

#### 4. TEMPERATURE IN STEEL SECTIONS

**Table 4.5:** Box value of the section factor  $[A_m/V]_b$

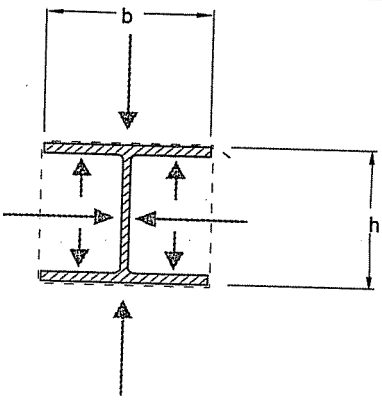
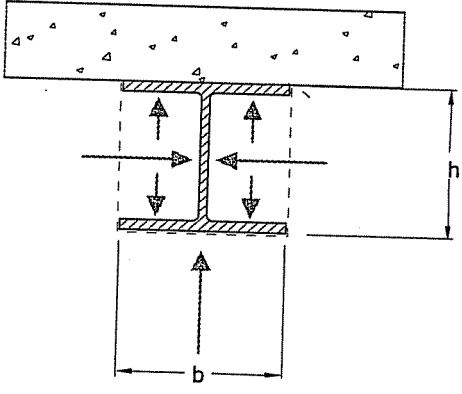
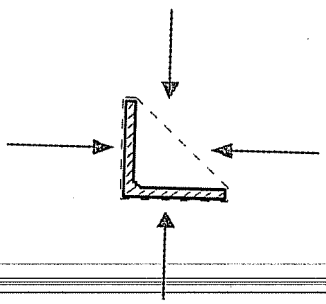
Sketch	Section factor $[A_m/V]_b$
	$\frac{2(b + h)}{\text{Steel cross-Section area}}$
	$\frac{2h + b}{\text{Steel cross-Section area}}$
	$\frac{\text{box perimeter}^*}{\text{Steel cross-Section area}}$
<p>* The dotted line defines the box perimeter that corresponds to the smallest box surrounding the section (Franssen J-M, <i>et al.</i>, 2009)</p>	

Table 4.6 gives the temperature after 30 minutes and 60 minutes of standard fire ISO 834 exposure, for different values of the modified section factor  $k_{sh}[A_m/V]$ .

The procedures for verifying the fire resistance of a tension member were shown in all three domains. To achieve the required fire resistance of R30 the member must be protected.

### Example 5.2: Laterally restrained beam

Consider a simply supported restrained beam 4.0 long, constructed from an IPE 300 section, in steel grade S235, supporting a concrete slab. Assuming the steel beam does not act compositely with the concrete slab and that the design load in the fire situation is  $q_{fi,Ed} = 33.8$  kN/m, verify if it is necessary to protect the beam for a fire resistance period of R90. If fire protection is needed, use fibre-cement boards.

#### Solution:

The relevant geometrical characteristics of the profile for the cross section classification are

$$h = 300 \text{ mm}$$

$$b = 150 \text{ mm}$$

$$t_w = 7.1 \text{ mm}$$

$$t_f = 10.7 \text{ mm}$$

$$r = 15 \text{ mm}$$

$$c = b/2 - t_w/2 - r = 56.45 \text{ mm (flange)}$$

$$c = h - 2t_f - 2r = 248.6 \text{ mm (web)}$$

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As the steel grade is S235

$$\varepsilon = 0.85 \sqrt{235 / f_y} = 0.85$$

The class of the flange in compression is

$$c/t_f = 56.45/10.7 = 5.3 < 9\varepsilon = 6.8 \Rightarrow \text{Class 1}$$

For the web in bending the class is

$$d/t_w = 248.6/7.1 = 35 < 72\varepsilon = 61.2 \Rightarrow \text{Class 1}$$

The cross section of the IPE 300 in bending and in fire situation is Class 1.



## 5. MECHANICAL ANALYSIS

This classification could be directly obtained using the table for cross-sectional classification of Annex F, Vila Real *et al.*, 2009b.

### At mid span:

The next step is to calculate the fire resistance of the unprotected beam. The design value of the resistance moment at time  $t = 0$ ,  $M_{fi,0,Rd}$ , according to Eq. (5.50), is

$$M_{fi,0,Rd} = W_{pl,y} f_y / (k_1 k_2 \gamma_{M,fi})$$

where:

$k_1 = 0.7$  for an unprotected beam exposed on three sides, with a concrete slab on the fourth side;

$k_2 = 1.0$  for sections not at the supports.

