
 R_y – radius of gyration about the minor axis
 S_w – warping statical moment
 t – plate thickness
 t_f – flange thickness
 t_w – web thickness
 U – painting area
 W_{n0} – normalized warping function
 W_x – elastic section modulus about the major axis
 W_y – elastic section modulus about the minor axis
 X_g – position of centroid on X axis
 X_p – horizontal distance from designated member edge to plastic neutral axis
 Y_g – position of centroid on Y axis
 Y_p – vertical distance from designated member edge to plastic neutral axis
 Z_x – plastic section modulus about the major axis
 Z_y – plastic section modulus about the minor axis



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4. TABLES OF STRUCTURAL PLATES AND PROFILES

The lists of structural plates and profiles with their main properties and standardized names for insertion in structural analysis software are presented hereinafter.

4.1. STANDARD NOMENCLATURE

The structure of the standard nomenclature was established in order to enable its using in a clear and comprehensive way to any FEM software. Therefore, it obeys the following rule:

XAAAA-N, where:

X – Indicates the type of structural profile or plate

A – Approximate profile height or plate thickness in millimeters

N – Sequential number to distinguish section names with same height or thickness

4.2. PLATES

Plates thicknesses are standardized according to Brazilian steel mills information and good engineering practices and are presented in Table 1.

Table 1 – Plates

Name		Thickness (mm)	kg/m ²
Original	FEM softwares	t	
Chapa 6.3 mm	A6	6.3	49.46
Chapa 8 mm	A8	8	62.80
Chapa 9.5 mm	A9	9.5	74.58
Chapa 12.5 mm	A12	12.5	98.13
Chapa 16 mm	A16	16	125.60
Chapa 19 mm	A19	19	149.15
Chapa 22.4 mm	A22	22.4	175.84
Chapa 25 mm	A25	25	196.25
Chapa 28 mm	A28	28	219.80
Chapa 31.5 mm	A31	31.5	247.28
Chapa 35 mm	A35	35	274.75
Chapa 37.5 mm	A37	37.5	294.38
Chapa 40 mm	A40	40	314.00
Chapa 44.5 mm	A44	44.5	349.33
Chapa 50 mm	A50	50	392.50
Chapa 55 mm	A55	55	431.75
Chapa 63 mm	A63	63	494.55
Chapa 70 mm	A70	70	549.50
Chapa 75 mm	A75	75	588.75
Chapa 88.9 mm	A89	89	698.65
Chapa 100 mm	A99	100	785.00

4.3. STRUCTURAL PROFILES

4.3.1. I / H PROFILE

I / H profiles are obtained from two different references as described in sections 4.3.1.1 and 4.3.1.2, and their dimensions are according to the follow cross section:

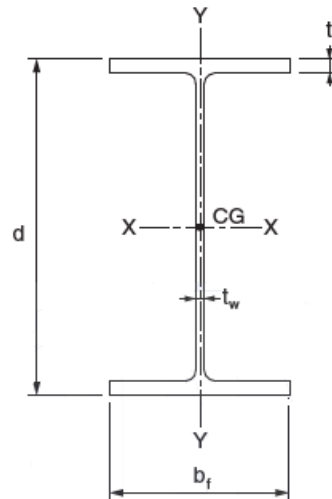


Figure 1 – I / H profile

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4.3.1.1. Welded I / H profiles (BR sections)

I / H profiles generated from welded plates with standardized thicknesses and greater dimensions which are not listed in any supplier catalog. Table 2 to Table 9 were based on a compilation among process modules projects of Petrobras Platforms, steel mills information and good engineering practices.

Table 2 – Properties and dimensions of welded I / H profiles (1/8)

Name	Dimensions (mm)										X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ²)	Z _y (cm ³)	r _y (cm)	J (cm ⁶)	C _w (cm ⁶)	Q _w (cm ³)	u (m ² /m)												
H150x14	75	6.3	150	6.3	14.2	18.11	624	83.2	97.6	5.87	45	11.9	19.1	1.57	2.4	2302	49	0.59												
H150x16	75	8	150	6.3	16.0	20.44	732	97.6	113.5	5.98	57	15.1	23.8	1.66	3.7	2850	57	0.59												
H150x17	100	6.3	150	6.3	16.7	21.26	787	104.9	120.3	6.09	105	21.1	32.9	2.23	2.9	5435	60	0.69												
H150x18	75	9.5	150	6.3	17.7	22.50	822	109.6	127.1	6.05	67	17.9	28.0	1.73	5.5	3310	64	0.59												
H150x22	150	6.3	150	6.3	21.6	27.56	1113	148.3	165.5	6.35	355	47.3	72.2	3.59	3.7	18309	83	0.89												
H150x29	150	9.5	150	6.3	28.9	36.75	1527	203.6	227.2	6.45	535	71.3	108.2	3.81	9.7	26385	114	0.89												
H150x31	150	9.5	150	8	30.6	38.98	1559	207.8	234.5	6.32	535	71.3	109.0	3.70	11.0	26399	117	0.88												
H150x36	150	12.5	150	6.3	35.6	45.38	1880	250.7	282.4	6.44	703	93.8	141.9	3.94	20.7	33246	141	0.89												
H200x22	100	8	200	6.3	21.7	27.59	1802	180.2	206.9	8.08	134	26.7	41.8	2.20	5.0	12323	103	0.79												
H200x28	100	12.5	200	6.3	28.3	36.03	2482	248.2	282.6	8.30	209	41.7	64.2	2.41	14.6	18343	141	0.79												
H200x34	200	8	200	6.3	34.2	43.59	3278	327.8	360.5	8.67	1067	106.7	161.8	4.95	8.4	98339	180	1.19												
H200x38	150	12.5	200	6.3	38.1	48.53	3582	358.2	399.8	8.59	703	93.8	142.4	3.81	21.1	61830	200	0.99												
H200x39	200	9.5	200	6.3	38.8	49.40	3762	376.2	413.5	8.73	1267	126.7	191.8	5.06	13.0	114953	207	1.19												
H200x48	200	12.5	200	6.3	47.9	61.03	4682	468.2	517.0	8.76	1667	166.7	251.7	5.23	27.6	146516	258	1.19												
H200x61	200	16	200	8	60.8	77.44	5747	574.7	645.2	8.61	2134	213.4	322.7	5.25	57.8	180626	323	1.18												
H200x68	200	19	200	6.3	67.7	86.21	6471	647.1	729.1	8.66	2534	253.4	381.6	5.42	93.0	207514	365	1.19												
H200x78	200	22.4	200	6.3	78.0	99.38	7299	729.9	833.6	8.57	2987	298.7	449.5	5.48	151.3	235537	417	1.19												
H200x88	200	25	200	8	87.9	112.00	7933	793.3	920.0	8.42	3334	333.4	502.4	5.46	211.3	255257	460	1.18												
H200x93	200	25	200	12.5	93.2	118.75	8060	806.0	945.3	8.24	3336	333.6	505.9	5.30	219.7	255395	473	1.18												
H250x37	200	8	250	6.3	36.7	46.74	5360	438.8	473.4	10.71	1067	106.7	162.3	4.78	8.8	156242	237	1.29												
H250x45	225	12.5	250	6.3	55.3	70.43	8537	683.0	747.7	11.01	2374	211.0	318.6	5.81	31.3	334703	374	1.39												
H250x67	225	16	250	6.3	67.3	85.73	10415	833.2	917.3	11.02	3038	270.0	407.2	5.95	63.4	415866	459	1.39												
H250x78	250	19	250	6.3	77.6	98.86	11932	954.5	1038.3	10.99	3607	320.7	483.0	6.04	104.8	481246	529	1.39												
H250x90	250	19	250	9.5	90.4	115.14	13456	1076.5	1204.0	10.81	4949	396.0	598.5	6.56	120.9	660267	602	1.48												
H250x101	250	22.4	250	8	100.8	128.42	15127	1210.2	1358.8	10.85	5834	466.7	703.3	6.74	191.2	755556	679	1.48												
H250x111	250	25	250	8	110.7	141.00	16419	1313.5	1486.3	10.79	6511	520.9	784.5	6.80	264.3	824083	743	1.48												
H250x134	250	28	250	16	134.3	171.04	18314	1465.2	1704.5	10.35	7298	583.9	887.4	6.53	396.2	899222	852	1.47												
H250x144	250	28	250	22.4	144.0	183.46	18704	1496.3	1764.8	10.10	7310	584.8	899.3	6.31	449.0	900645	882	1.46												
H300x38	125	12.5	300	6.3	38.1	48.58	7553	503.6	568.3	12.47	407	65.2	100.4	2.90	18.7	84201	284	1.09												
H300x47	150	12.5	300	8	46.7	59.50	9140	609.4	690.3	12.39	704	93.9	145.0	3.44	24.4	145537	345	1.18												
H300x55	150	16	300	8	54.5	69.44	10972	731.5	825.2	12.57	901	120.2	184.3	3.60	45.8	181707	413	1.18												
H300x58	225	12.5	300	6.3	57.8	73.58	12723	848.2	927.7	13.15	2374	211.0	319.1	5.68	31.7	490486	464	1.49												
H300x68	275	12.5	300	6.3	67.6	86.08	15307	1020.5	1107.4	13.34	4333	315.1	475.4	7.10	38.2	895427	554	1.69												
H300x76	300	12.5	300	8	76.1	97.00	16894	1126.3	1229.4	13.20	5626	375.1	566.9	7.62	44.0	1162596	615	1.78												
H300x82	275	16	300	6.3	82.3	104.88	18774	1251.6	1362.7	13.38	5546	403.4	607.7	7.27	77.5	1118374	681	1.69												
H300x86	275	16	300	8	85.9	109.44	19046	1269.8	1393.2	13.19	5547	403.4	609.3	7.12	79.9	1118492	697	1.68												
H300x92	300	16	300	8	92.2	117.44	20661	1377.4	1506.8	13.26	7201	480.1	724.3	7.83	86.8	1452039	753	1.78												
H300x98	275	19	300	8	98.5	125.46	21859	1457.3	1605.5	13.20	6587	479.0	722.6	7.25	130.5	1300250	803	1.68												
H300x109	300	19	300	9.5	109.0	138.89	23962	1597.5	1764.7	13.13	8552	570.1	860.9	7.85	145.2	1688161	882	1.78												
H300x116	275	22.4	300	9.5	115.7	147.44	25102	1673.5	1864.7	13.05	7766	564.8	852.8	7.26	214.0	1496152	932	1.68												

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Table 3 – Properties and dimensions of welded I / H profiles (2/8)

Name	Dimensions (mm)										X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ²)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ²)	r _y (cm)	J (cm ⁴)	C _w (cm ⁶)	Q _w (cm ³)	u (m ² /m)												
H300x122	300	22.4	300	8	121.5	154.82	27057	1803.8	1995.7	13.22	10081	672.1	1012.1	8.07	229.5	1942166	998	1.78												
H300x133	300	25	300	8	133.5	170.00	29479	1965.3	2187.5	13.17	11251	750.1	1129.0	8.14	317.2	2127155	1094	1.78												
H300x147	300	28	300	8	147.2	187.52	32151	2143.4	2403.9	13.09	12601	840.1	1263.9	8.20	443.7	2330689	1202	1.78												
H300x156	300	28	300	12.5	155.8	198.50	32696	2179.7	2470.9	12.83	12604	840.3	1269.5	7.97	456.7	2331231	1235	1.78												
H300x166	300	31.5	300	9.5	166.0	211.52	35274	2351.6	2670.7	12.91	14177	945.1	1422.8	8.19	632.8	2555074	1335	1.78												
H300x178	300	31.5	300	16	178.1	226.92	35995	2399.7	2762.0	12.59	14183	945.5	1432.7	7.91	661.8	2556227	1381	1.77												
H300x182	300	35	300	9.5	182.0	231.85	38046	2536.4	2908.1	12.81	15752	1050.1	1580.2	8.24	865.1	2765398	1454	1.78												
H300x199	300	37.5	300	12.5	198.7	253.13	40210	2680.7	3111.3	12.60	16879	1125.2	1696.3	8.17	1071.8	2907613	1556	1.78												
H300x210	300	37.5	300	19	210.2	267.75	40827	2721.8	3193.6	12.35	16888	1125.9	1707.8	7.94	1114.7	2909198	1597	1.76												
H300x38	175	8	350	6.3	38.5	49.04	10145	579.7	654.5	14.38	715	81.7	125.8	3.82	8.8	209155	327	1.39												
H300x46	130	12.5	350	8	45.9	58.50	11548	659.9	759.7	14.05	459	70.6	110.8	2.80	22.7	130734	380	1.20												
H300x50	225	9.5	350	6.3	49.9	63.60	14298	817.0	900.4	14.99	1804	160.4	243.8	5.33	15.7	522950	450	1.59												
H300x60	225	12.5	350	6.3	60.2	76.73	17828	1018.7	1115.6	15.24	2374	211.0	319.6	5.56	32.1	675955	558	1.59												
H300x69	250	12.5	350	8	69.5	88.50	20095	1148.3	1265.9	15.07	3257	260.5	395.8	6.07	38.3	927366	633	1.68												
H300x70	275	12.5	350	6.3	70.0	89.23	21389	1222.2	1326.5	15.48	4333	315.2	475.9	6.97	38.6	1233992	663	1.79												
H300x75	300	12.5	350	6.3	74.9	95.48	23169	1324.0	1432.0	15.58	5626	375.0	565.7	7.68	41.9	1601999	716	1.89												
H300x85	275	16	350	6.3	84.8	108.03	26249	1500.0	1628.9	15.59	5546	403.4	608.2	7.17	77.9	1546862	814	1.79												
H300x89	275	16	350	8	89.1	113.44	26705	1526.0	1671.8	15.34	5547	403.4	610.1	6.99	80.8	1547056	836	1.78												
H300x97	325	16	350	6.3	97.4	124.03	30715	1755.1	1896.1	15.74	9155	563.4	848.2	8.59	91.5	253190	948	1.99												
H300x100	320	16	350	8	100.4	127.84	30724	1755.7	1912.3	15.50	8739	546.2	824.3	8.27	93.1	2437356	956	1.96												
H300x112	350	16	350	9.5	111.6	142.21	33805	1931.7	2110.6	15.42	11436	653.5	987.2	8.97	105.1	3189276	1055	2.08												
H300x117	325	19	350	6.3	112.4	143.16	35459	2026.2	2197.2	15.74	10871	669.0	1006.5	8.71	151.4	2977655	1099	1.99												
H300x129	350	16	350	12.5	119.1	151.75	34609	1977.7	2186.4	15.10	11439	653.6	992.4	8.68	117.3	3190086	1093	2.08												
H300x133	325	22.4	350	8	133.5	170.02	41021	2344.1	2571.2	15.53	12817	788.7	1187.9	8.68	249.1	3438894	1286	1.98												
H300x146	350	22.4	350	9.5	145.8	185.79	44386	2536.4	2789.6	15.46	16009	914.8	1378.9	9.28	271.6	4295244	1395	2.08												
H300x160	350	25	350	9.5	159.7	203.50	48440	2768.0	3057.5	15.43	17867	1021.0	1538.0	9.37	373.9	4717933	1529	2.08												
H300x161	325	28	350	8	161.3	205.52	48989	2799.4	3103.1	15.44	16021	985.9	1483.5	8.83	481.1	4152815	1552	1.98												
H300x176	350	28	350	9.5	175.8	223.93	52945	3025.4	3360.9	15.38	20010	1149.5	1721.6	9.45	521.4	5186905	1680	2.08												
H300x194	350	31.5	350	9.5	194.5	247.77	57974	3312.8	3707.1	15.30	22511	1286.4	1935.9	9.53	738.4	5709024	1854	2.08												
H300x213	350	35	350	9.5	213.2	271.60	62763	3586.5	4045.0	15.20	25012	1429.3	2150.1	9.60	1009.4	6204643	2022	2.08												
H300x233	350	37.5	350	12.5	233.0	296.88	66561	3803.5	4337.9	14.97	26801	1531.5	2307.6	9.50	1250.8	6543299	2169	2.08												
H300x260	350	40	350	19	260.1	331.30	70760	4043.4	4686.3	14.61	28599	1634.2	2474.4	9.29	1564.2	6870854	2343	2.06												
H400x63	200	12.5	400	8	62.8	80.00	22292	1114.6	1250.0	16.69	1668	166.8	256.0	4.57	32.7	626252	625	1.58												
H400x68	225	12.5	400	8	67.7	86.25	24639	1231.9	1371.1	16.90	2375	211.1	322.4	5.25	35.9	891420	686	1.68												
H400x82	300	12.5	400	8	82.4	105.00	31680	1584.0	1734.4	17.37	5627	375.1	568.5	7.32	45.7	2112173	867	1.98												
H400x86	250	16	400	8	85.9	109.44	32831	1641.5	1806.8	17.32	4168	333.5	505.9	6.17	74.8	1536579	903	1.78												
H400x105	325	16	400	8	104.8	133.44	41683	2084.2	2267.6	17.67	9156	563.4	850.9	8.28	95.3	3375171	1134	2.08												

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Table 4 – Properties and dimensions of welded I / H profiles (3/8)

Name	Dimensions (mm)										X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	J (cm ⁴)	C _w (cm ⁵)	O _w (m ² /m)	u (m ² /m)												
H400x112	300	19	400	8	112.2	142.96	44568	2228.4	2433.8	17.66	8552	570.1	860.8	7.73	143.7	3103377	1217	1.98												
H400x127	350	19	400	8	127.1	161.96	51469	2573.4	2795.7	17.83	13579	775.9	1169.5	9.16	166.5	4927718	1398	2.18												
H400x137	400	16	400	12.5	136.6	174.00	52404	2620.2	2880.8	17.35	17073	853.6	1294.4	9.91	134.2	6293664	1440	2.38												
H400x145	350	22.4	400	8	145.4	185.22	58945	2947.3	3212.7	17.84	16008	914.8	1377.7	9.30	268.7	5706187	1606	2.18												
H400x146	400	19	400	9.5	146.3	186.39	58962	2948.1	3206.8	17.79	20269	1013.3	1528.2	10.43	193.8	7355763	1603	2.38												
H400x155	400	19	400	12.5	154.8	197.25	60148	3007.4	3305.1	17.46	20273	1013.6	1534.1	10.14	207.7	7356962	1653	2.38												
H400x167	375	22.4	400	12.5	166.7	212.40	64623	3231.1	3566.1	17.44	19693	1050.3	1588.9	9.63	305.6	7019757	1783	2.28												
H400x173	375	25	400	9.5	173.3	220.75	69410	3470.5	3806.6	17.73	21975	1172.0	1765.7	9.98	401.3	7725641	1903	2.28												
H400x186	375	28	400	8	186.5	237.52	75503	3775.1	4142.7	17.83	24611	1312.6	1974.3	10.18	555.1	8514367	2071	2.28												
H400x201	400	25	400	16	201.0	256.00	76133	3806.7	4240.0	17.25	26679	1333.9	2022.4	10.21	467.9	9379200	2120	2.37												
H400x231	400	31.5	400	12.5	230.9	294.13	89744	4487.2	4998.0	17.47	33605	1680.3	2533.2	10.69	857.5	11408411	2499	2.38												
H400x252	400	35	400	12.5	252.2	321.25	97287	4864.3	5450.3	17.40	37339	1866.9	2812.9	10.78	1167.1	12436122	2725	2.38												
H400x276	400	37.5	400	16	276.3	352.00	103483	5174.2	5860.0	17.15	40011	2000.6	3020.8	10.66	1455.7	13144269	2930	2.37												
H400x283	400	40	400	12.5	282.6	360.00	107520	5376.0	6080.0	17.28	42672	2133.6	3212.5	10.89	1730.1	13825688	3040	2.38												
H400x310	400	44.5	400	12.5	310.0	394.88	116199	5810.0	6630.2	17.15	47472	2373.6	3572.1	10.96	2373.0	14998722	3315	2.38												
H400x334	400	44.5	400	22.4	334.1	425.66	118681	5934.0	6869.5	16.70	47496	2374.8	3599.0	10.56	2483.1	15006326	3435	2.36												
H400x352	400	50	400	16	351.7	448.00	126933	6346.7	7360.0	16.83	53344	2667.2	4019.2	10.91	3381.1	16336469	3680	2.37												
H400x388	400	50	400	31.5	388.2	494.50	130421	6521.0	7708.8	16.24	53411	2670.6	4074.4	10.39	3698.0	16357264	3854	2.34												
H450x71	225	12.5	450	8	70.8	90.25	32042	1424.1	1591.7	18.84	2375	211.1	323.2	5.13	36.8	1136408	796	1.78												
H450x86	300	12.5	450	8	85.6	109.00	41016	1822.9	2001.9	19.40	5627	375.1	569.3	7.18	46.5	2692518	1001	2.08												
H450x108	325	16	450	8	107.9	137.44	53864	2393.9	2606.2	19.80	9156	563.4	851.7	8.16	96.2	4311445	1303	2.18												
H450x122	275	22.4	450	8	122.2	155.62	60802	2702.3	2962.4	19.77	7766	564.8	853.5	7.06	213.4	3549825	1481	1.98												
H450x127	400	16	450	8	126.7	161.44	65170	2896.5	3127.0	20.09	17068	853.4	1286.7	10.28	116.6	8037362	1564	2.48												
H450x145	400	19	450	8	145.2	184.96	75297	3346.5	3615.1	20.18	20268	1013.4	1526.6	10.47	190.3	9412707	1808	2.48												
H450x167	425	19	450	12.5	167.2	213.00	82334	3659.3	4010.8	19.66	24316	1144.3	1732.0	10.68	222.4	11292328	2005	2.58												
H450x189	425	22.4	450	12.5	189.2	241.05	94042	4179.7	4583.8	19.75	28666	1349.0	2038.8	10.91	346.3	13103246	2292	2.58												
H450x206	425	25	450	12.5	206.1	262.50	102734	4566.0	5015.6	19.78	31992	1505.5	2273.4	11.04	470.4	14446472	2508	2.58												
H450x227	450	25	450	16	226.9	289.00	110252	4900.1	5421.3	19.53	37982	1688.1	2556.9	11.46	526.8	17151429	2711	2.67												
H450x236	450	28	450	12.5	236.5	301.25	118729	5276.8	5802.3	19.85	42531	1890.3	2850.4	11.88	686.0	18935410	2901	2.68												
H450x260	450	31.5	450	12.5	260.5	331.88	130404	5795.7	6400.3	19.82	47847	2126.5	3204.5	12.01	964.9	20950045	3200	2.68												
H450x285	450	35	450	12.5	284.6	362.50	141665	6296.2	6987.5	19.77	53162	2362.8	3558.6	12.11	1313.3	22889751	3494	2.68												
H450x312	450	37.5	450	16	312.0	397.50	150996	6710.9	7523.4	19.49	56966	2531.8	3820.9	11.97	1638.4	24232770	3762	2.67												
H450x319	450	40	450	12.5	318.9	406.25	157046	6979.8	7807.8	19.66	60756	2700.3	4064.5	12.23	1946.7	25532718	3904	2.68												
H450x368	450	44.5	450	19	368.2	469.09	172746	7677.6	8739.2	19.19	67603	3001.7	4538.2	12.00	2736.3	27790771	4370	2.66												
H450x378	425	50	450	16	377.6	481.00	176602	7849.0	8990.0	19.63	63983	3011.0	4538.0	11.53	3596.3	25593320	4495	2.57												
H450x397	450	50	450	16	397.2	506.00	186654	8295.7	9490.0	19.21	75949	3375.5	5084.9	12.25	3804.6	30379779	4745	2.67												
H450x422	450	50	450	25	421.9	537.50	189870	8438.7	9765.6	18.79	75983	3373.0	5177.2	11.89	3958.3	30393229	4883	2.65												
I500x80	200	16	500	8	79.6	101.44	44328	1773.1	1986.8	20.90	2135	213.5	327.5	4.59	62.9	1250535	993	1.78												
I500x89	300	12.5	500	8	88.7	113.00	51715	2068.6	2279.4	21.39	5627	375.1	570.1	7.06	47.4	3343245	1140	2.18												
I500x98	250	16	500	9.5	97.7	124.46	45983	2199.3	2456.2	21.02	4170	333.6	510.6	5.79	82.1	2442125	1228	1.98												