The plastic section modulus  $W_{pl,y}$  of the IPE 300 profile is

$$W_{pl,y} = 628 \times 10^{-6} \text{ m}^3$$

and

$$M_{fi,0,Rd} = 211 \text{ kNm}$$

The degree of utilisation takes the value

$$\mu_0 = \frac{M_{fi,Ed}}{M_{fi,0,Rd}} = \frac{67.6}{211} = 0.32$$

and from Eq. (5.85) the critical temperature

$$\theta_{a,cr} = 654 \text{ } ^\circ\text{C}$$

Considering that the section factor for the IPE 300 is  $A_m/V = 187 \text{ m}^{-1}$ , and that

$$h = 300 \text{ mm}$$

$$b = 150 \text{ mm}$$

$$A = 53.8 \text{ cm}^2$$

the box value of the section factor  $[A_m/V]_b$ , is, according to the Table 4.5



$$\underline{[A_m/V]_b} = \frac{2h+b}{A} = \frac{2 \cdot 0.3 + 0.15}{53.8 \times 10^{-4}} = \underline{139 \text{ m}^{-1}}$$

and the correction factor for the shadow effect

$$k_{sh} = 0.9[A_m/V]_b/[A_m/V] = 0.9 \cdot 139/187 = 0.669$$

The modified section factor thus takes the value

$$k_{sh}[A_m/V] = 0.669 \cdot 187 = 125 \text{ m}^{-1} \leftarrow 0.9 \cdot 139$$

This value could be directly obtaining from the table of Annex E, Vila Real *et al.*, 2009a.

Interpolation of the values given in Table A.4 yields a time of 18 min. to reach the critical temperature,  $\theta_{a,cr} = 654 \text{ }^\circ\text{C}$ . This is less than the required 90 min. and therefore fire protection is necessary to achieve the required fire resistance.

As the value of  $k_2$  depends on whether or not the profile is protected, a new critical temperature must be obtained for the protected section. Considering  $k_1 = 0.85$ , the design value of the resistance moment at time  $t = 0$ ,  $M_{fi,0,Rd}$  is

$$M_{fi,0,Rd} = W_{pl,y} f_y / k_1 k_2 = W_{pl,y} f_y / (0.7 \cdot 0.85) = 174 \text{ kNm}$$

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The degree of utilisation takes the value

$$\mu_0 = \frac{M_{fi,Ed}}{M_{fi,0,Rd}} = \frac{67.6}{174} = 0.389$$

and from Eq. (5.85) the critical temperature is

$$\theta_{a,cr} = 624 \text{ }^\circ\text{C}$$

The thickness of a contour encasement protection with fibre-cement boards necessary to prevent the steel temperature exceeding the critical temperature before the required time of 90 minutes is 16 mm (see example 4.4).

**At the supports:**

Verification of the design shear resistance



## 5. MECHANICAL ANALYSIS

$$V_{fi,Ed} = \frac{q_{fi,Ed} \cdot l}{2} = 67.6 \text{ kN}$$

The shear area is

$$A_v = A - 2bt_f + (t_w + 2r)t_f \\ = 5380 - 2 \cdot 150 \cdot 10.7 + (7.1 + 2 \cdot 15)10.7 = 2567 \text{ mm}^2$$

Considering that the reduction factor for the yield strength for 624 °C is equal to the degree of utilisation

$$k_{y,\theta} = \mu_0 = 0.388$$

and the design value of the shear force at that temperature is

$$V_{fi,t,Rd} = \frac{A_v k_{y,\theta} f_y}{\sqrt{3} \gamma_{M0}} = \frac{2567 \cdot 0.388 \cdot 235}{\sqrt{3}} \times 10^{-3} = 135 \text{ kN} > N_{fi,Ed} \quad \text{OK!}$$

If interpolation in Table 5.2 was made for 624 °C,  $k_{y,\theta} = 0.412$  and

$$V_{fi,t,Rd} = \frac{A_v k_{y,\theta} f_y}{\sqrt{3} \gamma_{M0}} = \frac{2567 \cdot 0.412 \cdot 235}{\sqrt{3}} \times 10^{-3} = 144 \text{ kN}$$

### Example 5.3: Unprotected column under axial compression

Consider a 3.5 m long HE 180 B column in S275 grade steel, located in an intermediate storey of a braced frame and subject to a compression load of  $N_{fi,Ed} = 495 \text{ kN}$  in the fire situation. Assuming that the column doesn't have any fire protection and that the required fire resistance is R30, verify the fire resistance in each of the following domains:

- Temperature;
- Time;
- Resistance.

**Solution:**

**Classification of the cross section:**

The relevant geometrical characteristics of the profile for the cross section

**A.4. TABLES AND NOMOGRAMS FOR EVALUATING THE TEMP. IN UNPROTECTED STEEL  
MEMBERS SUBJECTED TO THE STANDARD FIRE CURVE ISO 834**

**A.4. TABLES AND NOMOGRAMS FOR EVALUATING THE  
TEMPERATURE IN UNPROTECTED STEEL MEMBERS  
SUBJECTED TO THE STANDARD FIRE CURVE ISO 834**

Temperature of unprotected steel in °C, exposed to the ISO 834 fire curve

for different values of  $k_{sh} \frac{A_m}{V}$ , [m<sup>-1</sup>]

Time [min.]	10 m <sup>-1</sup>	15 m <sup>-1</sup>	20 m <sup>-1</sup>	25 m <sup>-1</sup>	30 m <sup>-1</sup>	40 m <sup>-1</sup>	60 m <sup>-1</sup>	100 m <sup>-1</sup>	200 m <sup>-1</sup>	300 m <sup>-1</sup>	400 m <sup>-1</sup>
0	20	20	20	20	20	20	20	20	20	20	20
1	21	22	23	24	24	26	29	34	48	61	73
2	25	27	29	31	33	38	46	62	100	133	162
3	29	33	37	41	45	53	68	97	161	214	259
4	33	40	46	52	59	71	94	136	226	296	351
5	39	48	57	65	74	90	122	178	291	373	430
6	45	57	68	79	90	111	151	221	354	441	494
7	51	66	80	94	108	133	181	265	413	498	545
8	58	76	93	110	126	156	213	308	466	545	584
9	65	86	106	126	144	180	245	351	512	583	615
10	73	97	120	142	164	204	277	392	552	614	640
11	80	108	134	159	183	229	309	432	587	640	660
12	88	119	149	177	204	253	340	469	616	662	678
13	97	131	164	195	224	278	372	503	641	680	693
14	105	143	179	213	244	303	402	535	663	695	705
15	114	155	194	231	265	328	432	565	682	708	716
16	122	167	210	249	286	353	460	591	697	718	725
17	131	180	225	268	307	377	487	615	710	727	732
18	140	193	241	286	328	401	513	638	721	733	736
19	150	206	257	305	348	425	538	658	729	737	743
20	159	218	273	323	369	448	561	676	734	743	754
21	168	232	289	342	389	470	583	692	738	754	767
22	178	245	305	360	409	491	604	706	744	767	780
23	188	258	321	378	429	512	623	717	754	780	790



# A. THERMAL DATA FOR CARBON AND STAINLESS STEEL SECTIONS

Temperature of unprotected steel in °C, exposed to the ISO 834 fire curve  
for different values of  $k_{sh} \frac{A_m}{V}$ , [m<sup>-1</sup>] (continued)

Time [min.]	10 m <sup>-1</sup>	15 m <sup>-1</sup>	20 m <sup>-1</sup>	25 m <sup>-1</sup>	30 m <sup>-1</sup>	40 m <sup>-1</sup>	60 m <sup>-1</sup>	100 m <sup>-1</sup>	200 m <sup>-1</sup>	300 m <sup>-1</sup>	400 m <sup>-1</sup>
24	197	271	337	396	448	532	641	726	767	791	799
25	207	284	353	414	467	552	658	732	780	801	807
26	217	298	369	432	485	570	674	735	792	809	813
27	227	311	385	449	503	588	688	739	803	816	820
28	237	324	401	466	521	604	701	746	813	823	826
29	247	338	416	482	538	621	712	756	821	829	831
30	257	351	431	498	554	636	721	767	828	835	837
31	267	364	446	514	570	651	728	780	835	840	842
32	277	377	461	530	585	665	733	793	841	845	847
33	288	391	476	545	600	678	736	805	846	850	852
34	298	404	490	559	614	690	740	816	851	855	856
35	308	416	504	574	628	701	745	827	856	860	861
36	318	429	518	587	641	711	753	836	861	864	865
37	329	442	532	601	654	719	763	844	866	868	870
38	339	454	545	614	666	726	774	852	870	873	874
39	349	467	558	626	677	731	786	859	874	877	878
40	359	479	570	638	688	734	798	865	878	881	882
41	369	491	582	650	698	737	810	871	882	884	885
42	379	503	594	661	707	740	822	876	886	888	889
43	389	514	606	672	716	746	832	881	890	892	893
44	399	526	617	683	722	752	842	885	893	895	896
45	409	537	628	692	728	761	852	889	897	899	900
46	419	548	639	701	732	771	860	894	900	902	903
47	429	559	650	709	735	781	868	897	904	906	906
48	439	570	660	717	737	792	875	901	907	909	910
49	449	580	670	723	740	803	882	905	910	912	913
50	458	590	679	728	744	814	888	908	914	915	916