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Table 5 – Properties and dimensions of welded I / H profiles (4/8)

Name	Dimensions (mm)										X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	J (cm ⁴)	C _w (cm ⁶)	Q _w (cm ³)	u (m ² /m)												
H500x117	350	16	500	8	117.3	149.44	724.49	2898.0	3148.4	22.02	11435	653.4	987.5	8.75	103.8	6696987	1574	2.38												
H500x124	300	19	500	9.5	123.9	157.89	737.79	2951.2	3248.6	21.62	8553	570.2	865.4	7.36	150.9	4947251	1624	2.18												
H500x130	400	16	500	8	129.9	165.44	818.23	3272.9	3535.6	22.24	17069	853.4	1287.5	10.16	117.5	9996092	1768	2.58												
H500x135	300	19	500	12.5	134.8	171.75	762.44	3049.8	3408.7	21.07	8558	570.5	873.0	7.06	188.5	4949691	1704	2.18												
H500x146	375	19	500	9.5	146.3	186.39	902.72	3610.9	3934.1	22.01	16703	890.8	1346.4	9.47	185.2	9660779	1967	2.48												
H500x171	475	19	500	8	170.7	217.46	1110.30	4441.2	4767.9	22.60	33940	1429.0	2150.8	12.49	225.4	19630826	2384	2.88												
H500x191	400	25	500	9.5	190.6	242.75	1201.31	4805.2	5230.9	22.25	26670	1333.5	2010.2	10.48	430.2	15043480	2615	2.58												
H500x220	475	25	500	9.5	220.0	280.25	1413.00	5652.1	6121.6	22.45	44658	1880.3	2830.5	12.62	508.4	25189995	3061	2.88												
H500x233	500	22.4	500	16	233.0	296.83	1404.07	5616.3	6177.9	21.75	46682	1867.3	2829.1	12.54	439.9	26620732	3089	2.97												
H500x242	475	28	500	9.5	241.9	308.18	1552.84	6210.2	6745.8	22.45	50017	2106.0	3168.8	12.74	708.6	27857509	3373	2.88												
H500x276	500	28	500	16	275.6	351.04	1678.02	6712.1	7396.5	21.86	58348	2333.9	3528.4	12.89	796.2	32497774	3698	2.97												
H500x278	475	31.5	500	12.5	277.8	353.88	1731.48	6925.9	7606.7	22.12	56272	2369.4	3570.7	12.61	1020.3	30878360	3803	2.88												
H500x302	500	31.5	500	16	302.2	384.92	1842.38	7369.5	8142.8	21.88	65640	2625.6	3965.5	13.06	1105.8	36018632	4071	2.97												
H500x303	475	35	500	12.5	303.2	386.25	1883.58	7534.3	8308.4	22.08	62524	2632.6	3965.2	12.72	1388.0	33798090	4154	2.88												
H500x329	500	35	500	16	328.8	418.80	2001.55	8006.2	8877.1	21.86	72931	2917.3	4402.5	13.20	1492.7	39423950	4439	2.97												
H500x340	475	40	500	12.5	339.5	432.50	2092.44	8369.8	9291.3	22.00	71455	3008.6	4528.9	12.85	2056.6	37799564	4646	2.88												
H500x348	500	37.5	500	16	347.8	443.00	2112.12	8448.5	9394.4	21.84	78140	3125.6	4714.7	13.28	1821.0	41786322	4697	2.97												
H500x355	500	40	500	12.5	355.2	452.50	2198.51	8794.0	9751.3	22.04	83340	3333.6	5016.4	13.57	2163.3	44086950	4876	2.98												
H500x390	500	44.5	500	12.5	389.7	496.38	2387.88	9551.5	10662.8	21.93	92715	3709.3	5578.6	13.67	2967.0	48091340	5331	2.98												
H500x411	500	44.5	500	19	410.6	523.09	2425.49	9701.9	10937.2	21.53	92732	3709.3	5599.6	13.31	3041.5	48100056	5469	2.96												
H500x452	500	50	500	19	452.2	576.00	2643.00	10572.0	12010.0	21.42	104190	4167.6	6286.1	13.45	4269.6	52745950	6005	2.96												
H500x463	500	50	500	22.4	462.8	589.60	2661.13	10644.5	12146.0	21.24	104204	4188.2	6300.2	13.29	4353.3	52753342	6073	2.96												
H500x502	500	50	500	35	502.4	640.00	2728.33	10913.3	12650.0	20.65	104310	4172.4	6372.5	12.77	4809.8	52806727	6325	2.93												
H500x550	500	50	500	50	549.5	700.00	2808.33	11233.3	13250.0	20.03	104583	4183.3	6500.0	12.22	6041.7	52945313	6625	2.90												
H500x98	300	12.5	550	9.5	98.0	124.88	656.95	2386.7	2670.2	22.93	5629	375.3	574.3	6.71	54.4	4065453	1335	2.28												
H500x128	300	19	550	9.5	127.7	162.64	910.19	3309.8	3649.3	23.66	8554	570.2	866.6	7.25	152.4	6029495	1825	2.28												
H500x158	400	19	550	9.5	157.5	200.64	1178.16	4284.2	4658.2	24.23	20270	1013.5	1531.6	10.05	198.1	14288603	2329	2.68												
H500x172	450	19	550	9.5	172.4	219.64	1312.15	4771.5	5162.6	24.44	28860	1282.7	1995.3	11.46	220.9	20343421	2581	2.88												
H500x208	450	22.4	550	12.5	207.8	264.75	1538.10	5593.1	6115.8	24.10	34028	1512.4	2287.7	11.34	371.5	23680390	3058	2.88												
H500x225	500	22.4	550	12.5	225.4	287.15	1694.08	6160.3	6706.7	24.29	46675	1867.0	2819.7	12.75	409.0	32481261	3353	3.08												
H500x257	500	22.4	550	16	256.9	327.23	1887.66	6864.2	7520.9	24.02	62131	2259.3	3420.3	13.78	484.1	43236942	3760	3.27												
H500x268	500	28	550	12.5	268.3	341.75	2034.79	7399.3	8070.6	24.40	58341	2333.7	3519.3	13.07	765.7	39742727	4035	3.08												
H500x279	550	25	550	16	278.7	355.00	2065.02	7901.9	8218.8	24.11	69340	2521.5	3813.3	13.98	644.6	4779582	4109	3.27												
H500x295	500	31.5	550	12.5	295.1	375.88	2240.95	8145.6	8907.5	24.41	65633	2625.3	3956.5	13.21	1075.6	44112259	4454	3.08												
H500x304	550	28	550	16	303.8	387.04	2260.88	8221.4	9014.9	24.17	77659	2823.9	4266.6	14.17	876.2	52901766	4507	3.27												
H500x333	550	31.5	550	16	333.2	424.42	2485.71	9039.0	9931.7	24.20	87363	3176.9	4795.5	14.35	1216.8	58717498	4966	3.27												
H500x383	550	37.5	550	16	383.5	485.20	2856.37	10386.8	11472.8	24.18	104001	3781.8	5702.3	14.59	2003.6	68291011	5736	3.27												
H500x404	550	40	550	16	404.4	515.20	3005.40	10928.7	12103.6	24.15	110933	4033.9	6080.1	14.67	2416.3	72133994	6052	3.27												
H500x442	550	44.5	550	16	442.2	563.26	3265.76	11875.5	13222.2	24.08	123411	4487.7	6760.1	14.80	3300.1	78837807	6611	3.27												
H500x453	550	44.5	550	19	453.0	577.09	3290.25	11964.6	13381.6	23.88	123421	4488.0	6772.2	14.62	3346.7	78844588	6691	3.26												

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Table 6 – Properties and dimensions of welded I / H profiles (5/8)

Name	Dimensions (mm)				kg/m	Area (cm ²)	X axis						Y axis					
	b ₁	t ₁	d	t _w			t _w	l _x	W _x	Z _x	r _x	I _y	W _y	Z _y	r _y	J	C _w	O _w
H550x475	550	44.5	550	25	474.7	604.75	333924	12142.7	13700.4	23.50	123455	4489.3	6802.7	14.29	3494.4	78866101	6850	3.25
H550x488	550	50	550	16	488.3	622.00	357046	12983.5	14560.0	23.96	138661	5042.2	7591.3	14.93	4651.6	86663246	7280	3.27
H550x499	550	50	550	19	498.9	635.50	359324	13066.3	14711.9	23.78	138672	5042.6	7603.1	14.77	4697.7	86699722	7356	3.26
H550x520	550	50	550	25	520.1	662.50	363880	13232.0	15015.6	23.44	138704	5043.8	7632.8	14.47	4843.8	86690267	7508	3.25
H550x573	550	50	550	40	573.1	730.00	375271	13646.2	15775.0	22.67	138886	5050.4	7742.5	13.79	5650.0	86803646	7888	3.22
H600x102	225	19	600	8	102.4	130.46	84013	2800.4	3115.5	25.38	3609	320.8	489.9	5.26	112.8	3046006	1558	2.08
H600x130	250	19	600	12.5	129.7	165.25	98689	3289.6	3746.8	24.44	4957	396.6	615.7	5.48	152.1	4183279	1873	2.18
H600x156	400	16	600	12.5	156.2	199.00	128254	4275.1	4745.8	25.39	17076	853.8	1302.2	9.26	147.2	14559605	2373	2.78
H600x162	275	25	600	12.5	161.9	206.25	131055	4368.5	4898.4	25.21	8674	630.9	966.8	6.49	323.9	7169865	2449	2.28
H600x189	450	19	600	12.5	189.4	241.25	162849	5428.3	5954.6	25.98	28865	1282.9	1945.7	10.94	243.6	24359581	2977	2.98
H600x201	300	31.5	600	12.5	201.1	256.13	168995	5633.2	6273.5	25.69	14184	945.6	1438.5	7.44	662.1	11460187	3137	2.38
H600x230	500	22.4	600	12.5	230.3	293.40	204749	6825.0	7432.4	26.42	46676	1867.0	2812.7	12.61	412.3	38930076	3716	3.18
H600x248	550	22.4	600	12.5	247.9	315.80	223441	7448.0	8079.3	26.60	62122	2259.0	3409.7	14.03	449.7	51813436	4040	3.38
H600x270	550	25	600	12.5	269.8	343.75	244779	8159.3	8851.6	26.68	69332	2521.2	3802.7	14.20	610.4	57307123	4426	3.38
H600x310	550	28	600	16	310.1	395.04	273598	9119.9	9992.5	26.32	77660	2824.0	4269.8	14.02	883.0	63522966	4996	3.37
H600x318	600	25	600	19	317.5	404.50	274468	9148.9	10061.9	26.05	90031	3001.0	4549.6	14.92	766.5	74416610	5031	3.56
H600x345	600	28	600	19	344.9	439.36	300544	10018.1	11015.3	26.15	100831	3361.0	5089.1	15.15	1008.9	82475802	5508	3.56
H600x364	600	31.5	600	16	364.2	463.92	326376	10879.2	11898.1	26.52	113418	3780.6	5704.4	15.64	1327.9	91639813	5949	3.57
H600x396	600	35	600	16	396.3	504.80	355465	11848.8	12988.6	26.54	126018	4200.6	6333.9	15.80	1792.1	100570312	6494	3.57
H600x419	600	37.5	600	16	419.2	534.00	375778	12525.9	13758.8	26.53	135018	4500.6	6783.6	15.90	2186.2	106801284	6879	3.57
H600x454	600	40	600	19	454.4	578.80	399223	13307.4	14724.4	26.26	144030	4801.0	7246.9	15.77	2688.0	112919302	7362	3.56
H600x495	600	44.5	600	19	495.4	631.09	433963	14465.4	16072.2	26.22	160229	5341.0	8056.1	15.93	3651.9	123608923	8036	3.56
H600x509	600	44.5	600	22.4	509.0	648.46	437743	14591.4	16294.1	25.98	160248	5341.6	8074.1	15.72	3733.0	123623313	8147	3.56
H600x546	600	50	600	19	545.6	695.00	474792	15826.4	17687.5	26.14	180029	6001.0	9045.1	16.09	5125.7	136146613	8944	3.56
H600x569	600	50	600	25	569.1	725.00	481042	16034.7	18062.5	25.76	180065	6002.2	9078.1	15.76	5286.5	136174235	9031	3.55
H600x608	600	50	600	35	608.4	775.00	491458	16381.9	18687.5	25.18	180179	6006.0	9153.1	15.25	5786.0	136260101	9344	3.53
H600x667	600	50	600	50	667.3	850.00	507083	16902.8	19625.0	24.42	180521	6017.4	9312.5	14.57	7291.7	136518880	9813	3.50
H600x134	350	16	650	9.5	134.0	170.71	131257	4038.7	4457.5	27.73	11438	653.6	993.9	8.19	113.7	11493679	2229	2.68
H600x180	450	19	650	9.5	179.9	229.14	188412	5797.3	6284.6	28.68	28861	1282.7	1937.6	11.22	223.8	28727936	3142	3.08
H600x203	450	22.4	650	9.5	203.4	259.09	216149	6650.7	7196.1	28.88	34024	1512.2	2281.7	11.46	355.1	33503902	3598	3.08
H600x221	500	22.4	650	9.5	221.0	281.49	238216	7329.7	7899.0	29.09	46671	1866.8	2813.7	12.88	392.6	49597130	3950	3.28
H600x253	550	22.4	650	12.5	252.8	322.05	265284	8179.2	8876.6	28.73	62123	2259.0	3411.6	13.89	453.0	61172972	4438	3.48
H600x300	550	28	650	12.5	300.1	382.25	319934	9844.1	10681.4	28.93	77651	2823.7	4258.2	14.25	845.4	75105147	5341	3.48
H600x322	600	28	650	12.5	322.0	410.25	347034	10678.0	11552.2	29.08	100810	3360.3	5063.2	15.68	918.6	97504119	5776	3.68
H600x354	600	31.5	650	12.5	354.3	451.38	382884	11781.0	12766.4	29.12	113410	3780.3	5692.9	15.85	1290.5	108459865	6383	3.68
H600x374	650	28	650	19	374.3	476.86	385486	11861.1	12996.4	28.43	128192	3944.4	5968.6	16.40	1095.5	123988860	6498	3.86
H600x403	600	35	650	16	402.5	512.80	423580	13033.2	14260.6	28.74	126020	4200.7	6370.1	15.68	1799.0	119159595	7130	3.67
H600x409	650	31.5	650	19	409.0	521.03	423991	13045.9	14300.5	28.53	144212	4437.3	6307.4	16.64	1495.8	137917648	7150	3.86
H600x444	650	35	650	19	443.7	565.20	461588	14202.7	15589.2	28.58	160231	4930.2	7446.1	16.84	1998.5	151508490	7795	3.86
H600x493	650	40	650	19	493.2	628.30	513746	15807.6	17403.3	28.60	183116	5634.3	8501.4	17.07	2912.8	170343579	8702	3.86

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Table 7 – Properties and dimensions of welded I / H profiles (6/8)

Name	Dimensions (mm)										X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ²)	r _x (cm)	I _y (cm ⁴)	W _y (cm ²)	Z _y (cm ²)	r _y (cm)	J (cm ⁴)	C _w (cm ³)	Q _w (cm ²)	u (m ² /m)												
H650x338	650	44.5	650	19	537.8	685.09	559149	17204.6	19009.0	28.57	203712	6268.1	9451.3	17.24	3957.0	186717705	9505	3.86												
H650x553	650	44.5	650	22.4	552.8	704.16	564151	17358.5	19276.5	28.30	203733	6268.7	9471.0	17.01	4045.4	186736475	9638	3.86												
H650x592	650	50	650	19	592.3	754.50	612697	18852.2	20936.9	28.50	228886	7042.6	10612.1	17.42	5553.8	205997043	10468	3.86												
H650x619	650	44.5	650	37.5	619.3	788.88	586368	18042.1	20464.6	27.26	203977	6274.7	9597.9	16.08	4882.9	186914281	10232	3.83												
H650x631	650	50	650	28	631.1	804.00	625175	19236.2	21617.5	27.89	228955	7044.8	10670.3	16.88	5855.7	206059502	10809	3.84												
H650x672	650	50	650	37.5	672.2	856.25	688346	19641.4	22335.9	27.30	229096	7049.1	10755.9	16.36	6471.4	206186279	11168	3.83												
H650x726	650	50	650	50	726.1	925.00	655677	20174.7	23281.3	26.62	229427	7059.3	10906.3	15.75	7916.7	206484375	11641	3.80												
H700x105	250	16	700	8	104.8	133.44	113460	3241.7	3628.4	29.16	4170	333.6	510.7	5.59	79.9	4876634	1814	2.38												
H700x137	250	22.4	700	9.5	136.8	174.24	150874	4310.7	4814.1	29.43	5838	467.0	714.8	5.79	206.7	6701191	2407	2.38												
H700x159	300	25	700	8	158.6	202.00	189246	5407.0	5907.5	30.61	11253	750.2	1135.4	7.46	324.0	12817612	2954	2.58												
H700x172	350	22.4	700	9.5	171.9	219.04	202316	5780.5	6331.9	30.39	16011	914.9	1386.8	8.55	281.6	18378696	3166	2.78												
H700x199	450	19	700	12.5	199.2	253.75	228530	6529.4	7192.1	30.01	28867	1283.0	1949.6	10.67	250.1	33468501	3596	3.18												
H700x221	400	25	700	12.5	220.8	281.25	256523	7329.2	8070.3	30.20	26677	1333.9	2025.4	9.74	460.6	30387051	4035	2.98												
H700x240	450	25	700	12.5	240.4	306.25	285013	8143.2	8914.1	30.51	37979	1688.0	2556.6	11.14	512.7	43260830	4457	3.18												
H700x285	450	31.5	700	12.5	285.1	363.13	343894	9825.5	10744.0	30.77	47851	2126.7	3214.3	11.48	981.2	53460595	5372	3.18												
H700x326	450	35	700	16	326.4	415.80	381913	10911.8	12061.4	30.31	53178	2363.5	3584.1	11.31	1377.0	58791331	6031	3.17												
H700x391	450	44.5	700	16	391.1	498.26	461291	13179.8	14619.7	30.43	67605	3004.7	4544.7	11.65	2733.1	72621581	7310	3.17												
H750x143	300	19	750	9.5	142.6	181.64	180902	4824.1	5370.7	31.56	8555	570.3	871.1	6.86	158.1	11428762	2885	2.68												
H750x176	350	22.4	750	9.5	175.7	223.79	235355	6276.1	6885.5	32.43	16012	915.0	1387.9	8.46	283.0	21191562	3443	2.88												
H750x210	400	22.4	750	12.5	209.9	267.35	273778	7300.8	8073.4	32.00	23905	1195.2	1819.5	9.46	347.1	31638123	4037	3.08												
H750x227	450	22.4	750	12.5	227.5	289.75	303434	8091.6	8888.3	32.36	34031	1512.5	2295.5	10.84	384.6	45040811	4444	3.28												
H750x245	450	25	750	12.5	245.3	312.50	331510	8840.3	9687.5	32.57	37980	1688.0	2558.6	11.02	516.0	49908282	4844	3.28												
H750x266	450	28	750	12.5	265.9	338.75	363392	9690.4	10602.3	32.75	42536	1890.5	2862.1	11.21	705.6	55433726	5301	3.28												
H750x290	450	31.5	750	12.5	290.0	369.38	399896	10663.9	11659.6	32.90	47852	2126.7	3216.2	11.38	984.5	61757811	5830	3.28												
H750x320	400	37.5	750	16	320.3	408.00	422100	11256.0	12510.0	32.16	40023	2001.2	3043.2	9.90	1503.5	50794866	6255	3.07												
H750x350	450	37.5	750	16	349.7	445.50	469737	12596.3	13845.9	32.47	56976	2532.3	3840.1	11.31	1679.3	72310766	6923	3.27												
H750x397	450	44.5	750	16	397.4	506.26	57521	14333.9	15875.3	32.58	67607	3004.8	4547.9	11.56	2740.0	84125044	7938	3.27												
H800x146	300	19	800	9.5	146.3	186.39	208901	5222.5	5830.7	33.48	8555	570.4	872.2	6.78	159.5	13046218	2915	2.78												
H800x179	320	25	800	8	172.7	220.00	268458	6711.5	7325.0	34.93	13657	853.5	1292.0	7.88	346.6	20506138	3663	2.86												
H800x199	350	22.4	800	9.5	199.4	228.54	271191	6779.8	7450.9	34.45	16012	915.0	1389.0	8.37	284.5	24204705	3725	2.98												
H800x209	350	28	800	9.5	209.3	266.68	324763	8119.1	8880.2	34.90	20014	1143.6	1731.8	8.66	534.3	29819537	4440	2.98												
H800x232	450	22.4	800	12.5	232.4	296.00	349700	8742.5	9620.5	34.37	34032	1512.5	2297.5	10.72	387.8	51445063	4810	3.38												
H800x250	500	22.4	800	12.5	249.9	318.40	383570	9589.2	10491.4	34.71	46679	1867.2	2829.5	12.11	425.3	70562453	5246	3.58												
H800x270	500	25	800	12.5	269.8	343.75	419466	10486.7	11445.3	34.93	52096	2038.8	3154.3	12.31	571.3	78224710	5723	3.58												
H800x295	450	31.5	800	12.5	294.9	375.63	460516	11512.9	12590.9	35.01	47853	2126.8	3218.2	11.29	987.7	70653467	6295	3.38												
H800x319	450	35	800	12.5	318.9	406.25	501709	12542.7	13714.1	35.14	53168	2363.0	3572.3	11.44	1336.1	77788299	6857	3.38												
H800x346	500	35	800	12.5	346.4	441.25	552952	13823.8	15028.8	35.40	72929	2917.1	4403.5	12.86	1479.0	106699024	7526	3.58												
H800x385	500	37.5	800	16	385.4	491.00	596318	14908.0	16399.4	34.85	78150	3126.0	4733.9	12.62	1861.9	113591878	8200	3.57												

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Table 8 – Properties and dimensions of welded I / H profiles (7/8)

Name	Dimensions (mm)				X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ²)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ²)	r _y (cm)	J (cm ⁴)	C _w (cm ³)	O _w (cm ²)	u (m ² /m)						
1800x404	500	40	800	16	404.4	515.20	627900	15697.5	17273.6	34.91	83358	3334.3	5046.1	12.72	2237.1	120368821	8637	3.57						
1800x439	500	44.5	800	16	438.6	588.76	683651	17091.3	18832.0	34.98	92733	3709.3	5608.0	12.88	3040.5	132224845	9416	3.57						
1800x480	500	50	800	16	480.4	612.00	749900	18747.5	20710.0	35.00	104191	4167.6	6294.8	13.05	4269.1	146517975	10355	3.57						
1850x181	400	16	850	12.5	180.7	230.25	279620	6579.3	7428.6	34.85	17080	854.0	1312.0	8.61	163.5	29700207	3714	3.28						
1850x214	450	19	850	12.5	213.9	272.50	351036	8259.7	9165.5	35.89	28669	1283.1	1955.5	10.29	259.9	49840319	4583	3.48						
1850x255	500	22.4	850	12.5	254.9	324.65	438030	10306.6	11295.2	36.73	46880	1867.2	2831.5	11.99	428.5	79929979	5648	3.68						
1850x294	550	25	850	12.5	294.4	375.00	521406	12268.4	13343.8	37.29	69336	2521.3	3812.5	13.60	626.6	117979431	6672	3.88						
1850x320	550	28	850	12.5	319.7	407.25	572620	13473.4	14628.9	37.50	77655	2823.8	4266.0	13.81	858.4	131174910	7314	3.88						
1850x362	550	37.5	850	16	362.3	461.50	619467	14575.7	16113.4	36.64	56980	2532.4	3846.5	11.11	1693.0	94038562	8057	3.47						
1850x400	550	35	850	16	400.2	509.80	702983	16540.8	18122.4	37.13	97079	3530.1	5343.7	13.80	1683.4	161205261	9061	3.87						
1850x442	550	40	850	16	442.1	563.20	783168	18427.5	20191.6	37.29	110943	4034.3	6099.3	14.04	2573.3	181974173	10096	3.87						
1850x480	550	44.5	850	16	479.8	611.26	853575	20084.1	22031.1	37.37	123421	4488.0	6779.3	14.21	3341.1	200197818	11016	3.87						
1850x526	550	50	850	16	526.0	670.00	937396	22056.4	24250.0	37.40	138671	5042.6	7610.5	14.39	4692.6	221874293	12125	3.87						
1900x189	350	19	900	12.5	189.0	240.75	324833	7218.5	8180.7	36.73	13591	776.6	1197.4	7.51	217.4	26372230	4090	3.18						
1900x259	400	28	900	12.5	258.7	329.50	488588	10857.5	11922.5	38.51	29880	1494.0	2273.0	9.52	642.2	56801452	5996	3.38						
1900x280	400	31.5	900	12.5	280.0	356.63	536498	11922.1	13132.4	38.79	33614	1680.7	2522.7	9.71	890.0	63386238	6566	3.38						
1900x305	450	31.5	900	12.5	304.7	388.13	595920	13242.7	14500.3	39.18	47854	2126.9	3222.1	11.10	994.2	90240221	7250	3.58						
1900x348	550	28	900	16	347.8	443.04	665858	14796.9	16278.1	38.77	77670	2824.4	4289.0	13.24	924.0	147648467	8139	3.97						
1900x377	550	31.5	900	16	377.1	480.42	731876	16263.9	17849.0	39.03	87375	3177.3	4817.9	13.49	1264.6	164766552	8925	3.97						
1900x406	550	35	900	16	406.5	517.80	796798	17706.6	19406.9	39.23	97080	3530.2	5346.9	13.69	1690.2	181594982	9703	3.97						
1900x427	550	37.5	900	16	427.4	544.50	842505	18722.3	20511.6	39.34	104013	3782.3	5724.7	13.82	2051.4	193438937	10256	3.97						
1900x468	550	40	900	19	467.7	595.80	901447	20032.1	22113.9	38.90	110964	4035.0	6124.0	13.65	2543.3	205171579	11057	3.96						
1900x512	500	50	900	19	511.8	652.00	985233	21894.1	24290.0	38.87	104212	4168.5	6322.2	12.64	4361.0	182336655	12145	3.76						
1900x551	550	50	900	19	551.1	702.00	1075650	23903.3	26415.3	39.14	138692	5043.3	7634.7	14.06	4777.7	250511650	13208	3.96						
1950x212	350	22.4	950	12.5	211.9	269.95	414620	8728.8	9833.0	39.19	16021	915.5	1407.4	7.70	322.6	34463703	4916	3.28						
1950x245	400	25	950	12.5	245.3	312.50	503854	10607.5	11781.3	40.15	26681	1334.1	2035.2	9.24	476.9	57073001	5891	3.48						
1950x279	350	35	950	12.5	278.7	355.00	584037	12295.5	13628.8	40.56	25025	1480.0	2178.1	8.40	1060.0	52378344	6814	3.28						
1950x349	600	25	950	16	348.5	444.00	739075	15559.5	17115.0	40.80	90031	3001.0	4557.6	14.24	751.3	192581337	8558	4.27						
1950x376	600	28	950	16	376.0	479.04	809559	17043.3	18686.5	41.11	100831	3361.0	5097.2	14.51	1004.0	214286019	9343	4.27						
1950x413	550	35	950	16	412.8	525.80	897085	18886.0	20711.4	41.31	97082	3530.3	5350.1	13.59	1697.0	203198946	10356	4.07						
1950x461	600	35	950	19	461.0	587.20	987415	20787.7	22893.4	41.01	126050	4201.7	6379.4	14.65	1924.2	263831155	11447	4.26						
1950x507	600	40	950	19	506.6	645.30	1096623	23128.9	25495.3	41.26	144050	4801.7	7287.5	14.94	2768.1	298218949	12718	4.26						
1950x548	600	44.5	950	19	547.6	697.59	1196549	25190.5	27698.1	41.42	160249	5341.6	8087.7	15.16	3731.9	328482944	13849	4.26						
1950x588	600	44.5	950	25	588.2	749.25	1228463	25862.4	28810.1	40.49	160312	5343.7	8144.5	14.63	3996.5	328611870	14405	4.25						
11000x195	400	16	1000	12.5	195.5	249.00	404352	8087.0	9225.8	40.30	17082	854.1	1317.8	8.28	173.3	41350394	4613	3.58						
11000x199	350	19	1000	12.5	198.8	253.25	412762	8255.2	9415.7	40.37	13593	776.7	1201.3	7.33	223.9	32702809	4708	3.38						
11000x210	350	16	1000	16	209.5	266.88	392074	7841.5	9258.5	38.33	11466	655.2	1042.0	6.55	229.9	27755965	4629	3.37						
11000x234	400	22.4	1000	12.5	234.4	298.60	519014	10380.3	11610.6	41.69	23909	1195.4	1829.3	8.95	363.4	57124397	5805	3.58						

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Table 9 – Properties and dimensions of welded I / H profiles (8/8)

Name	Dimensions (mm)										X axis										Y axis									
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm)	r _y (cm)	J (cm ⁴)	C _w (cm ⁵)	O _w (cm ²)	u (m ² /m)												
I1000x240	400	19	1000	16	240.1	305.92	484447	9688.9	11157.4	39.79	20300	1015.0	1581.6	8.15	316.8	48838625	5579	3.57												
I1000x270	450	25	1000	12.5	269.8	343.75	624154	12483.1	13789.1	42.61	37984	1688.2	2568.4	10.51	532.2	90271854	6895	3.78												
I1000x276	400	25	1000	16	276.3	352.00	589733	11794.7	13360.0	40.93	26699	1335.0	2060.8	8.71	549.8	63452064	6680	3.57												
I1000x290	450	28	1000	12.5	290.5	370.00	683007	13660.1	15032.0	42.96	42540	1890.7	2871.9	10.72	721.8	100478640	7516	3.78												
I1000x296	500	22.4	1000	16	295.8	376.83	651491	13029.8	14598.7	41.58	46699	1868.0	2861.1	11.13	508.1	111576438	7299	3.97												
I1000x316	500	25	1000	16	315.6	402.00	708588	14171.8	15797.5	41.98	52116	2084.6	3185.8	11.39	654.0	123856361	7899	3.97												
I1000x336	550	22.4	1000	19	335.9	427.89	726808	14536.2	16378.0	41.21	62168	2260.7	3474.2	12.05	635.6	148535003	8189	4.16												
I1000x339	500	31.5	1000	12.5	339.2	432.13	824623	16492.5	17997.5	43.68	65640	2625.6	3974.1	12.32	1104.9	153925116	8999	3.98												
I1000x352	400	37.5	1000	16	351.7	448.00	800683	16013.7	17860.0	42.28	40032	2001.6	3059.2	9.45	1537.7	92713749	8930	3.57												
I1000x360	550	28	1000	16	360.3	459.04	839489	16797.0	18533.3	42.77	77674	2824.5	4295.4	13.01	937.6	183462618	9267	4.17												
I1000x361	550	22.4	1000	22.4	361.4	460.36	751501	15030.0	17153.5	40.40	62203	2130.2	3306.9	9.86	1300.5	112391137	9323	3.76												
I1000x387	450	31.5	1000	22.4	387.3	483.39	818599	16372.0	18645.1	40.73	47928	2130.2	3306.9	9.86	1300.5	112391137	9323	3.76												
I1000x390	550	31.5	1000	16	389.7	496.42	922510	18450.2	20291.1	43.11	87379	3177.4	4824.3	13.27	1278.3	204901729	10146	4.17												
I1000x411	500	37.5	1000	16	410.6	523.00	974472	19489.4	21469.4	43.17	78157	3126.3	4746.7	12.22	1889.2	181011845	10735	3.97												
I1000x419	550	35	1000	16	419.0	533.80	1003945	20078.9	22035.9	43.37	97084	3530.3	5353.3	13.49	1705.8	226017218	11018	4.17												
I1000x441	550	35	1000	19	440.9	561.70	1024054	20481.1	22684.5	42.70	97105	3531.1	5377.7	13.15	1792.7	226067069	11342	4.16												
I1000x446	450	37.5	1000	25	446.5	568.75	946937	18938.7	21589.8	40.80	57074	2536.6	3941.4	10.02	2083.3	132182275	10795	3.75												
I1000x449	550	28	1000	28	427.3	544.32	857819	17156.4	19846.0	39.70	58506	2340.2	3685.0	10.37	1443.0	138188885	9923	3.94												
I1000x479	500	31.5	1000	31.5	479.0	610.16	954877	19097.5	22167.9	39.56	65869	2634.8	4169.9	10.39	2050.9	154461661	11084	3.94												
I1000x483	550	40	1000	19	482.6	614.80	1137639	22752.8	25140.4	43.02	110969	4035.2	6133.0	13.43	2566.2	255673157	12570	4.16												
I1000x514	600	40	1000	19	514.0	654.80	1229852	24597.0	27060.4	43.34	144053	4801.8	7283.0	14.83	2779.5	331897157	13530	4.36												
I1000x519	450	37.5	1000	35	519.1	661.25	1012891	20257.8	23728.9	39.14	57284	2545.9	4080.2	9.31	2957.6	132669758	11864	3.73												
I1000x528	500	44.5	1000	25	528.1	672.75	1173937	23478.7	26446.9	41.77	92827	3713.1	5704.8	11.75	3435.0	211872937	13223	3.95												
I1000x545	650	37.5	1000	22.4	545.3	694.70	1277367	25547.3	28252.4	42.88	171727	5283.9	8037.9	15.72	2645.8	397723023	14126	4.56												
I1000x553	450	40	1000	37.5	553.4	705.00	1073260	21465.2	23215.0	39.02	61154	2718.0	4373.4	9.31	3607.5	140899500	12608	3.73												
I1000x570	650	40	1000	22.4	570.0	726.08	1344128	26882.6	29698.8	43.03	183170	5636.0	8565.4	13.88	3133.0	422022533	14850	4.56												
I1000x585	500	40	1000	37.5	584.8	745.00	1165473	23309.5	27135.0	39.55	83738	3349.5	5323.4	10.60	3820.8	192931500	13568	3.93												
I1500x473	500	37.5	1500	16	473.4	603.00	2391483	31886.4	35544.4	62.98	78174	3126.9	4778.7	11.39	1957.5	418015218	17772	4.97												
I1500x597	500	44.5	1500	22.4	597.4	761.06	2881936	38425.7	43534.0	61.04	92840	3713.6	5739.5	11.04	3482.7	491701862	17167	4.96												
I1500x817	600	50	1500	31.5	817.2	1041.00	3875300	51670.7	58935.0	61.01	180365	6012.2	9347.3	13.16	6510.7	948041701	29468	5.34												
I1500x935	750	50	1500	31.5	934.9	1191.00	4664050	62187.3	69810.0	62.58	351927	9384.7	14409.8	17.19	7760.7	1849817092	34905	5.94												
I1500x974	800	50	1500	31.5	974.2	1241.00	4928967	65692.9	73435.0	63.01	427031	10675.8	16547.3	18.55	8177.4	2244583368	36718	6.14												



PETROBRAS

TECHNICAL SPECIFICATION

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4.3.1.2.W / HP

Rolled profiles from Catálogo Perfis Estruturais Gerdau - Tabela de bitolas [3] and ABNT NBR 15980:2011 [1] and cover a range of height from 148mm to 628mm. Table 10 to Table 13 present their properties and dimensions.

Table 10 – Properties and dimensions of welded W / HP profiles (1/4)

Name	Dimensions (mm)					X axis										Y axis				
	b _r	t _r	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm)	r _y (cm)	J (cm ⁴)	C _w (cm ⁵)	O _w (cm ²)	u (m ² /m)		
W150x13	100	4,9	148	4,3	13,0	15,74	596	80,6	90,7	6,16	82	16,4	25,1	2,28	1,2	4186	45	0,69		
W150x13,5	100	5,5	150	4,3	13,5	16,98	671	89,4	100,2	6,29	92	18,4	28,1	2,32	1,5	4790	50	0,69		
W150x18	102	7,1	153	5,8	18,0	22,53	901	117,7	133,6	6,32	126	24,7	38,1	2,36	3,4	6695	67	0,70		
W150x22,5	152	6,6	152	5,8	22,5	28,11	1190	156,6	173,8	6,51	387	50,9	77,4	3,71	3,9	20429	87	0,90		
W150x24	102	10,3	160	6,6	24,0	30,21	1328	166,0	189,3	6,63	183	35,8	55,1	2,46	8,9	10225	95	0,71		
W150x29,8	153	9,3	157	6,6	29,8	37,59	1700	216,5	241,8	6,72	555	72,6	110,4	3,84	9,6	30295	121	0,91		
W150x37,1	154	11,6	162	8,1	37,1	46,97	2205	272,2	307,7	6,85	707	91,8	139,8	3,88	18,7	39965	154	0,92		
W200x15	100	5,2	200	4,3	15,0	18,55	1231	123,1	139,9	8,15	87	17,4	26,9	2,16	1,5	8234	70	0,79		
W200x19,3	102	6,5	203	5,8	19,3	24,28	1612	158,8	182,6	8,15	115	22,6	35,4	2,18	3,1	11127	91	0,80		
W200x22,5	102	8	206	6,2	22,5	28,10	1955	189,8	217,5	8,34	142	27,8	43,4	2,25	5,1	13905	109	0,81		
W200x26,6	133	8,4	207	5,8	26,6	33,38	2537	245,1	274,3	8,72	330	49,6	75,9	3,14	6,5	32508	137	0,93		
W200x31,3	134	10,2	210	6,4	31,3	39,47	3094	294,7	330,6	8,85	409	61,1	93,5	3,22	11,2	40863	165	0,94		
W200x35,9	165	10,2	201	6,2	35,9	44,86	3371	335,4	371,7	8,67	764	92,6	140,6	4,13	13,2	69535	186	1,05		
W200x41,7	166	11,8	205	7,2	41,7	52,24	4018	392,0	437,7	8,77	900	108,5	164,9	4,15	20,6	84000	219	1,06		
W200x46,1	203	11	203	7,2	46,1	57,69	4476	441,0	487,7	8,81	1534	151,2	229,0	5,16	20,4	141394	244	1,20		
W200x52	204	12,6	206	7,9	52,0	65,69	5203	505,1	561,7	8,90	1784	174,9	265,0	5,21	30,4	166780	281	1,21		
W200x59	205	14,2	210	9,1	59,0	74,75	6044	575,6	645,0	8,99	2040	199,0	302,1	5,22	44,0	195527	323	1,22		
W200x71	206	17,4	216	10,2	71,0	90,17	7593	709,0	795,6	9,18	2557	246,3	375,9	5,30	79,4	250134	398	1,24		
W200x86	209	20,6	222	13	86,0	109,61	9402	847,1	973,3	9,26	3138	300,3	457,6	5,35	136,6	318179	487	1,25		
W200x100	210	23,7	229	14,5	100,0	125,87	11259	983,3	1141,3	9,46	3663	348,8	532,1	5,39	207,2	385940	571	1,27		
W250x17,9	101	5,3	251	4,8	17,9	22,25	2172	173,0	200,9	9,88	91	18,1	28,4	2,03	1,9	13769	100	0,90		
W250x22,3	102	6,9	254	5,8	22,3	28,01	2819	222,0	257,6	10,03	122	24,0	37,9	2,09	3,8	18688	129	0,90		
W250x25,3	102	8,4	257	6,1	25,3	31,79	3353	260,9	301,0	10,27	149	29,2	45,9	2,17	5,9	23025	150	0,91		
W250x28,4	102	10	260	6,4	28,4	35,76	3926	302,0	347,2	10,48	177	34,8	54,5	2,23	9,0	27718	174	0,92		
W250x32,7	146	9,1	258	6,1	32,7	41,20	4818	373,5	418,4	10,81	472	64,7	99,2	3,39	9,2	73174	209	1,09		
W250x38,5	147	11,2	262	6,6	38,5	48,74	5938	453,3	507,6	11,04	594	80,8	123,6	3,49	16,2	93333	254	1,10		
W250x44,8	148	13	266	7,6	44,8	56,72	7039	529,2	596,2	11,14	703	95,0	145,8	3,52	25,4	112538	298	1,11		
W250x49,1	202	11	247	7,4	49,1	61,09	6895	558,3	618,0	10,62	1512	149,7	227,5	4,97	21,1	210512	309	1,29		
W250x58	203	13,5	252	8	58,0	72,81	8562	679,5	754,9	10,84	1883	185,5	281,8	5,09	37,4	267799	377	1,30		
W250x67	204	14,7	257	8,9	67,0	84,13	10189	792,9	886,1	11,00	2223	217,9	331,2	5,14	58,3	323558	443	1,31		
W250x73	254	14,2	253	8,6	73,0	91,45	11108	878,1	969,8	11,02	3879	305,5	462,2	6,51	53,5	553070	485	1,50		
W250x80	255	15,6	256	9,4	80,0	100,69	12401	968,8	1075,1	11,10	4313	338,3	512,2	6,54	71,2	623103	538	1,51		
W250x89	256	17,3	260	10,7	89,0	112,69	14087	1083,6	1210,8	11,18	4840	378,1	573,3	6,55	98,3	712690	605	1,52		
W250x101	257	19,6	264	11,9	101,0	127,50	16203	1227,5	1381,4	11,27	5548	431,8	655,2	6,60	142,7	828502	691	1,53		
W250x115	259	22,1	269	13,5	115,0	144,83	18771	1395,6	1583,8	11,38	6404	494,5	751,5	6,65	206,6	975967	792	1,55		
W250x131	261	25,1	275	15,4	131,0	165,64	21983	1598,7	1831,7	11,52	7445	570,5	868,2	6,70	305,6	1162294	916	1,56		
W250x149	263	28,4	282	17,3	149,0	188,34	25765	1827,3	2113,5	11,70	8620	655,5	999,0	6,77	445,4	1385998	1057	1,58		
W250x167	265	31,8	289	19,2	167,0	211,82	29847	2065,6	2411,3	11,87	9876	745,4	1137,4	6,83	628,8	1633354	1206	1,60		
W310x21	101	5,7	303	5,1	21,0	26,39	3598	237,5	279,6	11,68	98	19,4	31,0	1,93	2,6	21699	140	1,00		

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Table 11 – Properties and dimensions of welded W / HP profiles (2/4)

Name	Dimensions (mm)						X axis										Y axis					
	b _r	t _r	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ²)	Z _y (cm ³)	r _y (cm)	J (cm ⁴)	C _w (cm ⁵)	Q _w (cm ³ /m)	u (m ² /m)				
W310x23.8	101	6,7	305	5,6	23,8	29,86	4168	273,3	320,9	11,81	115	22,9	36,5	1,97	3,8	25689	160	1,00				
W310x28.3	102	8,9	309	6	28,3	35,63	5324	344,6	399,6	12,22	158	31,0	48,9	2,11	7,0	35559	200	1,01				
W310x32.7	102	10,8	313	6,6	32,7	41,26	6993	408,5	473,0	12,45	192	37,6	59,4	2,16	11,5	43771	237	1,02				
W310x38.7	165	9,7	310	5,8	38,7	48,86	8405	542,3	603,1	13,12	277	88,1	134,5	3,86	12,0	163835	302	1,27				
W310x44.5	166	11,2	313	6,6	44,5	56,36	9821	627,5	700,4	13,20	855	103,0	157,5	3,89	18,4	194591	350	1,28				
W310x52	167	13,2	317	7,6	52,0	66,17	11793	740,3	830,1	13,32	1026	122,8	188,3	3,94	30,1	236667	415	1,29				
W310x60	203	13,1	303	7,5	60,0	73,95	12508	825,6	914,6	13,01	1827	180,0	273,8	4,97	34,5	383951	457	1,40				
W310x67	204	14,6	306	8,5	67,0	83,10	14158	925,4	1030,7	13,05	2067	202,7	308,8	4,99	48,3	438843	515	1,41				
W310x74	205	16,3	310	9,4	74,0	92,91	16099	1038,6	1162,2	13,16	2342	228,5	348,6	5,02	67,3	505129	581	1,42				
W310x79	254	14,6	306	8,8	79,0	98,53	17313	1131,6	1249,2	13,26	3989	314,1	476,3	6,36	59,3	846824	625	1,61				
W310x86	254	16,3	310	9,1	86,0	108,05	19494	1257,7	1391,0	13,43	4454	350,7	531,5	6,42	80,7	960407	696	1,62				
W310x97	305	15,4	308	9,9	97,0	121,38	21882	1420,9	1564,5	13,43	7285	477,7	723,1	7,75	83,7	1559162	782	1,82				
W310x107	306	17	311	10,9	107,0	134,23	24438	1571,6	1738,5	13,49	8121	530,8	804,1	7,78	112,9	1754917	869	1,82				
W310x117	307	18,7	314	11,9	117,0	147,73	27168	1730,1	1922,9	13,56	9022	587,7	891,0	7,81	150,4	1966796	961	1,83				
W310x129	308	20,6	318	13,1	129,0	163,16	30419	1913,1	2137,9	13,65	10037	651,7	989,0	7,84	201,8	2219292	1069	1,84				
W310x143	309	22,9	323	14	143,0	180,33	34411	2130,7	2392,5	13,81	11267	729,2	1106,8	7,90	274,8	2536741	1196	1,85				
W310x158	310	25,1	327	15,5	158,0	198,52	38280	2341,3	2646,0	13,89	12471	804,6	1222,7	7,93	364,3	2841666	1323	1,86				
W310x179	313	28,1	333	18	179,0	225,73	44179	2653,4	3026,5	13,99	14375	918,5	1398,9	7,98	522,3	3340793	1513	1,88				
W310x20	315	31,8	341	20,1	202,0	256,10	51628	3028,0	3483,9	14,20	16584	1053,0	1605,7	8,05	759,0	3963861	1742	1,90				
W310x226	317	35,6	348	22,1	226,0	286,88	59212	3403,0	3948,8	14,37	18926	1194,0	1822,5	8,12	1065,9	4617536	1974	1,92				
W310x253	319	39,6	356	24,4	253,0	320,19	67873	3813,1	4464,3	14,56	21458	1345,3	2056,1	8,19	1473,9	5370413	2232	1,94				
W310x283	322	44,1	365	26,9	283,0	358,46	78329	4292,0	5072,1	14,78	24584	1526,9	2336,3	8,28	2049,3	6328901	2536	1,96				
W310x313	325	48,3	374	30	313,0	397,17	89207	4770,4	5689,8	14,99	27697	1704,4	2613,3	8,35	2734,5	7345160	2845	1,99				
W310x342	328	52,6	382	32,6	342,0	435,29	100157	5243,8	6307,5	15,17	31015	1891,2	2903,0	8,44	3562,7	8413248	3154	2,01				
W310x375	330	57,2	391	35,4	375,0	475,44	112433	5751,0	6977,9	15,38	34362	2082,6	3201,2	8,50	4610,9	9571799	3489	2,03				
W310x415	334	62,7	403	38,9	415,0	526,82	129564	6430,0	7875,9	15,68	39073	2339,7	3602,3	8,61	6156,3	11311906	3938	2,06				
W310x454	336	68,7	415	41,3	454,0	576,31	147589	7112,7	8789,4	16,00	43596	2595,0	3996,4	8,70	8076,2	13070576	4395	2,09				
W360x32.9	127	8,5	349	5,8	32,9	40,85	8028	460,1	527,4	14,02	291	45,8	71,3	2,67	7,4	84268	264	1,19				
W360x39	128	10,7	353	6,5	39,0	48,95	10001	566,7	647,5	14,29	375	58,6	91,2	2,77	13,6	109773	324	1,21				
W360x44.6	171	9,8	352	6,9	44,6	56,45	11926	677,6	764,1	14,54	818	95,6	147,2	3,81	14,5	239357	382	1,37				
W360x51	171	11,6	355	7,2	51,0	63,56	13892	782,6	879,3	14,78	968	113,2	173,9	3,90	22,1	285298	440	1,38				
W360x58	172	13,1	358	7,9	58,0	71,28	15813	883,4	994,6	14,89	1112	129,3	199,0	3,95	31,4	330799	497	1,39				
W360x64	203	13,5	347	7,7	64,0	79,45	17351	1000,1	1111,1	14,78	1883	185,6	282,9	4,87	38,4	523701	556	1,49				
W360x72	204	15,1	350	8,6	72,0	89,11	19630	1121,7	1251,5	14,84	2138	209,6	320,1	4,90	53,9	599558	626	1,50				
W360x79	205	16,8	354	9,4	79,0	99,00	22172	1252,7	1402,6	14,97	2414	235,6	360,1	4,94	74,1	686331	701	1,51				
W360x91	254	16,4	353	9,5	91,0	113,73	26216	1485,3	1645,6	15,18	4481	352,9	536,3	6,28	84,3	1269357	823	1,70				
W360x101	255	18,3	357	10,5	101,0	126,97	29671	1662,2	1850,0	15,29	5060	396,9	603,8	6,31	117,3	1451296	925	1,71				
W360x110	256	19,9	360	11,4	110,0	138,39	32615	1812,0	2024,8	15,35	5568	435,0	662,5	6,34	151,3	1610213	1012	1,72				
W360x122	257	21,7	363	13	122,0	153,09	36062	1986,9	2235,4	15,35	6145	478,2	730,1	6,34	200,1	1789510	1118	1,73				