A.4. TABLES AND NOMOGRAMS FOR EVALUATING THE TEMP. IN UNPROTECTED STEEL  
MEMBERS SUBJECTED TO THE STANDARD FIRE CURVE ISO 834

Temperature of unprotected steel in °C, exposed to the ISO 834 fire curve  
for different values of  $k_{sh} \frac{A_m}{V}$ , [m<sup>-1</sup>] (continued)

Time [min.]	10 m <sup>-1</sup>	15 m <sup>-1</sup>	20 m <sup>-1</sup>	25 m <sup>-1</sup>	30 m <sup>-1</sup>	40 m <sup>-1</sup>	60 m <sup>-1</sup>	100 m <sup>-1</sup>	200 m <sup>-1</sup>	300 m <sup>-1</sup>	400 m <sup>-1</sup>
51	468	600	688	732	750	825	894	911	917	918	919
52	477	610	697	734	757	835	899	915	920	921	922
53	487	620	704	736	765	845	904	918	923	924	925
54	496	629	711	739	774	854	908	921	926	927	928
55	505	638	718	743	784	863	913	924	928	930	930
56	514	648	723	747	794	872	917	927	931	932	933
57	523	656	728	753	804	880	920	930	934	935	936
58	532	665	731	760	814	887	924	933	937	938	938
59	541	673	734	768	825	894	927	935	939	940	941
60	549	681	736	777	834	901	931	938	942	943	944
61	558	689	738	786	844	907	934	941	944	946	946
62	566	696	741	796	853	912	937	943	947	948	949
63	574	703	744	805	862	917	940	946	949	950	951
64	583	709	749	815	871	922	942	948	952	953	953
65	591	715	755	824	879	927	945	951	954	955	956
66	598	720	761	834	887	931	948	953	957	958	958
67	606	725	769	843	894	935	950	956	959	960	960
68	614	728	776	852	901	939	953	958	961	962	963
69	622	731	785	861	907	943	955	960	963	964	965
70	629	734	793	869	914	946	958	963	966	967	967
71	636	735	802	877	919	949	960	965	968	969	969
72	644	737	811	885	925	953	963	967	970	971	971
73	651	739	820	893	930	956	965	969	972	973	973
74	658	742	829	900	935	958	967	971	974	975	975
75	665	745	837	906	939	961	969	973	976	977	977
76	671	750	846	913	944	964	972	975	978	979	979
77	678	755	855	919	948	966	974	978	980	981	981
78	684	760	863	925	952	969	976	980	982	983	983



# A. THERMAL DATA FOR CARBON AND STAINLESS STEEL SECTIONS

Temperature of unprotected steel in °C, exposed to the ISO 834 fire curve  
for different values of  $k_{sh} \frac{A_m}{V}$ , [m<sup>-1</sup>] (continued)

Time [min.]	10 m <sup>-1</sup>	15 m <sup>-1</sup>	20 m <sup>-1</sup>	25 m <sup>-1</sup>	30 m <sup>-1</sup>	40 m <sup>-1</sup>	60 m <sup>-1</sup>	100 m <sup>-1</sup>	200 m <sup>-1</sup>	300 m <sup>-1</sup>	400 m <sup>-1</sup>
79	690	767	871	930	955	971	978	982	984	985	985
80	696	773	879	935	959	974	980	984	986	987	987
81	702	780	886	940	962	976	982	985	988	989	989
82	707	788	893	945	966	978	984	987	990	991	991
83	712	795	900	949	969	980	986	989	992	992	993
84	716	803	907	954	972	983	988	991	993	994	995
85	720	811	914	958	974	985	990	993	995	996	996
86	724	819	920	961	977	987	992	995	997	998	998
87	727	827	926	965	980	989	993	997	999	1000	1000
88	730	835	931	969	982	991	995	998	1001	1001	1002
89	732	843	937	972	985	993	997	1000	1002	1003	1003
90	734	851	942	975	987	995	999	1002	1004	1005	1005