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Table 12 – Properties and dimensions of welded W / HP profiles (3/4)

Name	Dimensions (mm)							X axis							Y axis						
	Original	FEM softwares	b _f	t _f	d	t _w	t _{flange}	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm)	r _x (cm)	I _y (cm ⁴)	W _y (cm ²)	Z _y (cm ²)	r _y (cm)	J (cm ⁴)	C _w (cm ⁶)	Q _w (cm ³)	u (m ² /m)
W410x38.8	W410-1		140	8.8	399	6.4		38.8	49.05	12340	618.5	713.5	15.86	403	57.6	90.1	2.87	9.8	153507	357	1.35
W410x46.1	W410-2		140	11.2	403	7		46.1	58.00	15254	757.0	867.8	16.22	513	73.3	114.4	2.97	17.6	196989	434	1.35
W410x53	W410-3		177	10.9	403	7.5		53.0	67.18	18297	908.0	1028.9	16.50	1009	114.0	176.1	3.88	20.8	387709	514	1.50
W410x60	W410-4		178	12.8	407	7.7		60.0	74.94	21269	1045.1	1178.2	16.85	1205	135.3	208.4	4.01	30.9	467967	589	1.51
W410x67	W410-5		179	14.4	410	8.8		67.0	85.10	24241	1182.5	1339.4	16.88	1379	154.0	238.1	4.03	44.6	539393	670	1.52
W410x75	W410-6		180	16	413	9.7		75.0	94.56	27179	1316.2	1495.4	16.95	1558	173.1	268.2	4.06	61.2	613926	748	1.53
W410x85	W410-7		181	18.2	417	10.9		85.0	107.37	31222	1497.4	1708.5	17.05	1803	199.2	309.4	4.10	90.0	716798	854	1.54
W410x100	W410-8		260	16.9	415	10		100.0	126.00	39456	1901.5	2112.5	17.70	4954	381.1	580.8	6.27	96.9	1962720	1056	1.85
W410x114	W410-9		261	19.3	420	11.6		114.0	144.99	45834	2182.6	2440.3	17.78	5724	438.6	670.2	6.28	145.9	2297645	1220	1.86
W410x132	W410-10		263	22.2	425	13.3		132.0	167.39	53523	2518.8	2833.4	17.88	6738	512.4	784.6	6.34	223.4	2733185	1417	1.88
W410x149	W410-11		265	25	431	14.9		149.0	189.27	61538	2855.6	3230.5	18.03	7765	586.0	899.0	6.40	320.8	3199678	1615	1.89
W460x52	W460-1		152	10.8	450	7.6		52.0	65.39	20816	925.1	1069.7	17.84	634	83.4	130.9	3.11	19.2	305593	535	1.49
W460x60	W460-2		153	13.3	455	8		60.0	74.97	25098	1103.2	1265.9	18.30	796	104.0	162.5	3.26	31.5	388122	633	1.51
W460x68	W460-3		154	15.4	459	9.1		68.0	86.40	29298	1276.6	1469.2	18.41	940	122.1	191.5	3.30	48.6	462486	735	1.52
W460x82	W460-4		190	14.5	457	9		74.0	93.62	32862	1438.2	1631.3	18.74	1660	174.8	270.4	4.21	49.4	812690	816	1.66
W460x89	W460-5		191	16	460	9.9		82.0	103.49	36604	1591.5	1810.2	18.81	1862	194.9	302.3	4.24	66.5	917451	905	1.66
W460x97	W460-6		192	17.7	463	10.5		89.0	112.87	40553	1751.7	1993.3	18.96	2092	217.9	338.0	4.31	88.2	1037118	997	1.67
W460x106	W460-7		193	19	466	11.4		97.0	122.13	44105	1892.9	2161.2	19.00	2282	236.5	367.8	4.32	110.3	1139820	1081	1.68
W460x113	W460-8		194	20.6	469	12.6		106.0	133.83	48425	2065.0	2368.5	19.02	2514	259.2	404.6	4.33	143.0	1263648	1184	1.69
W460x128	W460-9		280	17.3	463	10.8		113.0	143.15	55213	2385.0	2654.5	19.64	6334	452.4	690.7	6.65	115.4	3145594	1327	2.02
W460x144	W460-10		282	19.6	467	12.2		128.0	162.74	63313	2711.5	3031.1	19.72	7332	520.0	795.3	6.71	168.6	3669169	1516	2.04
W460x158	W460-11		283	22.1	472	13.6		144.0	183.27	72221	3060.2	3436.1	19.85	8357	590.6	904.8	6.75	241.4	4229009	1718	2.05
W460x177	W460-12		284	23.9	476	15		158.0	199.98	79246	3329.7	3756.3	19.91	9136	643.4	987.9	6.76	309.3	4668566	1878	2.06
W460x193	W460-13		286	26.9	482	16.6		177.0	224.95	90625	3760.4	4262.2	20.07	10504	734.6	1129.7	6.83	440.5	5439114	2131	2.07
W460x213	W460-14		283	30.5	489	17		193.0	245.39	101968	4170.5	4736.1	20.38	11539	815.5	1252.3	6.86	610.4	6064383	2368	2.08
W460x235	W460-15		285	33.5	495	18.5		213.0	270.13	113938	4603.6	5253.4	20.54	12948	908.6	1397.1	6.92	811.7	6893975	2627	2.09
W460x260	W460-16		287	36.6	501	20.6		235.0	298.21	126945	5067.7	5820.7	20.63	14452	1007.1	1552.7	6.96	1073.4	7791795	2910	2.11
W460x289	W460-17		289	40.4	509	22.6		260.0	330.29	143294	5630.4	6507.1	20.83	16294	1127.6	1741.8	7.02	1450.7	8944735	3254	2.13
W530x66	W530-1		165	11.4	525	8.9		66.0	82.32	34207	1303.1	1527.2	20.39	856	103.8	165.1	3.23	28.4	564799	764	1.69
W530x72	W530-2		207	10.9	524	9		72.0	90.32	39205	1496.4	1725.2	20.83	1614	156.0	243.7	4.23	30.3	1062556	863	1.86
W530x74	W530-3		206	13.6	529	9.7		74.0	93.83	40206	1520.1	1774.2	20.70	1041	125.4	199.2	3.33	43.5	691093	887	1.70
W530x82	W530-4		209	13.3	528	9.5		82.0	103.23	46807	1773.0	2027.8	21.29	2041	145.4	301.8	4.43	47.5	1342628	1014	1.87
W530x85	W530-5		166	16.5	535	10.3		85.0	106.49	47689	1782.8	2069.1	21.16	1263	152.1	240.7	3.44	68.6	848335	1035	1.71
W530x92	W530-6		209	15.6	533	10.2		92.0	116.39	54394	2041.1	2329.0	21.62	2378	227.6	353.8	4.52	71.2	1591535	1165	1.88
W530x101	W530-7		210	17.4	537	10.9		101.0	127.82	60849	2466.3	2585.9	21.82	2691	256.3	398.6	4.59	96.2	1816392	1293	1.89
W530x109	W530-8		211	18.8	539	11.6		109.0	137.50	65881	2444.6	2792.6	21.89	2950	279.6	435.4	4.63	120.5	1995703	1396	1.90
W530x123	W530-9		212	21.2	544	13.1		123.0	155.60	75231	2765.9	3173.7	21.99	3376	318.5	497.9	4.66	173.8	2306821	1587	1.91
W530x138	W530-10		214	23.8	549	14.7		138.0	175.57	85734	3123.3	3598.9	22.10	3901	364.6	572.1	4.71	247.9	2689904	1799	1.92
W530x150	W530-11		312	20.3	543	12.2		150.0	187.96	99458	3663.3	4080.4	23.00	10283	659.2	1006.7	7.40	205.6	7023843	2040	2.31

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Table 13 – Properties and dimensions of welded W / HP profiles (4/4)

Name	Dimensions (mm)							X axis							Y axis						
	Original	FEM softwares	b _r	t _r	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ²)	r _x (cm)	I _y (cm ⁴)	W _y (cm ²)	Z _y (cm ²)	r _y (cm)	J (cm ⁴)	C _w (cm ⁵)	Q _w (cm ³)	u (m ² /m)	
W530x165	W530-12		313	22,2	546	14	165,0	209,20	110104	4033,3	4520,3	23,94	11357	725,7	1112,0	7,37	276,2	7790127	2260	2,32	
W530x182	W530-13		315	24,4	551	15,2	182,0	230,05	122689	4453,3	5005,8	23,09	12725	808,0	1239,6	7,44	366,7	8822138	2503	2,33	
W530x196	W530-14		316	26,3	554	16,5	196,0	248,95	133142	4806,6	5422,6	23,13	13850	876,6	1347,2	7,46	462,2	9642039	2711	2,34	
W530x219	W530-15		318	29,2	560	18,3	219,0	277,50	150188	5363,9	6079,9	23,26	15676	985,9	1518,4	7,52	636,3	11041424	3040	2,36	
W530x248	W530-16		315	34,5	571	19	248,0	312,73	176647	6187,3	7027,4	23,77	18001	1142,9	1756,9	7,59	985,0	12953042	3514	2,36	
W530x272	W530-17		317	37,6	577	21,1	272,0	344,26	195894	6790,1	7757,5	23,85	20002	1261,9	1945,0	7,62	1292,3	14548896	3879	2,38	
W530x300	W530-18		319	41,4	585	23,1	300,0	380,14	219887	7517,5	8635,6	24,05	22450	1407,5	2173,4	7,68	1732,4	16585139	4318	2,40	
W610x82	W610-1		178	12,8	599	10	82,0	102,91	54863	1831,8	2157,6	23,09	1208	135,7	217,1	3,43	44,4	1037700	1079	1,89	
W610x92	W610-2		179	15	603	10,9	92,0	116,16	63515	2106,6	2473,5	23,38	1440	160,9	257,3	3,52	65,7	1244694	1237	1,90	
W610x101	W610-3		228	14,9	603	10,5	101,0	128,13	75239	2495,5	2860,4	24,23	2949	258,7	403,1	4,80	73,0	2549747	1430	2,10	
W610x113	W610-4		228	17,3	608	11,2	113,0	143,11	86431	2843,1	3250,6	24,58	3424	300,4	467,6	4,89	106,4	2986934	1625	2,11	
W610x125	W610-5		229	19,6	612	11,9	125,0	157,93	97423	3183,8	3635,0	24,84	3931	343,3	534,2	4,99	148,2	3448823	1818	2,12	
W610x140	W610-6		230	22,2	617	13,1	140,0	177,13	110859	3593,5	4110,8	25,02	4513	392,4	611,8	5,05	212,3	3991175	2055	2,13	
W610x153	W610-7		229	24,9	623	14	153,0	194,29	124019	3981,4	4560,4	25,27	4997	436,4	681,0	5,07	290,4	4468717	2280	2,13	
W610x155	W610-8		324	19	611	12,7	155,0	195,89	127821	4184,0	4686,8	25,54	10780	665,5	1020,4	7,42	188,6	9445284	2343	2,49	
W610x174	W610-9		325	21,6	616	14	174,0	220,59	145993	4740,0	5321,0	25,73	12371	761,3	1168,8	7,49	272,7	10927234	2661	2,50	
W610x195	W610-10		327	24,4	622	15,4	195,0	247,85	166720	5360,8	6033,1	25,94	14237	870,8	1338,5	7,58	389,4	12710877	3017	2,52	
W610x217	W610-11		328	27,7	628	16,5	217,0	276,19	189635	6039,3	6806,6	26,20	16313	994,7	1529,0	7,69	534,6	14695994	3403	2,54	
HP200x53	HP200-1		207	11,3	204	11,3	53,0	67,28	4910	481,4	543,7	8,54	1673	161,6	247,9	4,99	29,2	155277	272	1,21	
HP250x62	HP250-1		256	10,7	246	10,5	62,0	78,37	8580	697,5	777,0	10,46	2994	233,9	356,8	6,18	30,0	414430	388	1,50	
HP250x85	HP250-2		260	14,4	254	14,4	85,0	107,31	12130	955,1	1079,6	10,63	4224	324,9	498,4	6,27	75,6	606208	540	1,52	
HP310x79	HP310-1		306	11	299	11	79,0	97,79	15915	1064,5	1180,4	12,76	5256	343,5	523,4	7,33	39,9	1089895	590	1,80	
HP310x93	HP310-2		308	13,1	303	13,1	93,0	116,96	19281	1272,7	1420,6	12,84	6384	414,6	633,2	7,39	67,9	1341410	710	1,81	
HP310x110	HP310-3		310	15,5	308	15,4	110,0	138,76	23302	1513,1	1700,9	13,96	7704	497,1	761,2	7,45	112,6	1647907	850	1,83	
HP310x125	HP310-4		312	17,4	312	17,4	125,0	156,81	26674	1709,9	1933,6	13,04	8820	565,4	867,9	7,50	161,3	1913669	967	1,84	
HP310x132	HP310-5		313	18,3	314	18,3	132,0	165,32	28329	1804,4	2045,8	13,09	9367	598,5	919,6	7,53	188,3	2047542	1023	1,84	

4.3.2. ANGLE BAR

Rolled profiles obtained from ABNT NBR 15980:2011 – Perfis laminados de aço para uso estrutural – Dimensões e tolerâncias [2]. Figure 2 presents its cross section and Table 14 and Table 15 present their properties and dimensions.

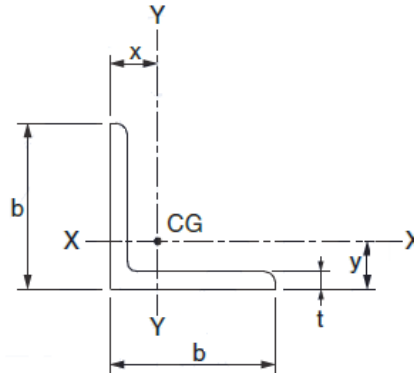


Figure 2 – Angle bar

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Table 14 – Properties and dimensions of Angle bars (1/2)

Name	Dimensions (mm)										X axis = Y axis									
	Original	FEM softwares	b	t	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	x _g (mm)	J (cm ⁴)	C _w (cm ⁵)	r _{xy} (cm)	r _o (cm)	u (m ² /m)			
L13x3.2	L13-1		12.7	3.18		0.55	0.707	0.1	0.11	0.21	0.37	4.31	0.024	0.002	0.25	0.68	0.05			
L16x3.2	L16-1		15.9	3.18		0.7	0.910	0.2	0.19	0.34	0.47	5.12	0.031	0.005	0.31	0.84	0.06			
L19x3.2	L19-1		19.1	3.18		0.9	1.114	0.4	0.28	0.50	0.57	5.93	0.038	0.010	0.37	1.00	0.08			
L22x3.2	L22-1		22.2	3.18		1.0	1.311	0.6	0.38	0.69	0.67	6.71	0.044	0.016	0.43	1.16	0.09			
L25x3.2	L25-1		25.4	3.18		1.2	1.514	0.9	0.51	0.91	0.77	7.52	0.051	0.024	0.50	1.33	0.10			
L25x4.8	L25-2		25.4	4.76		1.7	2.192	1.2	0.72	1.30	0.75	8.07	0.166	0.073	0.49	1.34	0.10			
L25x6.4	L25-3		25.4	6.35		2.2	2.823	1.5	0.91	1.65	0.74	8.62	0.379	0.156	0.50	1.35	0.10			
L32x3.2	L32-1		31.8	3.18		1.5	1.921	1.8	0.81	1.46	0.98	9.12	0.065	0.049	0.63	1.66	0.13			
L32x4.8	L32-2		31.8	4.76		2.2	2.801	2.6	1.16	2.10	0.96	9.69	0.212	0.153	0.62	1.67	0.13			
L32x6.4	L32-3		31.8	6.35		2.9	3.635	3.2	1.49	2.68	0.94	10.24	0.489	0.334	0.62	1.68	0.13			
L38x3.2	L38-1		38.1	3.18		1.8	2.322	3.2	1.18	2.13	1.18	10.70	0.078	0.087	0.75	1.98	0.15			
L38x4.8	L38-2		38.1	4.76		2.7	3.401	4.6	1.71	3.07	1.16	11.27	0.257	0.273	0.75	1.99	0.15			
L38x6.4	L38-3		38.1	6.35		3.5	4.435	5.8	2.20	3.96	1.14	11.83	0.596	0.606	0.74	2.00	0.15			
L44x3.2	L44-1		44.5	3.18		2.1	2.729	5.3	1.63	2.94	1.39	12.30	0.092	0.141	0.88	2.32	0.18			
L44x4.8	L44-2		44.5	4.76		3.1	4.010	7.5	2.36	4.26	1.37	12.88	0.303	0.45	0.87	2.32	0.18			
L44x6.4	L44-3		44.5	6.35		4.1	5.248	9.5	3.06	5.51	1.34	13.45	0.705	1.00	0.87	2.33	0.18			
L51x3.2	L51-1		50.8	3.18		2.5	3.130	7.9	2.14	3.86	1.59	13.88	0.105	0.21	1.01	2.64	0.20			
L51x4.8	L51-2		50.8	4.76		3.6	4.610	11.3	3.12	5.62	1.57	14.46	0.348	0.68	1.00	2.65	0.20			
L51x6.4	L51-3		50.8	6.35		4.7	6.048	14.5	4.04	7.29	1.55	15.03	0.813	1.54	0.99	2.65	0.20			
L51x7.9	L51-4		50.8	7.94		5.8	7.437	17.3	4.92	8.87	1.53	15.59	1.563	2.86	0.99	2.66	0.20			
L51x9.5	L51-5		50.8	9.52		6.9	8.766	19.9	5.75	10.37	1.51	16.15	2.648	4.68	0.99	2.67	0.20			
L64x4.8	L64-1		63.5	4.76		4.6	5.819	22.7	4.96	8.93	1.98	17.64	0.439	1.37	1.26	3.31	0.25			
L64x6.4	L64-2		63.5	6.35		6.0	7.661	29.3	6.46	11.64	1.95	18.21	1.030	3.12	1.25	3.31	0.25			
L64x7.9	L64-3		63.5	7.94		7.4	9.453	35.3	7.90	14.24	1.93	18.79	1.987	5.87	1.24	3.32	0.25			
L64x9.5	L64-4		63.5	9.52		8.8	11.184	40.9	9.27	16.72	1.91	19.35	3.379	9.71	1.24	3.33	0.25			
L76x4.8	L76-1		76.2	4.76		5.5	7.028	40.0	7.22	13.01	2.39	20.82	0.531	2.41	1.51	3.96	0.30			
L76x6.4	L76-2		76.2	6.35		7.3	9.274	51.8	9.45	17.02	2.36	21.40	1.247	5.54	1.50	3.97	0.30			
L76x7.9	L76-3		76.2	7.94		9.0	11.470	62.9	11.59	20.89	2.34	21.97	2.410	10.48	1.50	3.97	0.30			
L76x9.5	L76-4		76.2	9.52		10.7	13.602	73.2	13.64	24.59	2.32	22.54	4.109	17.48	1.49	3.98	0.30			
L76x11.1	L76-5		76.2	11.11		12.3	15.697	83.0	15.64	28.19	2.30	23.11	6.459	26.86	1.49	3.99	0.30			
L76x12.7	L76-6		76.2	12.7		13.9	17.742	92.3	17.56	31.66	2.28	23.67	9.539	38.78	1.48	4.00	0.30			
L89x6.4	L89-1		88.9	6.35		8.5	10.887	83.7	13.01	23.42	2.77	24.58	1.463	8.96	1.76	4.63	0.36			
L89x7.9	L89-2		88.9	7.94		10.6	13.487	102.0	15.99	28.81	2.75	25.16	2.834	17.04	1.75	4.63	0.36			
L89x9.5	L89-3		88.9	9.52		12.6	16.020	119.2	18.87	34.00	2.73	25.73	4.840	28.55	1.74	4.64	0.36			
L102x6.4	L102-1		101.6	6.35		9.8	12.500	126.5	17.13	30.85	3.18	27.76	1.680	13.56	2.02	5.29	0.41			
L102x7.9	L102-2		101.6	7.94		12.2	15.504	154.6	21.11	38.02	3.16	28.34	3.258	25.88	2.01	5.29	0.41			
L102x9.5	L102-3		101.6	9.52		14.5	18.438	181.3	24.95	44.94	3.14	28.91	5.570	43.53	2.00	5.29	0.41			
L102x11.1	L102-4		101.6	11.11		16.8	21.341	207.0	28.70	51.72	3.11	29.49	8.781	67.50	1.99	5.30	0.41			
L102x12.7	L102-5		101.6	12.7		19.0	24.194	231.5	32.36	58.31	3.09	30.06	13.007	98.34	1.99	5.31	0.41			