## **Annex E**

# **SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES**

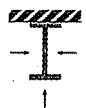
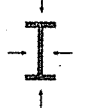



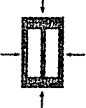
This annex presents tables with values of the section factor for unprotected ( $A_m/V$ ) and protected ( $A_p/V$ ), I and H European hot rolled steel profiles as well as values of the modified section factor  $k_{sh}A_m/V$  in accordance with EN 1993-1-2.



# E. SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES

Designation IPE	Unprotected sections		Protected sections			
	$k_{sh} A_m/V$		$A_p/V$			
	3 sides	4 sides	contour 3 sides	contour 4 sides	hollow 3 sides	hollow 4 sides
IPE AA 80	288.1	353.7	442.2	515.1	320.1	393.0
IPE A 80	285.0	349.8	437.3	509.4	316.6	388.7
IPE 80	242.7	296.9	369.1	429.3	269.6	329.8
IPE AA 100	263.1	320.9	398.3	462.6	292.3	356.5
IPE A 100	257.3	313.7	389.5	452.2	285.9	348.5
IPE 100	222.8	270.9	335.0	388.3	247.6	301.0
IPE AA 120	251.8	305.9	381.6	441.7	279.8	339.9
IPE A 120	244.8	297.2	370.9	429.1	272.0	330.2
IPE 120	207.3	250.9	311.4	359.8	230.3	278.8
IPE AA 140	243.2	294.5	368.9	425.9	270.3	327.2
IPE A 140	233.6	282.6	353.7	408.2	259.6	314.0
IPE 140	193.7	233.8	291.5	336.0	215.2	259.8
IPE AA 160	230.7	278.6	349.9	403.1	256.4	309.6
IPE A 160	220.0	265.6	331.5	382.1	244.4	295.1
IPE 160	180.0	216.7	269.2	310.0	200.0	240.8
IPE AA 180	209.9	252.9	316.2	364.0	233.2	281.0
IPE A 180	204.3	246.1	307.7	354.1	227.0	273.5
IPE 180	169.8	204.1	254.0	292.1	188.7	226.8
IPE O 180	151.4	182.0	226.2	260.1	168.3	202.2
IPE AA 200	193.9	233.3	290.0	333.7	215.5	259.2
IPE A 200	189.2	227.5	282.6	325.1	210.2	252.8
IPE 200	157.9	189.5	234.4	269.5	175.4	210.5
IPE O 200	142.3	171.0	211.6	243.4	158.1	190.0
IPE AA 220	181.0	217.7	271.5	312.3	201.1	241.9
IPE A 220	173.0	208.0	259.0	297.9	192.2	231.1
IPE 220	148.2	177.8	221.0	253.9	164.7	197.6
IPE O 220	133.8	160.7	199.5	229.4	148.7	178.6
IPE AA 240	168.2	202.3	251.5	289.3	186.9	224.8
IPE A 240	160.5	193.0	239.6	275.7	178.4	214.4
IPE 240	138.1	165.7	205.1	235.8	153.5	184.1
IPE O 240	124.8	149.9	185.4	213.3	138.7	166.6
IPE A 270	153.6	184.6	230.1	264.5	170.7	205.1
IPE 270	132.4	158.8	197.4	226.8	147.1	176.5
IPE O 270	114.4	137.2	170.1	195.4	127.1	152.4
IPE A 300	144.0	173.0	216.3	248.6	160.0	192.3