Table 15 – Properties and dimensions of Angle bars (2/2)

Name	Dimensions (mm)			kg/m	X axis = Y axis												
	FEM softwares	b	t		Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	x _{cg} (mm)	x _p (mm)	J (cm ⁴)	C _w (cm ⁶)	r _{xy} (cm)	r _o (cm)	H	u (m ² /m)
L102x15.9	L102_6	101.6	15.88	23.4	29.746	277.3	39.38	71.00	3.05	31.19	14.6	25.004	182.79	1.98	5.33	0.66	0.41
L127x6.4	L127_1	127	6.35	12.3	15.726	251.6	27.09	48.77	4.00	34.11	6.2	2.114	27.01	2.54	6.61	0.73	0.51
L127x7.9	L127_2	127	7.94	15.3	19.537	308.9	33.47	60.27	3.98	34.70	7.7	4.106	51.79	2.52	6.61	0.72	0.51
L127x9.5	L127_3	127	9.52	18.3	23.274	363.8	39.66	71.43	3.95	35.27	9.2	7.031	87.55	2.51	6.61	0.72	0.51
L127x11.1	L127_4	127	11.11	21.2	26.985	417.0	45.75	82.41	3.93	35.85	10.6	11.103	136.46	2.50	6.62	0.71	0.51
L127x12.7	L127_5	127	12.7	24.1	30.645	468.3	51.70	93.15	3.91	36.43	12.1	16.476	199.86	2.50	6.62	0.70	0.51
L127x15.9	L127_6	127	15.88	29.7	37.813	565.3	63.21	113.93	3.87	37.57	14.9	31.785	375.47	2.48	6.63	0.68	0.51
L127x19.1	L127_7	127	19.05	35.1	44.758	655.2	74.21	133.78	3.83	38.70	17.6	54.143	622.66	2.48	6.65	0.66	0.51
L152x9.5	L152_1	152.4	9.52	22.1	28.111	640.1	57.79	104.07	4.77	41.63	9.2	8.492	154.26	3.03	7.93	0.72	0.61
L152x12.7	L152_2	152.4	12.7	29.1	37.097	828.6	75.60	136.17	4.73	42.79	12.2	19.944	354.52	3.01	7.94	0.71	0.61
L152x15.9	L152_3	152.4	15.88	36.0	45.880	1005.8	92.74	167.09	4.68	43.95	15.1	38.566	670.69	2.99	7.95	0.69	0.61
L152x19.1	L152_4	152.4	19.05	42.7	54.435	1171.9	109.20	196.81	4.64	45.09	17.9	65.849	1120.16	2.98	7.96	0.68	0.61
L203x15.9	L203_1	203.2	15.88	48.7	62.015	2474.3	168.87	304.15	6.32	56.67	15.3	52.128	1656.22	4.02	10.58	0.71	0.81
L203x19.1	L203_2	203.2	19.05	57.9	73.790	2902.7	199.67	359.71	6.27	57.83	18.2	89.262	2790.19	4.00	10.59	0.70	0.81
L500x258x16	L500_1	258	16	93.2	118.720	31955.2	971.50	1702.77	16.41	171.07	11.9	101.308	15328.20	5.72	18.62	0.93	1.52
L500x262.5x25	L500_2	262.5	25	144.7	184.375	48778.5	1494.06	2620.12	16.27	173.52	18.4	384.115	57067.02	5.75	18.65	0.91	1.53

4.3.3. CHANNEL BAR

Rolled profiles obtained from ABNT NBR 15980:2011 – Perfis laminados de aço para uso estrutural – Dimensões e tolerâncias [2]. Figure 3 presents its cross section and Table 16 presents their properties and dimensions.

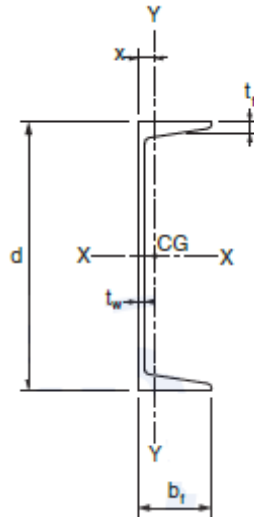


Figure 3 – Channel bar

Table 16 – Properties and dimensions of Channel bars

Name	Dimensions (mm)						X axis						Y axis						u (m ² /m)			
	Original	FEM softwares	b _r	t _r	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	x _g (mm)	x ₀ (mm)		J (cm ⁴)	C _w (cm ⁵)	r ₀ (cm)
U76x6.1	U76-1		35,81	6,93	76,2	4,32	6,1	7,66	68	18,0	21,4	2,99	10	4,1	7,4	1,12	12,4	11,6	0,9	93	4,0	0,29
U76x7.4	U76-2		38,05	6,93	76,2	6,55	7,4	9,36	77	20,1	24,6	2,86	12	4,7	8,5	1,14	12,2	9,8	1,4	102	3,8	0,29
U102x8	U102-1		40,23	7,52	101,6	4,67	8,0	10,09	159	31,4	37,2	3,97	16	5,8	10,6	1,25	13,0	12,7	1,4	283	4,9	0,35
U102x9.3	U102-2		41,83	7,52	101,6	6,27	9,3	11,72	173	34,1	41,3	3,85	19	6,4	11,5	1,26	12,7	11,2	1,9	300	4,7	0,36
U102x10.8	U102-3		43,71	7,52	101,6	8,2	10,8	13,67	190	37,4	46,3	3,73	22	7,0	12,7	1,26	12,6	9,6	2,9	319	4,5	0,36
U152x12.2	U152-1		48,77	8,71	152,4	5,08	12,2	15,35	543	71,3	84,2	5,95	35	10,3	18,6	1,51	14,6	15,1	2,7	1498	6,8	0,49
U152x15.6	U152-2		51,66	8,71	152,4	7,98	15,6	19,77	629	82,5	101,0	5,64	44	11,7	21,1	1,49	13,9	12,3	4,5	1626	6,4	0,50
U152x19.4	U152-3		54,79	8,71	152,4	11,1	19,4	24,53	721	94,6	119,1	5,42	53	13,1	24,6	1,47	14,1	9,6	8,7	1773	6,1	0,50
U203x17.1	U203-1		57,4	9,5	203,2	5,59	17,1	21,20	1315	129,4	153,0	7,88	66	15,9	28,6	1,76	16,1	17,4	4,2	5113	8,7	0,62
U203x20.5	U203-2		59,51	9,5	203,2	7,7	20,5	25,49	1462	143,9	174,8	7,57	76	17,3	31,1	1,73	15,3	15,0	6,1	5381	8,3	0,63
U254x22.8	U254-1		66,04	11,1	254	6,1	22,8	28,80	2797	220,2	260,0	9,85	118	24,8	44,6	2,03	18,3	20,2	7,6	14825	10,8	0,76
U254x29.8	U254-2		69,57	11,1	254	9,63	29,8	37,77	3279	258,2	316,9	9,32	146	27,8	50,4	1,97	17,1	16,1	13,1	15960	10,1	0,77
U305x30.8	U305-1		74	12,7	305	7,2	30,8	38,93	5329	349,4	415,4	11,70	195	35,9	64,4	2,24	19,7	21,6	13,3	35130	12,6	0,89
U305x37	U305-2		77	12,7	305	9,8	37,0	46,96	5965	391,2	477,4	11,27	228	39,2	70,6	2,20	18,9	18,7	19,0	37444	12,1	0,90

4.3.4. TUBULAR PROFILE

Hollow and circular section obtained from Catálogo Tubos Estruturais Vallourec – Seção Circular, Quadrada e Retangular [4] (diameter up to 355.6mm) and good engineering practices (diameter greater than 355.6mm). Figure 4 presents its cross section and Table 17 to Table 22 present their properties and dimensions.

Listed sections comprise both seamless and welded profiles.

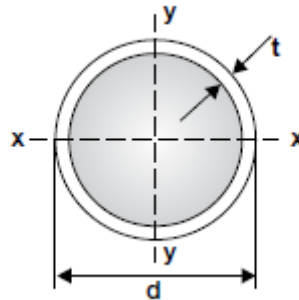


Figure 4 – Tubular profile

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Table 17 – Properties and dimensions of Tubular profiles (1/6)

Name	Dimensions (mm)					X axis = Y axis						
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	J (cm ⁴)	u (m ² /m)
D33.4x3.2	P33_1		33.4	3.2	2.38	3.04	3.5	2.1	2.9	1.07	7.0	0.10
D33.4x3.6	P33_2		33.4	3.6	2.65	3.37	3.8	2.3	3.2	1.06	7.6	0.10
D38.1x3.2	P38_1		38.1	3.2	2.75	3.51	5.4	2.8	3.9	1.24	10.8	0.12
D38.1x3.6	P38_2		38.1	3.6	3.06	3.90	5.9	3.1	4.3	1.23	11.7	0.12
D38.1x4	P38_3		38.1	4	3.36	4.29	6.3	3.3	4.7	1.21	12.6	0.12
D42.2x3.6	P42_1		42.2	3.6	3.43	4.37	8.2	3.9	5.4	1.37	16.4	0.13
D42.2x4	P42_2		42.2	4	3.77	4.80	8.9	4.2	5.9	1.36	17.7	0.13
D42.2x4.5	P42_3		42.2	4.5	4.18	5.33	9.6	4.6	6.4	1.34	19.2	0.13
D42.2x5	P42_4		42.2	5	4.59	5.84	10.3	4.9	7.0	1.33	20.6	0.13
D48.3x3.6	P48_1		48.3	3.6	3.97	5.06	12.7	5.3	7.2	1.59	25.4	0.15
D48.3x4	P48_2		48.3	4	4.37	5.57	13.8	5.7	7.9	1.57	27.5	0.15
D48.3x4.5	P48_3		48.3	4.5	4.86	6.19	15.0	6.2	8.7	1.56	30.0	0.15
D48.3x5	P48_4		48.3	5	5.34	6.80	16.2	6.7	9.4	1.54	32.3	0.15
D48.3x5.6	P48_5		48.3	5.6	5.90	7.51	17.4	7.2	10.3	1.52	34.8	0.15
D48.3x6.4	P48_6		48.3	6.4	6.61	8.42	18.9	7.8	11.3	1.50	37.8	0.15
D60.3x3.6	P60_1		60.3	3.6	5.03	6.41	25.9	8.6	11.6	2.01	51.7	0.19
D60.3x4	P60_2		60.3	4	5.55	7.07	28.2	9.3	12.7	2.00	56.3	0.19
D60.3x4.5	P60_3		60.3	4.5	6.19	7.89	30.9	10.2	14.0	1.98	61.8	0.19
D60.3x5	P60_4		60.3	5	6.82	8.69	33.5	11.1	15.3	1.96	67.0	0.19
D60.3x5.6	P60_5		60.3	5.6	7.55	9.62	36.4	12.1	16.8	1.94	72.7	0.19
D60.3x6.4	P60_6		60.3	6.4	8.51	10.84	39.9	13.2	18.7	1.92	79.8	0.19
D60.3x7.1	P60_7		60.3	7.1	9.32	11.87	42.7	14.2	20.2	1.90	85.5	0.19
D60.3x8	P60_8		60.3	8	10.32	13.14	46.0	15.3	22.0	1.87	92.0	0.19
D60.3x8.8	P60_9		60.3	8.8	11.18	14.24	48.6	16.1	23.6	1.85	97.2	0.19
D73x3.6	P73_1		73	3.6	6.16	7.85	47.4	13.0	17.4	2.46	94.8	0.23
D73x4	P73_2		73	4	6.81	8.67	51.8	14.2	19.1	2.44	103.6	0.23
D73x4.5	P73_3		73	4.5	7.60	9.68	57.0	15.6	21.1	2.43	114.1	0.23
D73x5	P73_4		73	5	8.38	10.68	62.1	17.0	23.2	2.41	124.1	0.23
D73x5.6	P73_5		73	5.6	9.31	11.86	67.8	18.6	25.5	2.39	135.6	0.23
D73x6.4	P73_6		73	6.4	10.51	13.39	74.9	20.5	28.5	2.37	149.9	0.23
D73x7.1	P73_7		73	7.1	11.54	14.70	80.7	22.1	30.9	2.34	161.4	0.23
D73x8	P73_8		73	8	12.82	16.34	87.6	24.0	34.0	2.32	175.2	0.23
D73x8.8	P73_9		73	8.8	13.93	17.75	93.2	25.5	36.5	2.29	186.3	0.23
D73x10	P73_10		73	10	15.54	19.79	100.7	27.6	40.0	2.26	201.3	0.23
D73x11	P73_11		73	11	16.82	21.43	106.2	29.1	42.7	2.23	212.4	0.23
D88.9x3.6	P89_1		88.9	3.6	7.57	9.65	87.9	19.8	26.2	3.02	175.8	0.28
D88.9x4	P89_2		88.9	4	8.38	10.67	96.3	21.7	28.8	3.00	192.7	0.28
D88.9x4.5	P89_3		88.9	4.5	9.37	11.93	106.5	24.0	32.1	2.99	213.1	0.28

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Table 18 – Properties and dimensions of tubular profiles (2/6)

Name	Dimensions (mm)				X axis = Y axis							
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ³)	r _x (cm)	J (cm ⁴)	u (m ² /m)
D88.9x5	P89_4		88.9	5	10.35	13.18	116.4	26.2	35.2	2.97	232.7	0.28
D88.9x5.6	P89_5		88.9	5.6	11.50	14.65	127.7	28.7	38.9	2.95	255.4	0.28
D88.9x6.4	P89_6		88.9	6.4	13.02	16.59	142.0	31.9	43.6	2.93	283.9	0.28
D88.9x7.1	P89_7		88.9	7.1	14.32	18.25	153.8	34.6	47.6	2.90	307.5	0.28
D88.9x8	P89_8		88.9	8	15.96	20.33	168.0	37.8	52.5	2.87	335.9	0.28
D88.9x8.8	P89_9		88.9	8.8	17.38	22.14	179.7	40.4	56.7	2.85	359.5	0.28
D88.9x10	P89_10		88.9	10	19.46	24.79	196.0	44.1	62.6	2.81	392.0	0.28
D88.9x11	P89_11		88.9	11	21.13	26.92	208.3	46.9	67.2	2.78	416.6	0.28
D88.9x12.5	P89_12		88.9	12.5	23.55	30.00	224.8	50.6	73.6	2.74	449.5	0.28
D101.6x4	P101_1		101.6	4	9.63	12.26	146.3	28.8	38.1	3.45	292.6	0.32
D101.6x4.5	P101_2		101.6	4.5	10.78	13.73	162.1	31.9	42.4	3.44	324.3	0.32
D101.6x5	P101_3		101.6	5	11.91	15.17	177.5	34.9	46.7	3.42	354.9	0.32
D101.6x5.6	P101_4		101.6	5.6	13.26	16.89	195.2	38.4	51.7	3.40	390.5	0.32
D101.6x6.4	P101_5		101.6	6.4	15.03	19.14	217.8	42.9	58.1	3.37	435.7	0.32
D101.6x7.1	P101_6		101.6	7.1	16.55	21.08	236.6	46.6	63.5	3.35	473.2	0.32
D101.6x8	P101_7		101.6	8	18.47	23.52	259.5	51.1	70.2	3.32	519.0	0.32
D101.6x8.8	P101_8		101.6	8.8	20.14	25.66	278.7	54.9	76.0	3.30	557.3	0.32
D101.6x10	P101_9		101.6	10	22.59	28.78	305.4	60.1	84.2	3.26	610.8	0.32
D101.6x11	P101_10		101.6	11	24.58	31.31	326.0	64.2	90.7	3.23	652.0	0.32
D101.6x12.5	P101_11		101.6	12.5	27.47	34.99	354.1	69.7	99.9	3.18	708.1	0.32
D114.3x4	P114_1		114.3	4	10.88	13.86	211.1	36.9	48.7	3.90	422.1	0.36
D114.3x4.5	P114_2		114.3	4.5	12.19	15.52	234.3	41.0	54.3	3.89	468.6	0.36
D114.3x5	P114_3		114.3	5	13.48	17.17	256.9	45.0	59.8	3.87	513.8	0.36
D114.3x5.6	P114_4		114.3	5.6	15.01	19.12	285.2	49.6	66.2	3.85	566.4	0.36
D114.3x6.4	P114_5		114.3	6.4	17.03	21.69	316.8	55.4	74.6	3.82	633.7	0.36
D114.3x7.1	P114_6		114.3	7.1	18.77	23.91	345.0	60.4	81.7	3.80	690.0	0.36
D114.3x8	P114_7		114.3	8	20.97	26.72	379.5	66.4	90.5	3.77	759.0	0.36
D114.3x8.8	P114_8		114.3	8.8	22.90	29.17	408.6	71.5	98.1	3.74	817.2	0.36
D114.3x10	P114_9		114.3	10	25.72	32.77	449.7	78.7	109.1	3.70	899.3	0.36
D114.3x11	P114_10		114.3	11	28.02	35.70	481.6	84.3	117.8	3.67	963.1	0.36
D114.3x12.5	P114_11		114.3	12.5	31.38	39.98	525.7	92.0	130.2	3.63	1051.3	0.36
D114.3x14.2	P114_12		114.3	14.2	35.05	44.66	570.6	99.8	143.2	3.57	1141.1	0.36
D141.3x5	P141_1		141.3	5	16.81	21.41	497.9	70.5	92.9	4.82	995.7	0.44
D141.3x5.6	P141_2		141.3	5.6	18.74	23.87	550.5	77.9	103.2	4.80	1100.9	0.44
D141.3x6.4	P141_3		141.3	6.4	21.29	27.12	618.4	87.5	116.5	4.77	1236.8	0.44
D141.3x7.1	P141_4		141.3	7.1	23.50	29.93	675.8	95.6	128.0	4.75	1351.5	0.44
D141.3x8	P141_5		141.3	8	26.30	33.50	748.8	105.7	142.3	4.72	1493.6	0.44
D141.3x8.8	P141_6		141.3	8.8	28.76	36.63	807.4	114.3	154.7	4.69	1614.8	0.44

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Table 19 – Properties and dimensions of tubular profiles (3/6)

Name	Dimensions (mm)				X axis = Y axis							
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ²)	r _x (cm)	J (cm ⁴)	u (m ² /m)
D141.3x10	P141_7		141.3	10	32.38	41.25	894.1	126.5	172.7	4.66	1788.1	0.44
D141.3x11	P141_8		141.3	11	35.35	45.03	962.4	136.2	187.2	4.62	1924.9	0.44
D141.3x12.5	P141_9		141.3	12.5	39.71	50.58	1058.7	149.9	208.0	4.58	2117.5	0.44
D141.3x14.2	P141_10		141.3	14.2	44.51	56.70	1159.2	164.1	230.3	4.52	2318.5	0.44
D141.3x16	P141_11		141.3	16	49.44	62.98	1256.2	177.8	252.5	4.47	2512.4	0.44
D141.3x17.5	P141_12		141.3	17.5	53.43	68.06	1330.0	188.3	269.9	4.42	2660.0	0.44
D168.3x5	P168_1		168.3	5	20.14	25.65	855.8	101.7	133.3	5.78	1711.7	0.53
D168.3x5.6	P168_2		168.3	5.6	22.47	28.62	948.3	112.7	148.3	5.76	1896.5	0.53
D168.3x6.4	P168_3		168.3	6.4	25.55	32.55	1068.2	126.9	167.8	5.73	2136.4	0.53
D168.3x7.1	P168_4		168.3	7.1	28.23	35.96	1170.2	139.1	184.6	5.70	2340.4	0.53
D168.3x8	P168_5		168.3	8	31.63	40.29	1297.3	154.2	205.7	5.67	2594.5	0.53
D168.3x8.8	P168_6		168.3	8.8	34.61	44.10	1406.5	167.1	224.0	5.65	2813.0	0.53
D168.3x10	P168_7		168.3	10	39.04	49.73	1564.0	185.9	250.9	5.61	3128.0	0.53
D168.3x11	P168_8		168.3	11	42.67	54.36	1689.5	200.8	272.6	5.57	3379.0	0.53
D168.3x12.5	P168_9		168.3	12.5	48.03	61.18	1868.4	222.0	304.0	5.53	3736.7	0.53
D168.3x14.2	P168_10		168.3	14.2	53.96	68.74	2057.9	244.6	338.1	5.47	4115.8	0.53
D168.3x16	P168_11		168.3	16	60.10	76.55	2244.1	266.7	372.4	5.41	4488.2	0.53
D168.3x17.5	P168_12		168.3	17.5	65.08	82.91	2388.4	283.8	399.6	5.37	4776.8	0.53
D168.3x20	P168_13		168.3	20	73.15	93.18	2608.2	309.9	442.4	5.29	5216.4	0.53
D219.1x6.4	P219_1		219.1	6.4	33.57	42.77	2420.7	221.0	289.6	7.52	4841.3	0.69
D219.1x7.1	P219_2		219.1	7.1	37.12	47.29	2659.6	242.8	319.1	7.50	5319.2	0.69
D219.1x8	P219_3		219.1	8	41.65	53.06	2959.6	270.2	356.6	7.47	5919.3	0.69
D219.1x8.8	P219_4		219.1	8.8	45.64	58.14	3219.7	293.9	389.3	7.44	6439.5	0.69
D219.1x10	P219_5		219.1	10	51.57	65.69	3598.4	328.5	437.5	7.40	7196.9	0.69
D219.1x11	P219_6		219.1	11	56.45	71.91	3903.7	356.3	476.7	7.37	7807.5	0.69
D219.1x12.5	P219_7		219.1	12.5	63.69	81.13	4344.6	396.6	534.1	7.32	8689.2	0.69
D219.1x14.2	P219_8		219.1	14.2	71.75	91.41	4820.1	440.0	597.0	7.26	9640.2	0.69
D219.1x16	P219_9		219.1	16	80.14	102.09	5296.6	483.5	661.2	7.20	10593.2	0.69
D219.1x17.5	P219_10		219.1	17.5	87.01	110.84	5673.2	517.9	712.9	7.15	11346.4	0.69
D219.1x20	P219_11		219.1	20	98.20	125.10	6261.3	571.5	795.3	7.07	12522.6	0.69
D219.1x25	P219_12		219.1	25	119.67	152.45	7298.3	666.2	946.8	6.92	14596.6	0.69
D273x6.4	P273_1		273	6.4	42.08	53.60	4765.1	349.1	454.9	9.43	9530.2	0.86
D273x7.1	P273_2		273	7.1	46.56	59.31	5245.5	384.3	502.0	9.40	10490.9	0.86
D273x8	P273_3		273	8	52.28	66.60	5851.7	428.7	561.8	9.37	11703.4	0.86
D273x8.8	P273_4		273	8.8	57.34	73.04	6380.0	467.4	614.3	9.35	12760.1	0.86
D273x10	P273_5		273	10	64.86	82.62	7154.1	524.1	691.9	9.31	14308.2	0.86
D273x11	P273_6		273	11	71.07	90.54	7782.5	570.1	755.3	9.27	15565.1	0.86
D273x12.5	P273_7		273	12.5	80.30	102.30	8697.4	637.2	848.7	9.22	17394.9	0.86

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Table 20 – Properties and dimensions of tubular profiles (4/6)