# E. SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES







Designation IPE	Unprotected sections		Protected sections			
						
	$k_{sh} A_m/V$		$A_p/V$			
	3 sides	4 sides	contour 3 sides	contour 4 sides	hollow 3 sides	hollow 4 sides
IPE 300	125.5	150.6	187.7	215.6	139.4	167.3
IPE O 300	108.9	130.7	162.7	186.9	121.0	145.2
IPE A 330	133.9	160.3	199.3	228.5	148.8	178.1
IPE 330	117.9	140.9	174.8	200.3	131.0	156.5
IPE O 330	102.9	123.0	152.3	174.7	114.3	136.6
IPE A 360	124.5	148.4	184.5	211.1	138.3	164.9
IPE 360	110.2	131.2	162.7	186.1	122.4	145.8
IPE O 360	96.3	114.7	142.1	162.5	107.0	127.5
IPE A 400	119.9	142.1	175.6	200.3	133.2	157.9
IPE 400	104.4	123.6	152.3	173.6	116.0	137.3
IPE O 400	92.4	109.4	134.8	153.6	102.7	121.6
IPE A 450	114.0	133.9	165.1	187.3	126.6	148.8
IPE 450	99.3	116.6	143.2	162.4	110.3	129.6
IPE O 450	84.2	98.8	121.2	137.5	93.6	109.8
IPE A 500	106.4	124.2	152.6	172.4	118.2	138.0
IPE 500	93.1	108.6	133.1	150.3	103.4	120.7
IPE O 500	79.8	93.0	113.7	128.5	88.6	103.4
IPE A 550	100.3	116.5	142.3	160.3	111.5	129.4
IPE 550	88.0	102.1	124.4	140.1	97.8	113.4
IPE O 550	76.4	88.6	107.8	121.3	84.9	98.5
IPE A 600	92.9	107.3	130.9	146.9	103.2	119.3
IPE 600	81.9	94.6	115.1	129.2	91.0	105.1
IPE O 600	66.0	76.2	92.4	103.8	73.3	84.7
IPE 750 x 137	91.0	104.5	128.2	143.2	101.1	116.1
IPE 750 x 147	84.8	97.5	119.4	133.5	94.2	108.3
IPE 750 x 173	72.9	83.8	102.6	114.7	81.0	93.1
IPE 750 x 196	64.8	74.4	91.0	101.7	72.0	82.7

# E. SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES







Designation HE	Unprotected sections		Protected sections			
	$k_{sh} A_m/V$		$A_p/V$			
	3 sides	4 sides	contour 3 sides	contour 4 sides	hollow 3 sides	hollow 4 sides
HE 100 AA	162.7	220.4	290.4	354.5	180.8	244.9
HE 100 A	124.0	166.4	217.5	264.6	137.7	184.9
HE 100 B	103.8	138.5	179.6	218.1	115.4	153.8
HE 100 C	74.0	97.6	124.8	151.0	82.2	108.4
HE 100 M	58.5	76.5	96.4	116.4	65.0	85.0
HE 120 AA	163.5	221.6	295.2	359.7	181.7	246.2
HE 120 A	123.8	166.5	220.2	267.6	137.5	185.0
HE 120 B	95.3	127.1	166.5	201.8	105.9	141.2
HE 120 C	69.1	91.3	118.1	142.8	76.8	101.4
HE 120 M	55.0	72.1	92.2	111.1	61.1	80.1
HE 140 AA	155.0	209.7	281.3	342.2	172.2	233.0
HE 140 A	116.4	156.5	208.3	252.9	129.3	173.9
HE 140 B	87.9	117.2	154.7	187.2	97.7	130.2
HE 140 C	64.8	85.8	111.9	135.2	72.0	95.3
HE 140 M	52.0	68.3	88.2	106.3	57.8	75.9
HE 160 AA	135.0	182.4	243.8	296.4	150.0	202.6
HE 160 A	107.6	144.7	192.3	233.5	119.6	160.8
HE 160 B	79.6	106.1	139.6	169.1	88.4	117.9
HE 160 C	60.0	79.5	103.6	125.2	66.7	88.3
HE 160 M	48.8	64.1	82.8	99.9	54.2	71.3
HE 180 AA	126.7	171.1	229.6	278.9	140.8	190.1
HE 180 A	103.7	139.5	186.3	226.0	115.2	155.0
HE 180 B	74.4	99.2	131.2	158.8	82.7	110.3
HE 180 C	56.9	75.4	98.9	119.5	63.3	83.8
HE 180 M	46.5	61.3	79.7	96.1	51.7	68.1
HE 200 AA	116.7	157.6	210.9	256.2	129.7	175.1
HE 200 A	97.0	130.5	174.0	211.2	107.8	145.0
HE 200 B	69.1	92.2	121.8	147.4	76.8	102.4
HE 200 C	53.7	71.2	93.3	112.7	59.7	79.1
HE 200 M	44.3	58.4	75.9	91.6	49.2	64.9
HE 220 AA	110.1	148.5	199.4	242.1	122.3	165.0
HE 220 A	89.6	120.4	161.0	195.2	99.5	133.7
HE 220 B	65.3	87.0	115.4	139.6	72.5	96.7
HE 220 C	51.3	68.0	89.5	108.1	57.0	75.6
HE 220 M	42.5	56.1	73.4	88.5	47.3	62.4
HE 240 AA	102.5	138.3	185.3	225.0	113.9	153.6