Name	Dimensions (mm)				X axis = Y axis							
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	J (cm ⁴)	u (m ² /m)
D273x14.2	P273_8		273	14.2	90.63	115.45	9695.0	710.3	951.8	9.16	19389.9	0.86
D273x16	P273_9		273	16	101.41	129.18	10706.8	784.4	1057.9	9.10	21413.6	0.86
D273x17.5	P273_10		273	17.5	110.27	140.47	11516.0	843.7	1143.9	9.05	23032.1	0.86
D273x20	P273_11		273	20	124.79	158.96	12798.4	937.6	1282.5	8.97	25596.9	0.86
D273x25	P273_12		273	25	152.90	194.78	15126.8	1108.2	1542.4	8.81	30253.5	0.86
D273x30	P273_13		273	30	179.78	229.02	17162.1	1257.3	1780.0	8.66	34324.1	0.86
D323.8x6.4	P323_1		323.8	6.4	50.10	63.82	8039.7	496.6	644.7	11.22	16079.3	1.02
D323.8x7.1	P323_2		323.8	7.1	55.45	70.64	8861.0	547.3	712.1	11.20	17721.9	1.02
D323.8x8	P323_3		323.8	8	62.30	79.37	9900.7	611.5	797.8	11.17	19801.4	1.02
D323.8x8.8	P323_4		323.8	8.8	68.36	87.08	10809.7	667.7	873.2	11.14	21619.4	1.02
D323.8x10	P323_5		323.8	10	77.39	98.58	12146.7	750.3	984.8	11.10	24293.5	1.02
D323.8x11	P323_6		323.8	11	84.86	108.10	13237.0	817.6	1076.5	11.07	26474.0	1.02
D323.8x12.5	P323_7		323.8	12.5	95.96	122.25	14832.2	916.1	1211.7	11.01	29664.5	1.02
D323.8x14.2	P323_8		323.8	14.2	108.42	138.11	16583.0	1024.3	1361.7	10.96	33166.0	1.02
D323.8x16	P323_9		323.8	16	121.45	154.72	18372.1	1134.8	1516.8	10.90	36744.1	1.02
D323.8x17.5	P323_10		323.8	17.5	132.19	168.40	19813.2	1233.8	1643.2	10.85	39626.4	1.02
D323.8x20	P323_11		323.8	20	149.84	190.88	22117.3	1366.1	1848.1	10.76	44234.5	1.02
D323.8x25	P323_12		323.8	25	184.22	234.68	26373.7	1629.0	2236.7	10.60	52747.4	1.02
D355.6x8	P355_1		355.6	8	68.58	87.36	13201.4	742.5	966.5	12.29	26402.7	1.12
D355.6x8.8	P355_2		355.6	8.8	75.26	95.88	14423.1	811.2	1058.3	12.27	28846.3	1.12
D355.6x10	P355_3		355.6	10	85.23	108.57	16223.5	912.5	1194.4	12.22	32447.0	1.12
D355.6x11	P355_4		355.6	11	93.48	119.09	17694.6	995.2	1306.4	12.19	35389.2	1.12
D355.6x12.5	P355_5		355.6	12.5	105.77	134.74	19852.2	1116.5	1471.8	12.14	39704.4	1.12
D355.6x14.2	P355_6		355.6	14.2	119.56	152.30	22227.4	1250.1	1655.6	12.08	44454.9	1.12
D355.6x16	P355_7		355.6	16	134.00	170.70	24663.0	1387.1	1846.2	12.02	49326.0	1.12
D355.6x17.5	P355_8		355.6	17.5	145.92	185.88	26631.5	1497.8	2001.7	11.97	53263.0	1.12
D355.6x20	P355_9		355.6	20	165.53	210.86	29791.7	1675.6	2254.7	11.89	59583.4	1.12
D355.6x25	P355_10		355.6	25	203.83	259.65	35676.7	2006.6	2736.9	11.72	71353.4	1.12
D400x12.5	P400_1		400	12.5	119.45	152.17	28591.5	1429.6	1877.1	13.71	57183.0	1.26
D400x16	P400_2		400	16	151.52	193.02	35639.1	1782.0	2360.1	13.59	71278.2	1.26
D400x19	P400_3		400	19	178.52	227.42	41368.2	2068.4	2759.7	13.49	82736.5	1.26
D400x22.4	P400_4		400	22.4	208.59	265.72	47525.8	2376.3	3196.8	13.37	95051.6	1.26
D400x25	P400_5		400	25	231.20	294.52	52001.9	2600.1	3520.0	13.29	104003.9	1.26
D406.4x6.4	P406_1		406.4	6.4	63.13	80.42	16089.1	791.8	1023.8	14.14	32178.1	1.28
D406.4x7.9	P406_2		406.4	7.9	77.64	98.90	19650.1	966.5	1254.4	14.09	39280.1	1.28
D406.4x9.5	P406_3		406.4	9.5	92.99	118.46	23338.6	1148.6	1496.4	14.04	46677.3	1.28
D406.4x12.7	P406_4		406.4	12.7	123.31	157.08	30465.7	1499.3	1968.7	13.93	60931.5	1.28
D406.4x16.7	P406_5		406.4	16.7	160.50	204.45	38883.4	1913.6	2537.1	13.79	77766.8	1.28

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Table 21 – Properties and dimensions of tubular profiles (5/6)

Name	Dimensions (mm)				X axis = Y axis							
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	J (cm ⁴)	u (m ² /m)
D406.4x21.4	P406_6		406.4	21.4	203.19	258.84	48105.6	2367.4	3174.5	13.63	96211.2	1.28
D406.4x26.2	P406_7		406.4	26.2	245.66	312.94	56813.9	2796.0	3792.3	13.47	113627.9	1.28
D450x12.5	P450_1		450	12.5	134.87	171.81	41139.4	1828.4	2392.6	15.47	82278.9	1.41
D450x16	P450_2		450	16	171.25	218.15	51432.7	2285.9	3014.3	15.35	102865.3	1.41
D450x19	P450_3		450	19	201.95	257.27	59853.4	2660.1	3530.9	15.25	119706.7	1.41
D450x22.4	P450_4		450	22.4	236.21	300.91	68962.2	3065.0	4098.4	15.14	137924.4	1.41
D457.2x19	P457_1		457.2	19	205.33	261.56	62899.4	2751.5	3649.7	15.51	125798.7	1.44
D500x12.5	P500_1		500	12.5	150.28	191.44	46909.8	2276.4	2970.6	17.24	113817.5	1.57
D500x16	P500_2		500	16	190.98	243.28	71316.5	2852.7	3748.5	17.12	142633.1	1.57
D500x19	P500_3		500	19	225.38	287.11	83162.2	3326.5	4397.0	17.02	166324.3	1.57
D500x22.4	P500_4		500	22.4	263.83	336.10	96040.7	3841.6	5111.9	16.90	192081.3	1.57
D500x25	P500_5		500	25	292.86	373.06	105507.2	4220.3	5644.4	16.82	211014.4	1.57
D508x19	P508_1		508	19	229.13	291.89	87376.6	3440.0	4544.4	17.30	174753.2	1.60
D550x16	P550_1		550	16	210.71	268.42	95762.0	3482.3	4562.7	18.89	191524.1	1.73
D550x19	P550_2		550	19	248.81	316.96	111854.3	4067.4	5358.2	18.79	223708.6	1.73
D550x22.4	P550_3		550	22.4	291.46	371.28	129420.9	4706.2	6237.5	18.67	258841.8	1.73
D550x25	P550_4		550	25	323.68	412.33	142384.1	5177.6	6894.1	18.58	284768.2	1.73
D600x16	P600_1		600	16	230.44	293.55	125240.4	4174.7	5456.9	20.66	250480.7	1.88
D600x19	P600_2		600	19	272.24	346.80	146489.4	4883.0	6414.3	20.55	292978.7	1.88
D600x22.4	P600_3		600	22.4	319.08	406.47	169762.6	5658.8	7475.0	20.44	339525.3	1.88
D600x25	P600_4		600	25	354.51	451.60	186992.3	6233.1	8268.8	20.35	373984.5	1.88
D630x31.5	P630_1		630	31.5	464.94	592.28	265928.1	8442.2	11291.0	21.19	531856.3	1.98
D650x22.4	P650_1		650	22.4	346.70	441.65	217725.7	6699.3	8824.5	22.20	435451.3	2.04
D650x25	P650_2		650	25	385.34	490.87	240068.0	7386.7	9768.4	22.11	480136.0	2.04
D650x31.5	P650_3		650	31.5	480.47	612.07	293436.8	9028.8	12057.5	21.90	586873.6	2.04
D700x19	P700_1		700	19	319.10	406.49	235826.6	6737.9	8811.5	24.09	471653.2	2.20
D700x22.4	P700_2		700	22.4	374.32	476.84	273969.6	7827.7	10285.9	23.97	547939.3	2.20
D700x25	P700_3		700	25	416.16	530.14	302347.6	8638.5	11393.0	23.88	604695.2	2.20
D700x31.5	P700_4		700	31.5	519.32	661.55	370371.8	10582.1	14084.0	23.66	740743.6	2.20
D700x35	P700_5		700	35	574.00	731.21	405316.5	11580.5	15488.3	23.54	810632.9	2.20
D750x19	P750_1		750	19	342.52	436.34	291647.9	7777.3	10152.6	25.85	583295.9	2.36
D750x22.4	P750_2		750	22.4	401.94	512.02	339154.4	9044.1	11859.4	25.74	678308.7	2.36
D750x25	P750_3		750	25	446.99	569.41	374567.4	9988.5	13142.5	25.65	749134.9	2.36
D750x31.5	P750_4		750	31.5	558.16	711.03	459710.8	12259.0	16268.0	25.43	919421.6	2.36
D750x37.5	P750_5		750	37.5	658.92	839.39	534130.2	14243.5	19049.9	25.23	1068260.4	2.36
D800x22.4	P800_1		800	22.4	429.56	547.21	413999.5	10348.5	13544.8	27.50	827879.0	2.51
D800x25	P800_2		800	25	477.82	608.68	457463.8	11436.6	15017.1	27.41	914927.5	2.51
D800x31.5	P800_3		800	31.5	597.00	760.51	562381.6	14059.5	18609.4	27.19	1124763.2	2.51

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Table 22 – Properties and dimensions of tubular profiles (6/6)

Name	Dimensions (mm)				X axis = Y axis							
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	J (cm ⁴)	u (m ² /m)
D800x37.5	P800_4		800	37.5	705.16	898.30	654425.0	16360.6	21814.9	26.99	1308849.9	2.51
D850x22.4	P850_1		850	22.4	457.18	582.40	498984.9	11740.8	15342.2	29.27	997969.8	2.67
D850x25	P850_2		850	25	508.64	647.95	551772.9	12982.9	17016.6	29.18	1103545.8	2.67
D850x31.5	P850_3		850	31.5	635.84	809.99	679311.9	15983.8	21108.3	28.96	1358623.9	2.67
D850x37.5	P850_4		850	37.5	751.41	957.20	791562.8	18625.0	24767.2	28.76	1583125.7	2.67
D900x25	P900_1		900	25	539.47	687.22	658231.2	14627.4	19141.0	30.95	1316462.3	2.83
D900x31.5	P900_2		900	31.5	674.68	859.47	811429.6	18031.8	23764.7	30.73	1622859.2	2.83
D900x37.5	P900_3		900	37.5	797.65	1016.11	946648.3	21036.6	27907.1	30.52	1893296.6	2.83
D900x44.5	P900_4		900	44.5	938.86	1196.00	1097118.2	24380.4	32589.9	30.29	2194236.4	2.83
D1000x25	P1000_1		1000	25	601.12	765.76	910540.3	18210.8	23764.9	34.48	1821080.6	3.14
D1000x31.5	P1000_2		1000	31.5	752.37	958.43	1124937.7	22498.8	29549.8	34.26	2249875.5	3.14
D1000x37.5	P1000_3		1000	37.5	890.13	1133.92	1315079.8	26301.6	34749.1	34.06	2630159.6	3.14
D1000x44.5	P1000_4		1000	44.5	1048.60	1335.80	1527752.3	30555.0	40646.8	33.82	3055504.5	3.14
D1000x50	P1000_5		1000	50	1171.42	1492.26	1688115.2	33762.3	45155.4	33.63	3376230.4	3.14
D1200x31.5	P1200_1		1200	31.5	907.73	1156.35	1975022.7	32917.0	43009.5	41.33	3950045.3	3.77
D1200x37.5	P1200_2		1200	37.5	1075.09	1369.54	2315910.2	38598.5	50682.6	41.12	4631820.5	3.77
D1200x44.5	P1200_3		1200	44.5	1268.09	1615.40	2700059.8	45001.0	59430.0	40.88	5400119.6	3.77
D1200x50	P1200_4		1200	50	1418.04	1806.42	2991876.1	49864.6	66150.1	40.70	5983752.3	3.77
D1200x60	P1200_5		1200	60	1644.29	2147.70	3547765.1	60912.8	83831.9	41.04	9099530.2	3.77
D1500x25	P1500_1		1500	25	909.39	1158.46	1513379.5	42018.4	54382.2	52.16	6302758.9	4.71
D1500x31.5	P1500_2		1500	31.5	1140.79	1453.23	3919151.7	52255.4	67922.9	51.93	7838303.4	4.71
D1500x37.5	P1500_3		1500	37.5	1352.53	1722.97	4609610.4	61461.5	80206.5	51.72	9219220.7	4.71
D1500x44.5	P1500_4		1500	44.5	1597.32	2034.80	5393395.8	71911.9	94278.2	51.48	10786791.6	4.71
D1500x50	P1500_5		1500	50	1787.96	2277.65	5993078.9	79907.7	105140.4	51.30	11986157.7	4.71
D1500x63	P1500_6		1500	63	2232.63	2844.12	7355372.6	98071.6	130143.9	50.85	14710745.3	4.71
D1500x60	P1500_7		1500	60	2130.75	2714.34	7047773.6	93970.3	124456.9	50.96	14095547.1	4.71
D1750x25	P1750_1		1750	25	1063.53	1354.81	5040323.4	57603.7	74377.2	60.99	10080646.8	5.50
D1750x31.5	P1750_2		1750	31.5	1334.99	1700.63	6280076.6	71772.3	93014.3	60.77	12560153.2	5.50
D1750x37.5	P1750_3		1750	37.5	1583.73	2017.49	7399307.8	84563.5	109964.7	60.56	14798615.6	5.50
D1750x44.5	P1750_4		1750	44.5	1871.68	2384.30	8675023.0	99143.1	129435.5	60.32	17350045.9	5.50
D1750x50	P1750_5		1750	50	2096.23	2670.35	9654997.8	110342.8	144505.5	60.13	19309995.6	5.50
D1750x63	P1750_6		1750	63	2621.05	3338.92	11894629.8	135938.6	179334.6	59.69	23789259.6	5.50
D2000x25	P2000_1		2000	25	1217.66	1551.16	7564335.4	75643.4	97496.5	69.83	15128670.8	6.28
D2000x31.5	P2000_2		2000	31.5	1529.20	1948.03	9438172.1	94381.7	122042.2	69.61	18876344.1	6.28
D2000x37.5	P2000_3		2000	37.5	1814.93	2312.02	11134704.4	111347.0	144409.2	69.40	22269408.9	6.28
D2000x44.5	P2000_4		2000	44.5	2146.04	2733.81	13074292.6	130742.9	170153.9	69.16	26148585.1	6.28
D2000x50	P2000_5		2000	50	2404.50	3063.05	14568645.1	145686.5	190119.1	68.97	29137290.1	6.28
D2000x63	P2000_6		2000	63	3009.47	3833.72	17999003.9	179990.0	236398.3	68.52	35988007.8	6.28

4.3.5. T / WT PROFILE

Rolled profile obtained from ABNT NBR 15980:2011 – Perfis laminados de aço para uso estrutural – Dimensões e tolerâncias [2], Catálogo Perfis Estruturais Gerdau - Tabela de bitolas [3] and welded profiles from good engineering practices. Figure 5 presents its cross section and Table 23 to Table 26 present their properties and dimensions.

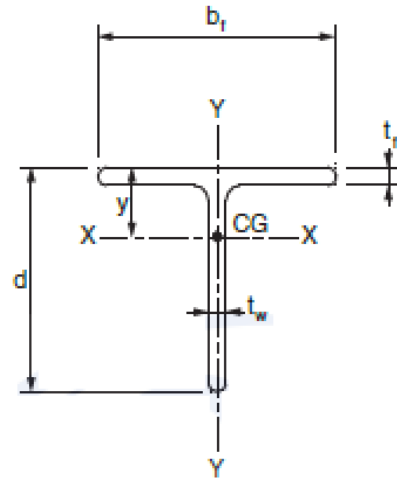


Figure 5 – T / WT profile

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Table 23 – Properties and dimensions of T profiles (1/4)

Name	Dimensions (mm)						X axis										Y axis					
	b ₁	t ₁	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	Y _g (mm)	J (cm ⁴)	C _w (cm ⁶)	u (m ² /m)				
T300x80	150	24	300	24	80.3	102.24	9470.1	496.29	862.06	9.62	706.8	94.24	174.74	2.63	190.8	201.83	9496.943	0.90				
T350x85	350	19	350	12.5	84.7	107.88	11608.7	424.64	742.72	10.37	6793.9	388.22	594.80	7.94	273.4	102.19	4184.019	1.40				
T500x98	400	16	500	12.5	97.7	124.50	31261.8	843.74	1519.19	15.85	8541.2	427.06	658.91	8.28	370.5	86.64	8281.788	1.80				
T500x135	450	25	500	12.5	134.9	171.88	35512.1	885.29	1536.13	14.37	18992.1	844.09	1284.18	10.51	401.1	266.11	16173.363	1.90				
T500x158	500	25	500	16	157.8	201.00	43894.5	1116.99	1947.73	14.78	26057.9	1042.32	1592.90	11.39	393.0	326.98	26745.368	2.00				
T500x170	500	31.5	500	12.5	169.6	216.06	37522.8	900.93	1569.79	13.18	32820.1	1312.81	1987.05	12.32	416.5	552.46	33292.626	2.00				
T500x176	500	37.5	500	16	175.8	224.00	44337.6	1112.16	1961.03	14.07	20015.8	1000.79	1529.60	9.45	398.7	768.83	36118.972	1.80				
T500x205	500	37.5	500	16	205.3	261.50	46572.7	1134.52	1996.18	13.35	39078.3	1563.13	2373.35	12.22	410.5	944.61	58457.839	2.00				
T500x264	500	44.5	500	25	264.1	336.38	67133.8	1707.74	3023.23	14.13	46413.5	1856.54	2852.42	11.75	393.1	1717.51	123822.191	2.00				
T500x194	450	31.5	500	22.4	193.7	246.69	57000.5	1508.35	2676.46	15.20	23964.2	1065.08	1653.46	9.86	377.9	650.26	55231.900	1.90				
T600x118	300	19	600	16	117.7	149.96	57967.7	1432.96	2552.59	19.66	4294.8	286.32	464.68	5.35	404.5	149.21	24713.088	1.80				
T600x146	200	24	600	24	146.2	186.24	70309.6	1924.61	3190.66	19.43	1666.4	166.64	322.94	2.99	365.3	363.11	78834.229	1.60				
T800x156	300	25	800	16	156.2	199.00	136877.5	2542.99	4523.59	26.23	5651.5	376.76	612.10	5.33	538.3	263.77	58495.688	2.20				
T1000x181	300	25	1000	16	181.3	231.00	250243.7	3850.86	6673.59	32.91	5658.3	377.22	624.90	4.95	649.8	291.08	112493.910	2.60				
WT75x6.5	100	4.9	74	4.3	6.5	7.87	37.2	6.47	11.27	2.18	40.9	8.18	12.57	2.28	57.6	0.58	1.626	0.35				
WT75x6.75	100	5.5	75	4.3	6.8	8.49	39.4	6.67	11.64	2.15	45.9	9.18	14.07	2.32	59.0	0.75	1.988	0.35				
WT75x9	102	7.1	76.5	5.8	9.0	11.27	54.3	9.16	16.10	2.20	62.9	12.33	19.05	2.36	59.3	1.69	4.742	0.36				
WT75x11.25	152	6.6	76	5.8	11.3	14.06	58.0	9.38	16.37	2.03	193.3	25.43	38.71	3.71	61.8	1.93	9.094	0.46				
WT75x12	102	10.3	80	6.6	12.0	15.11	70.7	11.29	20.35	2.16	91.3	17.89	27.55	2.46	62.7	4.43	11.402	0.36				
WT75x14.9	153	9.3	78.5	6.6	14.9	18.80	72.5	11.28	20.48	1.96	277.7	36.31	55.18	3.84	64.3	4.81	23.222	0.46				
WT75x18.55	154	11.6	81	8.1	18.6	23.49	94.7	14.46	26.81	2.01	353.4	45.89	69.91	3.88	65.5	9.34	45.867	0.47				
WT100x7.5	100	5.2	100	4.3	7.5	9.28	87.8	11.64	20.62	3.08	43.4	8.68	13.44	2.16	75.4	0.73	3.017	0.40				
WT100x9.65	102	6.5	101.5	5.8	9.7	12.14	119.2	15.84	28.24	3.13	57.6	11.30	17.71	2.18	75.2	1.57	7.164	0.41				
WT100x11.25	102	8	103	6.2	11.3	14.05	135.5	17.50	31.05	3.11	70.9	13.91	21.72	2.25	77.4	2.53	10.197	0.41				
WT100x13.3	133	8.4	103.5	5.8	13.3	16.69	141.1	17.17	30.09	2.91	164.8	24.79	37.95	3.14	82.2	3.27	14.990	0.47				
WT100x15.65	134	10.2	105	6.4	15.7	19.74	162.4	19.39	34.37	2.87	204.7	30.56	46.76	3.22	83.8	5.61	24.992	0.48				
WT100x17.95	165	10.2	100.5	6.2	18.0	22.43	145.6	17.57	31.56	2.55	382.0	46.30	70.29	4.13	82.9	6.59	38.853	0.53				
WT100x20.85	166	11.8	102.5	7.2	20.9	26.12	175.7	20.97	38.07	2.59	450.1	54.23	82.47	4.15	83.8	10.29	61.538	0.54				
WT100x23.05	203	11	101.5	7.2	23.1	28.85	176.6	20.90	38.04	2.47	767.1	75.58	114.50	5.16	84.5	10.20	86.495	0.61				
WT100x26	204	12.6	103	7.9	26.0	32.85	200.3	23.42	43.47	2.47	891.8	87.43	132.50	5.21	85.5	15.19	130.318	0.61				
WT100x29.5	205	14.2	105	9.1	29.5	37.37	239.1	27.70	51.83	2.53	1020.0	99.51	151.07	5.22	86.3	22.02	190.944	0.62				
WT100x35.5	206	17.4	108	10.2	35.5	45.09	286.5	32.47	63.14	2.52	1268.4	123.14	186.95	5.30	88.2	39.69	348.670	0.63				
WT100x43	209	20.6	111	13	43.0	54.81	379.6	42.75	83.58	2.63	1568.9	150.13	228.78	5.35	88.8	68.28	616.533	0.64				
WT100x50	210	23.7	114.5	14.5	50.0	62.94	455.0	50.18	100.09	2.69	1831.4	174.41	266.07	5.39	90.7	103.62	947.728	0.65				
WT125x8.95	101	5.3	125.5	4.8	9.0	11.12	178.9	19.81	36.00	4.01	45.6	9.03	14.21	2.03	90.3	0.92	6.761	0.45				
WT125x11.15	102	6.9	127	5.8	11.2	14.00	225.2	24.48	44.44	4.01	61.2	12.00	18.96	2.09	92.0	1.95	12.642	0.46				
WT125x12.65	102	8.4	128.5	6.1	12.7	15.89	251.6	26.57	47.75	3.98	74.5	14.61	22.97	2.17	94.7	2.96	16.477	0.46				

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Table 24 – Properties and dimensions of T profiles (2/4)

Name	Dimensions (mm)					X axis										Y axis					u (m ² /m)
	Original / FEM softwares	b _t	t _t	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	Y _g (mm)	J (cm ⁴)	C _w (cm ⁶)			
WT125x14.2	T125_4	102	10	130	6.4	14.2	17.88	278.1	28.65	51.24	3.94	88.7	17.39	27.24	2.23	97.1	4.49	21.592	0.46		
WT125x16.35	T125_5	146	9.1	129	6.1	16.4	20.60	284.8	28.04	49.08	3.72	236.2	32.36	49.61	3.39	101.5	4.61	28.439	0.55		
WT125x19.25	T125_6	147	11.2	131	6.6	19.3	24.37	325.5	31.25	55.09	3.65	296.8	40.38	61.81	3.49	104.1	8.09	46.739	0.56		
WT125x22.4	T125_7	148	13	133	7.6	22.4	28.36	385.8	36.70	65.17	3.69	351.6	47.52	72.92	3.52	105.1	12.69	74.144	0.56		
WT125x24.55	T125_8	202	11	123.5	7.4	24.6	30.55	321.0	31.73	55.98	3.24	755.9	74.84	113.75	4.97	101.2	10.56	94.679	0.65		
WT125x29	T125_9	203	13.5	126	8	29.0	36.41	368.0	35.49	64.15	3.18	941.6	92.77	140.88	5.09	103.7	18.68	167.049	0.66		
WT125x33.5	T125_10	204	15.7	128.5	8.9	33.5	42.07	428.5	40.69	74.84	3.19	1111.4	108.96	165.58	5.14	105.3	29.15	262.545	0.67		
WT125x36.5	T125_11	254	14.2	126.5	8.6	36.5	45.73	412.3	38.88	71.81	3.00	1939.7	152.73	231.11	6.51	106.0	26.77	355.914	0.76		
WT125x40	T125_12	255	15.6	128	9.4	40.0	50.35	461.2	43.20	80.65	3.03	2156.4	169.13	256.08	6.54	106.8	35.60	477.219	0.77		
WT125x44.5	T125_13	256	17.3	130	10.7	44.5	56.35	539.1	50.18	94.31	3.09	2419.9	189.05	286.67	6.55	107.4	49.14	664.057	0.77		
WT125x50.5	T125_14	257	19.6	132	11.9	50.5	63.75	617.3	56.98	108.98	3.11	2774.1	215.88	327.62	6.60	108.4	71.37	972.994	0.78		
WT125x57.5	T125_15	259	22.1	134.5	13.5	57.5	72.41	725.5	66.34	128.55	3.17	3202.0	247.26	375.74	6.65	109.4	103.31	1430.887	0.79		
WT125x65.5	T125_16	261	25.1	137.5	15.4	65.5	82.82	863.8	78.11	153.45	3.23	3722.3	285.23	434.12	6.70	110.6	152.79	2150.362	0.80		
WT125x74.5	T125_17	263	28.4	141	17.3	74.5	94.17	1023.9	91.25	181.94	3.30	4310.2	327.77	499.52	6.77	112.2	222.70	3186.962	0.81		
WT125x83.5	T125_18	265	31.8	144.5	19.2	83.5	105.91	1198.8	105.31	212.95	3.36	4938.2	372.69	568.68	6.83	113.8	314.40	4573.960	0.82		
WT155x10.5	T155_1	101	5.7	151.5	5.1	10.5	13.19	318.1	30.02	54.47	4.91	49.1	9.72	15.48	1.93	106.0	1.28	13.428	0.51		
WT155x11.9	T155_2	101	6.7	152.5	5.6	11.9	14.93	360.0	33.50	60.92	4.91	57.7	11.43	18.23	1.97	107.5	1.89	18.338	0.51		
WT155x14.15	T155_3	102	8.9	154.5	6	14.2	17.81	420.6	37.50	68.20	4.86	79.0	15.48	24.46	2.11	112.2	3.48	25.466	0.51		
WT155x16.35	T155_4	102	10.8	156.5	6.6	16.4	20.63	485.6	42.36	76.63	4.85	95.9	18.80	29.68	2.16	114.6	5.73	36.834	0.52		
WT155x19.35	T155_5	165	9.7	155	5.8	19.4	24.43	481.1	38.98	67.97	4.44	363.3	44.04	67.24	3.86	123.4	6.00	46.818	0.64		
WT155x22.25	T155_6	166	11.2	156.5	6.6	22.3	28.18	558.0	44.90	78.66	4.45	427.3	51.48	78.74	3.89	124.3	9.22	72.070	0.65		
WT155x26	T155_7	167	13.2	158.5	7.6	26.0	33.09	659.6	52.58	92.69	4.46	512.9	61.42	94.13	3.94	125.5	15.03	117.127	0.65		
WT155x30	T155_8	203	13.1	151.5	7.5	30.0	36.97	597.9	48.34	85.39	4.02	913.7	90.02	136.91	4.97	123.7	17.25	166.288	0.71		
WT155x33.5	T155_9	204	14.6	153	8.5	33.5	41.55	686.6	55.35	98.37	4.07	1033.6	101.34	154.40	4.99	124.0	24.15	236.243	0.71		
WT155x37	T155_10	205	16.3	155	9.4	37.0	46.45	779.7	62.33	111.60	4.10	1171.2	114.26	174.32	5.02	125.1	33.66	332.161	0.72		
WT155x39.5	T155_11	254	14.6	153	8.8	39.5	49.26	737.5	58.17	104.03	3.87	1994.5	157.05	238.16	6.36	126.8	29.66	412.708	0.81		
WT155x43	T155_12	254	16.3	155	9.1	43.0	54.02	792.5	61.56	111.82	3.83	2226.8	175.34	265.77	6.42	128.7	40.36	559.124	0.82		
WT155x48.5	T155_13	305	15.4	154	9.9	48.5	60.69	858.6	66.61	120.34	3.76	3642.3	238.84	361.54	7.75	128.9	41.86	804.012	0.92		
WT155x53.5	T155_14	306	17	155.5	10.9	53.5	67.12	961.2	74.22	135.37	3.78	4060.6	268.40	402.07	7.78	129.5	56.46	1091.841	0.92		
WT155x58.5	T155_15	307	18.7	157	11.9	58.5	73.87	1067.3	82.00	151.14	3.80	4510.9	293.87	445.51	7.81	130.2	75.21	1464.620	0.93		
WT155x64.5	T155_16	308	20.6	159	13.1	64.5	81.58	1203.1	91.81	170.87	3.84	5018.4	325.87	494.49	7.84	131.0	100.89	1979.072	0.93		
WT155x71.5	T155_17	309	22.9	161.5	14	71.5	90.17	1334.5	100.59	190.41	3.85	5633.4	364.62	553.42	7.90	132.7	137.42	2717.985	0.94		
WT155x79	T155_18	310	25.1	163.5	15.5	79.0	99.26	1507.1	113.07	215.88	3.90	6235.6	402.30	611.34	7.93	133.3	182.14	3627.265	0.95		
WT155x89.5	T155_19	313	28.1	166.5	18	89.5	112.87	1801.0	134.33	257.97	3.99	7187.3	459.25	699.44	7.98	134.1	261.13	5298.847	0.96		
WT155x101	T155_20	315	31.8	170.5	20.1	101.0	128.05	2116.3	155.57	303.29	4.07	8292.2	526.49	802.85	8.05	136.0	379.50	7813.438	0.97		
WT155x113	T155_21	317	35.6	174	22.1	113.0	143.44	2428.8	176.45	349.64	4.11	9462.8	597.02	911.25	8.12	137.6	532.95	11123.460	0.98		
WT155x126.5	T155_22	319	39.6	178	24.4	126.5	160.09	2814.8	201.88	405.01	4.19	10729.1	672.67	1028.03	8.19	139.4	736.93	15596.606	0.99		
WT155x141.5	T155_23	322	44.1	182.5	26.9	141.5	179.23	3280.4	231.84	471.24	4.28	12291.9	763.47	1168.15	8.28	141.5	1024.66	22118.221	1.01		

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Table 25 – Properties and dimensions of T profiles (3/4)

Name	Dimensions (mm)										X axis										Y axis									
	Original	FEM softwares	b _f	t _r	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	Y _g (mm)	J (cm ⁴)	C _w (cm ⁶)	u (m ² /m)										
WT155x156.5	T155_24		325	48.3	187	30	156.5	198.59	3847.7	268.58	547.39	4.40	13848.3	852.20	1306.63	8.35	143.3	1367.25	30100.522	1.02										
WT155x171	T155_25		328	52.6	191	32.6	171.0	217.65	4379.9	302.26	620.98	4.49	15507.7	945.59	1451.50	8.44	144.9	1781.35	39962.499	1.04										
WT155x187.5	T155_26		330	57.2	195.5	35.4	187.5	237.72	5009.6	341.32	705.17	4.59	17181.1	1041.28	1600.60	8.50	146.8	2305.44	52434.401	1.05										
WT155x207.5	T155_27		334	62.7	201.5	38.9	207.5	263.41	5910.1	395.33	819.74	4.74	19536.3	1169.84	1801.15	8.61	149.5	3078.13	71833.834	1.07										
WT155x227	T155_28		336	68.7	207.5	41.3	227.0	288.16	6771.1	443.98	932.01	4.85	21798.2	1297.51	1998.18	8.70	152.5	4038.10	95571.472	1.09										
WT180x16.45	T180_1		127	8.5	174.5	5.8	16.5	20.42	609.2	47.18	84.90	5.46	145.4	22.89	35.67	2.67	129.1	3.71	35.481	0.60										
WT180x19.5	T180_2		128	10.7	176.5	6.5	19.5	24.47	717.9	54.27	97.02	5.42	187.4	29.28	45.58	2.77	132.3	6.79	56.085	0.61										
WT180x22	T180_3		171	9.8	176	6.9	22.0	28.23	792.6	58.56	103.04	5.30	408.8	47.81	73.62	3.81	135.3	7.24	78.390	0.69										
WT180x25.5	T180_4		171	11.6	171.5	7.2	25.5	31.78	863.4	62.41	109.61	5.21	483.9	56.59	86.95	3.90	138.3	11.03	106.682	0.70										
WT180x28.9	T180_5		172	13.1	179	7.9	28.9	35.64	967.6	69.34	122.09	5.21	556.2	64.67	99.48	3.95	139.5	15.72	149.677	0.70										
WT180x32	T180_6		203	13.5	173.5	7.7	32.0	39.73	906.6	64.83	113.75	4.78	941.7	92.78	141.45	4.87	139.8	19.19	201.730	0.75										
WT180x36	T180_7		204	15.1	175	8.6	36.0	44.56	1026.7	73.11	129.00	4.80	1069.1	104.82	160.06	4.90	140.4	26.96	285.939	0.76										
WT180x39.5	T180_8		205	16.8	177	9.4	39.5	49.50	1150.8	81.23	144.20	4.82	1207.2	117.78	180.04	4.94	141.7	37.07	394.253	0.76										
WT180x45.5	T180_9		254	16.4	176.5	9.5	45.5	56.87	1201.9	83.06	147.69	4.60	2240.7	176.43	268.13	6.28	144.7	42.16	615.494	0.86										
WT180x50.5	T180_10		255	18.3	178.5	10.5	50.5	63.49	1357.6	93.18	167.06	4.62	2530.2	198.45	301.90	6.31	145.7	58.63	861.864	0.87										
WT180x55	T180_11		256	19.9	180	11.4	55.0	69.20	1495.1	102.19	184.41	4.65	2784.2	217.52	331.24	6.34	146.3	75.65	1120.524	0.87										
WT180x61	T180_12		257	21.7	181.5	13	61.0	76.54	1710.5	117.14	212.03	4.73	3072.5	239.10	365.07	6.34	146.0	100.03	1507.808	0.88										
WT205x19.4	T205_1		140	8.8	199.5	6.4	19.4	24.52	980.7	67.42	122.50	6.32	201.6	28.81	45.07	2.87	145.5	4.89	67.062	0.68										
WT205x23.05	T205_2		140	11.2	201.5	7	23.1	29.00	1134.7	75.84	136.27	6.26	256.7	36.66	57.21	2.97	149.6	8.80	98.402	0.68										
WT205x26.5	T205_3		177	10.9	201.5	7.5	26.5	33.59	1268.1	82.79	146.60	6.14	504.4	56.99	88.05	3.88	153.2	10.40	138.174	0.76										
WT205x30	T205_4		178	12.8	203.5	7.7	30.0	37.47	1372.6	87.30	153.87	6.05	602.3	67.67	104.22	4.01	157.2	15.44	179.237	0.76										
WT205x33.5	T205_5		179	14.4	205	8.8	33.5	42.55	1579.8	100.37	177.51	6.09	689.3	77.02	119.04	4.03	157.4	22.31	265.424	0.77										
WT205x37.5	T205_6		180	16	206.5	9.7	37.5	47.28	1765.0	111.60	197.83	6.11	779.0	86.56	134.08	4.06	158.1	30.61	364.175	0.77										
WT205x42.5	T205_7		181	18.2	208.5	10.9	42.5	53.68	2018.4	126.85	225.58	6.13	901.4	99.60	154.71	4.10	159.1	44.98	533.451	0.78										
WT205x50	T205_8		260	16.9	207.5	10	50.0	63.00	2018.4	120.39	211.55	5.66	2476.9	190.53	290.38	6.27	167.7	48.47	808.209	0.94										
WT205x57	T205_9		261	19.3	210	11.6	57.0	72.49	2380.7	141.45	250.16	5.73	2862.0	219.31	335.10	6.28	168.3	72.97	1236.318	0.94										
WT205x66	T205_10		263	22.2	212.5	13.3	66.0	83.70	2781.0	164.29	292.91	5.76	3369.1	256.21	392.30	6.34	169.3	111.71	1916.041	0.95										
WT205x74.5	T205_11		265	25	215.5	14.9	74.5	94.63	3199.9	187.48	336.68	5.81	3882.3	293.00	449.48	6.40	170.7	160.40	2787.951	0.96										
WT230x26	T230_1		152	10.8	225	7.6	26.0	32.49	1658.5	101.38	184.48	7.12	316.8	41.69	65.47	3.11	163.6	9.60	159.854	0.75										
WT230x30	T230_2		153	13.3	227.5	8	30.0	37.49	1861.8	110.27	198.26	7.05	397.9	52.01	81.26	3.26	168.9	15.77	211.715	0.76										
WT230x34	T230_3		154	15.4	229.5	9.1	34.0	43.20	2157.3	126.87	228.27	7.07	470.1	61.05	95.74	3.30	170.0	24.32	321.038	0.77										
WT230x37	T230_4		190	14.5	228.5	9	37.0	46.81	2219.5	127.38	225.70	6.89	830.1	87.38	135.20	4.21	174.2	24.68	364.530	0.84										
WT230x41	T230_5		191	16	230	9.9	41.0	51.75	2469.8	141.20	250.62	6.91	930.8	97.46	151.17	4.24	174.9	33.26	493.089	0.84										
WT230x44.5	T230_6		192	17.7	231.5	10.5	44.5	56.43	2675.3	151.48	268.99	6.89	1046.1	108.96	169.02	4.31	176.6	44.08	627.482	0.85										
WT230x48.5	T230_7		193	19	233	11.4	48.5	61.07	2930.4	165.60	294.68	6.93	1140.9	118.23	183.89	4.32	177.0	55.16	801.886	0.85										
WT230x53	T230_8		194	20.6	234.5	12.6	53.0	66.92	3254.6	183.90	328.10	6.97	1257.0	129.58	202.32	4.33	177.0	71.48	1069.450	0.86										
WT230x56.5	T230_9		280	17.3	231.5	10.8	56.5	71.57	2994.3	161.47	282.48	6.47	3167.0	226.21	345.33	6.65	185.4	57.68	1176.578	1.02										
WT230x64	T230_10		282	19.6	233.5	12.2	64.0	81.37	3428.9	184.09	323.79	6.49	3666.1	260.01	397.63	6.71	186.3	84.32	1737.253	1.03										

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Table 26 – Properties and dimensions of T profiles (4/4)

Name	Dimensions (mm)										X axis										Y axis									
	Original	FEM-sofwares	b _f	t _r	d	t _w	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	Y _g (mm)	J (cm ⁴)	C _w (cm ⁶)	u (m ² /m)										
T230_11	283	22.1	236	13.6	72.0	91.63	3899.2	207.97	367.93	6.52	4178.7	295.31	452.38	6.75	187.5	120.68	2494.298	1.04												
T230_12	284	23.9	238	15	79.0	99.99	4346.2	231.39	410.68	6.59	4568.2	321.70	493.96	6.76	187.8	154.67	3254.523	1.04												
T230_13	286	26.9	241	16.6	88.5	112.47	4933.9	260.40	465.25	6.62	5252.2	367.29	564.83	6.83	189.5	220.26	4659.328	1.05												
T230_14	283	30.5	244.5	17	96.5	122.70	5280.2	273.58	495.10	6.56	5769.5	407.74	626.14	6.86	193.0	305.19	6110.037	1.06												
T230_15	285	33.5	247.5	18.5	106.5	135.07	5885.9	302.65	551.58	6.60	6473.8	454.30	698.57	6.92	194.5	405.86	8204.666	1.07												
T230_16	287	36.6	250.5	20.6	117.5	149.11	6667.0	341.57	625.31	6.69	7225.8	503.54	776.37	7.02	195.2	536.70	11088.799	1.08												
T230_17	289	40.4	254.5	22.6	130.0	165.14	7546.5	383.04	706.30	6.76	8146.9	563.80	870.90	7.02	197.0	725.37	15177.071	1.09												
T265_1	165	11.4	262.5	8.9	33.0	41.16	2935.7	158.23	287.78	8.45	428.2	51.91	82.56	3.23	185.5	14.18	377.846	0.86												
T265_2	207	10.9	262	9	36.0	45.16	3127.2	163.73	296.03	8.32	807.2	77.99	121.85	4.23	191.0	15.17	421.701	0.94												
T265_3	166	13.6	264.5	9.7	37.0	46.91	3228.6	176.03	319.86	8.42	520.3	62.69	99.59	3.33	189.1	21.76	513.772	0.86												
T265_4	209	13.3	264	9.5	41.0	51.61	3486.4	177.48	317.96	8.22	1013.6	97.00	150.90	4.43	196.4	23.74	555.073	0.95												
T265_5	166	16.5	267.5	10.3	42.5	53.24	3742.7	192.62	350.43	8.38	631.3	76.05	120.33	3.44	194.3	34.30	671.587	0.87												
T265_6	209	15.6	266.5	10.2	46.0	58.20	3894.9	194.64	347.20	8.18	1189.0	113.78	176.88	4.52	200.1	35.60	751.058	0.95												
T265_7	210	17.4	268.5	10.9	50.5	63.91	4267.7	210.95	375.88	8.17	1345.6	128.15	199.29	4.59	202.3	48.09	969.604	0.96												
T265_8	211	18.8	269.5	11.6	54.5	68.75	4581.6	225.58	402.08	8.16	1475.0	139.81	217.68	4.63	203.1	60.27	1196.413	0.96												
T265_9	212	21.2	272	13.1	61.5	77.80	5249.5	257.37	459.89	8.21	1688.0	159.25	248.96	4.66	204.0	86.92	1745.847	0.97												
T265_10	214	23.8	274.5	14.7	69.0	87.78	5982.0	291.83	522.57	8.25	1950.4	182.28	286.03	4.71	205.0	123.97	2515.349	0.98												
T265_11	312	20.3	271.5	12.2	75.0	93.98	5439.2	250.56	438.82	7.61	5141.6	329.59	503.37	7.40	217.1	102.82	2664.788	1.17												
T265_12	313	22.2	273	14	82.5	104.60	6215.1	287.63	505.55	7.71	5678.6	362.85	556.02	7.37	216.1	138.11	3699.125	1.17												
T265_13	315	24.4	275.5	15.2	91.0	115.03	6882.7	316.31	588.13	7.74	6362.7	403.98	619.78	7.44	217.6	183.35	4933.766	1.18												
T265_14	316	26.3	277	16.5	98.0	124.47	7512.3	344.88	610.49	7.77	6925.1	438.30	673.62	7.46	217.8	231.12	6278.295	1.19												
T265_15	318	29.2	280	18.3	109.5	138.75	8491.8	387.59	689.34	7.82	7837.8	492.94	759.20	7.52	219.1	318.13	8742.297	1.20												
T265_16	315	34.5	285.5	19	124.0	156.37	9365.7	416.79	751.85	7.74	9000.4	571.45	878.47	7.59	224.7	492.50	12590.762	1.20												
T265_17	317	37.6	288.5	21.1	136.0	172.13	10545.4	467.99	847.77	7.83	10000.9	630.97	972.52	7.62	225.3	646.15	16878.259	1.21												
T265_18	319	41.4	292.5	23.1	150.0	190.07	11856.7	521.94	951.50	7.90	11225.1	703.77	1086.72	7.68	227.2	866.20	22871.114	1.22												
T305_1	178	12.8	299.5	10	41.0	51.45	4813.8	229.60	416.90	9.67	604.0	67.86	108.56	3.43	209.7	22.21	781.566	0.96												
T305_2	179	15	301.5	10.9	46.0	58.08	5422.0	254.62	463.09	9.66	720.0	80.45	128.66	3.52	212.9	32.83	1048.575	0.96												
T305_3	228	14.9	301.5	10.5	50.5	64.07	6022.6	255.00	458.41	9.43	1474.4	129.34	201.54	4.80	223.2	36.49	1089.848	1.06												
T305_4	228	17.3	304	11.2	56.5	71.55	6298.9	277.31	496.15	9.38	1712.1	150.18	233.82	4.89	227.1	53.18	1431.622	1.06												
T305_5	229	19.6	306	11.9	62.5	78.97	6878.8	298.86	533.30	9.33	1965.5	171.66	267.10	4.99	230.2	74.11	1844.379	1.07												
T305_6	230	22.2	308.5	13.1	70.0	88.57	7727.5	332.92	594.57	9.34	2256.3	196.20	305.88	5.05	232.1	106.17	2567.052	1.08												
T305_7	324	19	305.5	12.7	77.5	97.95	7843.2	327.82	573.48	8.95	5390.2	332.73	510.19	7.42	239.3	94.29	3095.720	1.26												
T305_8	325	21.6	308	14	87.0	110.30	8820.3	365.66	641.35	8.94	6185.6	380.65	584.41	7.49	241.2	136.36	4403.332	1.27												

4.3.6. SQUARE BAR

Rolled profile obtained from Catálogo Barras e perfis Gerdau [2]. Figure 6 presents its cross section and Table 27 presents their properties and dimensions.

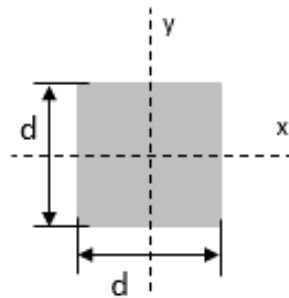


Figure 6 – Square bar

Table 27 – Properties and dimensions of square bars

Name	FEM softwares	Dimension (mm)	d	kg/m	Área (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	u (m ² /m)
SB 6	Q6	6,35	0,32	0,40	0,014	0,043	0,064	0,183	0,025	0,025
SB 8	Q8	7,94	0,49	0,63	0,033	0,083	0,125	0,229	0,032	0,032
SB 10	Q10	9,53	0,71	0,91	0,069	0,144	0,216	0,275	0,038	0,038
SB 13	Q13	12,7	1,27	1,61	0,217	0,341	0,512	0,367	0,051	0,051
SB 16	Q16	15,88	1,98	2,52	0,530	0,667	1,001	0,458	0,064	0,064
SB 19	Q19	19,05	2,85	3,63	1,097	1,152	1,728	0,550	0,076	0,076
SB 22	Q22	22,23	3,88	4,94	2,035	1,831	2,746	0,642	0,089	0,089
SB 25	Q25	25,4	5,06	6,45	3,469	2,731	4,097	0,733	0,102	0,102
SB 29	Q29	28,58	6,41	8,17	5,560	3,891	5,836	0,825	0,114	0,114
SB 32	Q32	31,75	7,91	10,08	8,468	5,334	8,001	0,917	0,127	0,127
SB 38	Q38	38,1	11,40	14,52	17,560	9,218	13,827	1,100	0,152	0,152
SB 44	Q44	44,45	15,51	19,76	32,532	14,637	21,956	1,283	0,178	0,178
SB 51	Q51	50,8	20,26	25,81	55,498	21,849	32,774	1,466	0,203	0,203

4.3.7. FLAT BAR

Rolled profile obtained from Catálogo Barras e perfis Gerdau [2]. Figure 7 presents its cross section and Table 28 to Table 30 present their properties and dimensions.

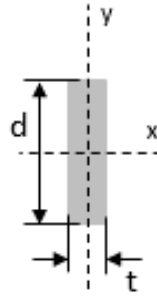


Figure 7 – Flat bar

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Table 28 – Properties and dimensions of flat bars (1/3)

Name	Dimensions (mm)				X axis										Y axis			
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ²)	Z _x (cm ²)	r _x (cm)	I _y (cm ⁴)	W _y (cm ²)	Z _y (cm ²)	r _y (cm)	u (m ² /m)			
FB 10x3,2	F10-1	9,53	3,18	0,24	0,30	0,02	0,048	0,07	0,28	0,003	0,016	0,024	0,092	0,03				
FB 13x2,5	F13-1	12,7	2,5	0,25	0,32	0,04	0,07	0,10	0,37	0,002	0,013	0,020	0,072	0,03				
FB 13x3,2	F13-2	12,7	3,18	0,32	0,40	0,05	0,09	0,13	0,37	0,003	0,021	0,032	0,092	0,03				
FB 13x4	F13-3	12,7	3,96	0,39	0,50	0,07	0,11	0,16	0,37	0,007	0,033	0,050	0,114	0,03				
FB 13x4,8	F13-4	12,7	4,76	0,47	0,60	0,08	0,13	0,19	0,37	0,011	0,048	0,072	0,137	0,03				
FB 13x6,4	F13-5	12,7	6,35	0,63	0,81	0,11	0,17	0,26	0,37	0,027	0,085	0,128	0,183	0,04				
FB 16x2,5	F16-1	15,88	2,5	0,31	0,40	0,08	0,11	0,16	0,46	0,002	0,017	0,025	0,072	0,04				
FB 16x3,2	F16-2	15,88	3,18	0,40	0,50	0,11	0,13	0,20	0,46	0,004	0,027	0,040	0,092	0,04				
FB 16x4,8	F16-3	15,88	4,76	0,59	0,76	0,16	0,20	0,30	0,46	0,014	0,060	0,090	0,137	0,04				
FB 16x6,4	F16-4	15,88	6,35	0,79	1,01	0,21	0,27	0,40	0,46	0,034	0,107	0,160	0,183	0,04				
FB 19x3,2	F19-1	19,05	3,18	0,48	0,61	0,18	0,19	0,29	0,55	0,005	0,032	0,048	0,092	0,04				
FB 19x4,8	F19-2	19,05	4,76	0,71	0,91	0,27	0,29	0,43	0,55	0,017	0,072	0,108	0,137	0,05				
FB 19x6,4	F19-3	19,05	6,35	0,95	1,21	0,37	0,38	0,58	0,55	0,041	0,128	0,192	0,183	0,05				
FB 22x3,2	F22-1	22,23	3,18	0,55	0,71	0,29	0,26	0,39	0,64	0,006	0,037	0,056	0,092	0,05				
FB 22x4,8	F22-2	22,23	4,76	0,83	1,06	0,44	0,39	0,59	0,64	0,020	0,084	0,126	0,137	0,05				
FB 22x6,4	F22-3	22,23	6,35	1,11	1,41	0,58	0,52	0,78	0,64	0,047	0,149	0,224	0,183	0,06				
FB 22x12,7	F22-4	22,23	12,7	2,22	2,82	1,16	1,05	1,57	0,64	0,379	0,598	0,896	0,367	0,07				
FB 25x3,2	F25-1	25,4	3,18	0,63	0,81	0,43	0,34	0,51	0,73	0,007	0,043	0,064	0,092	0,06				
FB 25x4,8	F25-2	25,4	4,76	0,95	1,21	0,65	0,51	0,77	0,73	0,023	0,096	0,144	0,137	0,06				
FB 25x6,4	F25-3	25,4	6,35	1,27	1,61	0,87	0,68	1,02	0,73	0,054	0,171	0,256	0,183	0,06				
FB 25x7,9	F25-4	25,4	7,94	1,58	2,02	1,08	0,85	1,28	0,73	0,106	0,267	0,400	0,229	0,07				
FB 25x9,5	F25-5	25,4	9,53	1,90	2,42	1,30	1,02	1,54	0,73	0,183	0,384	0,577	0,275	0,07				
FB 25x12,7	F25-6	25,4	12,7	2,53	3,23	1,73	1,37	2,05	0,73	0,434	0,683	1,024	0,367	0,08				
FB 32x3,2	F32-1	31,75	3,18	0,79	1,01	0,85	0,53	0,80	0,92	0,009	0,054	0,080	0,092	0,07				
FB 32x4,8	F32-2	31,75	4,76	1,19	1,51	1,27	0,80	1,20	0,92	0,029	0,120	0,180	0,137	0,07				
FB 32x6,4	F32-3	31,75	6,35	1,58	2,02	1,69	1,07	1,60	0,92	0,068	0,213	0,320	0,183	0,08				
FB 32x7,9	F32-4	31,75	7,94	1,98	2,52	2,12	1,33	2,00	0,92	0,132	0,334	0,500	0,229	0,08				
FB 32x9,5	F32-5	31,75	9,53	2,38	3,03	2,54	1,60	2,40	0,92	0,229	0,481	0,721	0,275	0,08				
FB 32x12,7	F32-6	31,75	12,7	3,17	4,03	3,39	2,13	3,20	0,92	0,542	0,853	1,280	0,367	0,09				
FB 38x3,2	F38-1	38,1	3,18	0,95	1,21	1,47	0,77	1,15	1,10	0,010	0,064	0,096	0,092	0,08				
FB 38x4,8	F38-2	38,1	4,76	1,42	1,81	2,19	1,15	1,73	1,10	0,034	0,144	0,216	0,137	0,09				
FB 38x6,4	F38-3	38,1	6,35	1,90	2,42	2,93	1,54	2,30	1,10	0,081	0,256	0,384	0,183	0,09				
FB 38x7,9	F38-4	38,1	7,94	2,37	3,03	3,66	1,92	2,88	1,10	0,159	0,400	0,600	0,229	0,09				
FB 38x9,5	F38-5	38,1	9,53	2,85	3,63	4,39	2,31	3,46	1,10	0,275	0,577	0,865	0,275	0,10				
FB 38x12,7	F38-6	38,1	12,7	3,80	4,84	5,85	3,07	4,61	1,10	0,650	1,024	1,536	0,367	0,10				
FB 38x15,9	F38-7	38,1	15,88	4,75	6,05	7,32	3,84	5,76	1,10	1,271	1,601	2,402	0,458	0,11				
FB 44x15,9	F44-1	44,45	15,88	5,54	7,06	11,62	5,23	7,84	1,28	1,483	1,868	2,802	0,458	0,12				
FB 51x3,2	F51-1	50,8	3,18	1,27	1,62	3,47	1,37	2,05	1,47	0,014	0,086	0,128	0,092	0,11				
FB 51x4,8	F51-2	50,8	4,76	1,90	2,42	5,20	2,05	3,07	1,47	0,046	0,192	0,288	0,137	0,11				

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Table 29 – Properties and dimensions of flat bars (2/3)

Name	Dimensions (mm)				X axis										Y axis			
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	I _x (cm ⁴)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	r _x (cm)	u (m ² /m)		
FB 51x6,4	F51-3		50,8	6,35	2,53	3,23	6,94	2,73	4,10	1,47	0,108	0,341	0,512	0,183	0,11			
FB 51x7,9	F51-4		50,8	7,94	3,17	4,03	8,67	3,42	5,12	1,47	0,212	0,534	0,801	0,229	0,12			
FB 51x9,5	F51-5		50,8	9,53	3,80	4,84	10,41	4,10	6,15	1,47	0,366	0,769	1,153	0,275	0,12			
FB 51x12,7	F51-6		50,8	12,7	5,06	6,45	13,87	5,46	8,19	1,47	0,867	1,366	2,048	0,367	0,13			
FB 51x15,9	F51-7		50,8	15,88	6,33	8,07	17,35	6,83	10,25	1,47	1,695	2,135	3,203	0,458	0,13			
FB 51x19,1	F51-8		50,8	19,05	7,60	9,68	20,81	8,19	12,29	1,47	2,927	3,073	4,609	0,550	0,14			
FB 51x25,4	F51-9		50,8	25,4	10,13	12,90	27,75	10,92	16,39	1,47	6,937	5,462	8,194	0,733	0,15			
FB 64x6,4	F64-1		63,5	6,35	3,17	4,03	13,55	4,27	6,40	1,83	0,135	0,427	0,640	0,183	0,14			
FB 64x7,9	F64-2		63,5	7,94	3,96	5,04	16,94	5,34	8,00	1,83	0,265	0,667	1,001	0,229	0,14			
FB 64x9,5	F64-3		63,5	9,53	4,75	6,05	20,33	6,40	9,61	1,83	0,458	0,961	1,442	0,275	0,15			
FB 64x12,7	F64-4		63,5	12,7	6,33	8,06	27,10	8,53	12,80	1,83	1,084	1,707	2,560	0,367	0,15			
FB 64x15,9	F64-5		63,5	15,88	7,92	10,08	33,88	10,67	16,01	1,83	2,119	2,669	4,003	0,458	0,16			
FB 64x19,1	F64-6		63,5	19,05	9,50	12,10	40,65	12,80	19,20	1,83	3,658	3,841	5,761	0,550	0,17			
FB 76x6,4	F76-1		76,2	6,35	3,80	4,84	23,41	6,15	9,22	2,20	0,163	0,512	0,768	0,183	0,17			
FB 76x7,9	F76-2		76,2	7,94	4,75	6,05	29,28	7,68	11,53	2,20	0,318	0,801	1,201	0,229	0,17			
FB 76x9,5	F76-3		76,2	9,53	5,70	7,26	35,14	9,22	13,83	2,20	0,550	1,153	1,730	0,275	0,17			
FB 76x12,7	F76-4		76,2	12,7	7,60	9,68	46,83	12,29	18,44	2,20	1,301	2,048	3,073	0,367	0,18			
FB 76x15,9	F76-5		76,2	15,88	9,50	12,10	58,55	15,37	23,05	2,20	2,543	3,203	4,804	0,458	0,18			
FB 76x19,1	F76-6		76,2	19,05	11,40	14,52	70,24	18,44	27,65	2,20	4,390	4,609	6,913	0,550	0,20			
FB 76x25,4	F76-7		76,2	25,4	15,19	19,35	93,65	24,58	36,87	2,20	10,406	8,194	12,290	0,733	0,20			
FB 76x50,8	F76-8		76,2	50,8	30,39	38,71	187,30	49,16	73,74	2,20	83,246	32,774	49,161	1,466	0,25			
FB 89x15,9	F89-1		88,9	15,88	11,08	14,12	92,98	20,92	31,38	2,57	2,967	3,736	5,605	0,458	0,21			
FB 89x17,5	F89-2		88,9	17,46	12,18	15,52	102,23	23,00	34,50	2,57	3,943	4,517	6,775	0,504	0,21			
FB 89x19,1	F89-3		88,9	19,05	13,29	16,94	111,54	25,09	37,64	2,57	5,122	5,377	8,066	0,550	0,22			
FB 89x25,4	F89-4		88,9	25,4	17,73	22,58	148,72	33,46	50,19	2,57	12,140	9,559	14,339	0,733	0,23			
FB 102x6,4	F102-1		101,6	6,35	5,06	6,45	55,50	10,92	16,39	2,93	0,217	0,683	1,024	0,183	0,22			
FB 102x7,9	F102-2		101,6	7,94	6,33	8,07	69,39	13,66	20,49	2,93	0,424	1,068	1,601	0,229	0,22			
FB 102x9,5	F102-3		101,6	9,53	7,60	9,68	83,29	16,40	24,59	2,93	0,733	1,538	2,307	0,275	0,22			
FB 102x12,7	F102-4		101,6	12,7	10,13	12,90	111,00	21,85	32,77	2,93	1,734	2,731	4,097	0,367	0,23			
FB 102x15,9	F102-5		101,6	15,88	12,67	16,13	138,79	27,32	40,98	2,93	3,391	4,270	6,405	0,458	0,23			
FB 102x19,1	F102-6		101,6	19,05	15,19	19,35	166,49	32,77	49,16	2,93	5,853	6,145	9,218	0,550	0,24			
FB 102x25,4	F102-7		101,6	25,4	20,26	25,81	221,99	43,70	65,55	2,93	13,874	10,925	16,387	0,733	0,25			
FB 102x31,8	F102-8		101,6	31,75	25,32	32,26	277,49	54,62	81,94	2,93	27,098	17,070	25,605	0,917	0,27			
FB 102x38,1	F102-9		101,6	38,1	30,39	38,71	332,99	65,55	98,32	2,93	46,826	24,581	36,871	1,100	0,28			
FB 108x38,1	F108-1		107,95	38,1	32,29	41,13	399,40	74,00	111,00	3,12	49,753	26,117	39,175	1,100	0,29			
FB 114x12,7	F114-1		114,3	12,7	11,40	14,52	158,04	27,65	41,48	3,30	1,951	3,073	4,609	0,367	0,25			
FB 121x9,5	F121-1		120,65	9,53	9,03	11,50	139,47	23,12	34,68	3,48	0,870	1,826	2,739	0,275	0,26			
FB 152x6,4	F152-1		152,4	6,35	7,60	9,68	187,30	24,58	36,87	4,40	0,325	1,024	1,536	0,183	0,32			
FB 152x7,9	F152-2		152,4	7,94	9,50	12,10	234,20	30,74	46,10	4,40	0,636	1,601	2,402	0,229	0,32			

Table 30 – Properties and dimensions of flat bars (3/3)

Name	Dimensions (mm)				X axis						Y axis					
	Original	FEM softwares	d	t	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	I _y (cm ⁴)	W _y (cm ³)	Z _y (cm ³)	r _y (cm)	u (m ² /m)	
FB 152x9,5	F152-3	152,4	9,53	11,40	14,52	281,10	36,89	55,34	4,40	1,099	2,307	3,460	0,275	0,32		
FB 152x12,7	F152-4	152,4	12,7	15,19	19,35	374,61	49,16	73,74	4,40	2,601	4,097	6,145	0,367	0,33		
FB 152x15,9	F152-5	152,4	15,88	19,00	24,20	468,41	61,47	92,21	4,40	5,086	6,405	9,608	0,458	0,34		
FB 152x19,1	F152-6	152,4	19,05	22,79	29,03	561,91	73,74	110,61	4,40	8,780	9,218	13,827	0,550	0,34		
FB 152x25,4	F152-7	152,4	25,4	30,39	38,71	749,22	98,32	147,48	4,40	20,812	16,387	24,581	0,733	0,36		
FB 203x6,4	F203-1	203,2	6,35	10,13	12,90	443,98	43,70	65,55	5,87	0,434	1,366	2,048	0,183	0,42		
FB 203x7,9	F203-2	203,2	7,94	12,67	16,13	555,15	54,64	81,96	5,87	0,848	2,135	3,203	0,229	0,42		
FB 203x9,5	F203-3	203,2	9,53	15,20	19,36	666,32	65,58	98,37	5,87	1,466	3,076	4,614	0,275	0,43		
FB 203x12,7	F203-4	203,2	12,7	20,26	25,81	887,96	87,40	131,10	5,87	3,469	5,462	8,194	0,367	0,43		
FB 203x15,9	F203-5	203,2	15,88	25,33	32,27	1110,30	109,28	163,92	5,87	6,781	8,540	12,810	0,458	0,44		
FB 203x19,1	F203-6	203,2	19,05	30,39	38,71	1331,94	131,10	196,64	5,87	11,707	12,290	18,435	0,550	0,44		
FB 203x25,4	F203-7	203,2	25,4	40,52	51,61	1775,92	174,80	262,19	5,87	27,749	21,849	32,774	0,733	0,46		

4.3.8. ROUND BAR

Rolled profile obtained from Catálogo Barras e perfis Gerdau [2]. Figure 8 presents its cross section and Table 31 and Table 32 present their properties and dimensions.

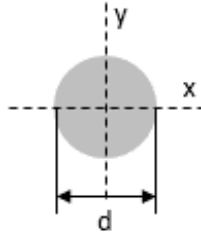


Figure 8 – Round bar

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Table 31 – Properties and dimensions of round bars (1/2)

Name	Original	FEM softwares	Dimension (mm)	d	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ²)	r _x (cm)	J (cm ⁴)	X axis = Y axis	
												u (m ² /m)	
RB 6	R6		6,35	0,25	0,32	0,008	0,03	0,04	0,16	0,016	0,02		
RB 8	R8		7,94	0,39	0,50	0,020	0,05	0,08	0,20	0,039	0,02		
RB 10	R10		9,53	0,56	0,71	0,040	0,08	0,14	0,24	0,081	0,03		
RB 13	R13		12,7	0,99	1,27	0,128	0,20	0,34	0,32	0,255	0,04		
RB 14	R14		14,29	1,26	1,60	0,205	0,29	0,49	0,36	0,409	0,04		
RB 16	R16		15,88	1,55	1,98	0,312	0,39	0,67	0,40	0,624	0,05		
RB 17	R17		17,46	1,88	2,39	0,456	0,52	0,89	0,44	0,912	0,05		
RB 19	R19		19,05	2,24	2,85	0,646	0,68	1,15	0,48	1,293	0,06		
RB 21	R21		20,64	2,63	3,35	0,891	0,86	1,47	0,52	1,782	0,06		
RB 22	R22		22,23	3,05	3,88	1,199	1,08	1,83	0,56	2,397	0,07		
RB 24	R24		23,81	3,50	4,45	1,578	1,33	2,25	0,60	3,155	0,07		
RB 25	R25		25,4	3,98	5,07	2,043	1,61	2,73	0,64	4,086	0,08		
RB 27	R27		26,99	4,49	5,72	2,605	1,93	3,28	0,67	5,210	0,08		
RB 29	R29		28,58	5,04	6,42	3,275	2,29	3,89	0,71	6,550	0,09		
RB 30	R30		30,16	5,61	7,14	4,062	2,69	4,57	0,75	8,123	0,09		
RB 32	R32		31,75	6,22	7,92	4,988	3,14	5,33	0,79	9,976	0,10		
RB 33	R33		33,34	6,85	8,73	6,065	3,64	6,17	0,83	12,130	0,10		
RB 35	R35		34,93	7,52	9,58	7,307	4,18	7,10	0,87	14,615	0,11		
RB 37	R37		36,51	8,22	10,47	8,722	4,78	8,11	0,91	17,444	0,11		
RB 38	R38		38,1	8,95	11,40	10,344	5,43	9,22	0,95	20,687	0,12		
RB 40	R40		39,69	9,71	12,37	12,181	6,14	10,42	0,99	24,363	0,12		
RB 41	R41		41,28	10,51	13,38	14,254	6,91	11,72	1,03	28,507	0,13		
RB 43	R43		42,86	11,33	14,43	16,565	7,73	13,12	1,07	33,129	0,13		
RB 44	R44		44,45	12,18	15,52	19,163	8,62	14,63	1,11	38,325	0,14		
RB 46	R46		46,04	13,07	16,65	22,050	9,58	16,26	1,15	44,101	0,14		
RB 48	R48		47,63	13,99	17,82	25,263	10,61	18,00	1,19	50,527	0,15		
RB 51	R51		50,8	15,91	20,27	32,691	12,87	21,84	1,27	65,381	0,16		
RB 52	R52		52,39	16,92	21,56	36,980	14,12	23,96	1,31	73,959	0,16		
RB 54	R54		53,98	17,96	22,89	41,677	15,44	26,21	1,35	83,355	0,17		
RB 57	R57		57,15	20,14	25,65	52,364	18,33	31,10	1,43	104,728	0,18		
RB 59	R59		58,74	21,27	27,10	58,439	19,90	33,77	1,47	116,879	0,18		
RB 60	R60		60,33	22,44	28,59	65,028	21,56	36,59	1,51	130,057	0,19		
RB 62	R62		61,91	23,63	30,10	71,113	23,30	39,54	1,55	144,226	0,19		
RB 64	R64		63,5	24,86	31,67	79,811	25,14	42,66	1,59	159,623	0,20		
RB 65	R65		65,08	26,11	33,26	88,056	27,06	45,93	1,63	176,112	0,20		
RB 67	R67		66,68	27,41	34,92	97,040	29,11	49,40	1,67	194,081	0,21		
RB 70	R70		69,85	30,08	38,32	116,852	33,46	56,79	1,75	233,704	0,22		
RB 71	R71		71,44	31,46	40,08	127,842	35,79	60,75	1,79	255,685	0,22		
RB 73	R73		73,03	32,88	41,89	139,629	38,24	64,90	1,83	279,258	0,23		

Table 32 – Properties and dimensions of round bars (2/2)

Name	Dimension (mm)	X axis = Y axis										
		Original	FEM softwares	d	kg/m	Area (cm ²)	I _x (cm ⁴)	W _x (cm ³)	Z _x (cm ³)	r _x (cm)	J (cm ⁴)	u (m ² /m)
RB 76	R76			76,2	35,80	45,60	165,497	43,44	73,72	1,91	330,994	0,24
RB 78	R78			77,79	37,31	47,53	179,748	46,21	78,44	1,94	359,497	0,24
RB 79	R79			79,38	38,85	49,49	194,901	49,11	83,34	1,98	389,802	0,25
RB 83	R83			82,55	42,01	53,52	227,949	55,23	93,73	2,06	455,899	0,26
RB 87	R87			87,31	47,00	59,87	285,250	65,34	110,90	2,18	570,500	0,27
RB 89	R89			88,9	48,73	62,07	306,603	68,98	117,07	2,22	613,207	0,28
RB 95	R95			95,25	55,94	71,26	404,045	84,84	143,99	2,38	808,090	0,30
RB 102	R102			101,6	63,64	81,07	523,052	102,96	174,75	2,54	1046,104	0,32
RB 103	R103			103,19	65,65	83,63	556,571	107,87	183,09	2,58	1113,141	0,32

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ANNEX

All tables present in this document are in the excel file attached below.



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