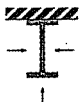




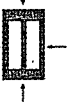
# E. SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES

Designation HE	Unprotected sections		Protected sections			
						
	$k_{sh} A_m/V$		$A_p/V$			
	3 sides	4 sides	contour 3 sides	contour 4 sides	hollow 3 sides	hollow 4 sides
HE 240 A	82.0	110.2	147.0	178.3	91.1	122.4
HE 240 B	61.1	81.5	107.9	130.6	67.9	90.6
HE 240 C	44.6	59.0	77.4	93.4	49.5	65.6
HE 240 M	35.5	46.7	60.7	73.1	39.5	51.9
HE 260 AA	97.6	131.5	175.9	213.6	108.4	146.1
HE 260 A	78.8	105.8	141.0	171.0	87.6	117.5
HE 260 B	59.3	79.1	104.6	126.6	65.9	87.8
HE 260 C	43.5	57.6	75.6	91.3	48.3	64.0
HE 260 M	34.8	45.7	59.5	71.7	38.6	50.8
HE 280 AA	93.2	125.5	168.3	204.2	103.6	139.5
HE 280 A	75.8	101.7	136.0	164.7	84.3	113.1
HE 280 B	57.5	76.7	101.8	123.1	63.9	85.2
HE 280 C	42.5	56.3	74.1	89.4	47.2	62.5
HE 280 M	34.0	44.8	58.5	70.5	37.8	49.8
HE 300 AA	87.7	118.0	158.0	191.8	97.4	131.2
HE 300 A	70.4	94.4	126.0	152.6	78.2	104.9
HE 300 B	54.3	72.4	96.0	116.2	60.4	80.5
HE 300 C	37.8	50.0	65.6	79.1	42.0	55.5
HE 300 M	29.4	38.6	50.2	60.4	32.7	42.9
HE 320 AA	85.8	114.4	152.2	183.9	95.3	127.1
HE 320 A	66.6	88.3	117.0	141.2	74.0	98.1
HE 320 B	52.4	69.2	91.2	109.8	58.3	76.9
HE 320 C	37.4	49.0	64.0	76.9	41.6	54.5
HE 320 M	29.6	38.5	49.9	59.8	32.9	42.8
HE 340 AA	84.2	111.0	147.0	176.8	93.5	123.4
HE 340 A	64.7	84.9	112.0	134.5	71.9	94.4
HE 340 B	51.6	67.4	88.4	105.9	57.3	74.9
HE 340 M	30.3	39.1	50.4	60.2	33.7	43.4
HE 360 AA	82.6	107.9	142.0	170.2	91.7	119.9
HE 360 A	63.0	81.9	107.4	128.4	70.0	91.0
HE 360 B	50.8	65.8	85.8	102.4	56.5	73.1
HE 360 M	31.0	39.7	51.0	60.7	34.4	44.1
HE 400 AA	80.7	103.7	135.2	160.7	89.7	115.2
HE 400 A	61.1	78.1	101.4	120.3	67.9	86.8
HE 400 B	50.1	63.7	82.3	97.4	55.6	70.8
HE 400 M	32.3	40.8	52.1	61.5	35.9	45.4

# E. SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES

Designation HE	Unprotected sections		Protected sections			
						
	$k_{sh} A_m/V$		$A_p/V$			
	3 sides	4 sides	contour 3 sides	contour 4 sides	hollow 3 sides	hollow 4 sides
HE 450 AA	81.4	102.7	132.5	156.1	90.5	114.1
HE 450 A	59.7	74.8	96.1	113.0	66.3	83.1
HE 450 B	49.5	61.9	79.2	92.9	55.0	68.8
HE 450 M	33.9	42.1	53.3	62.5	37.7	46.8
HE 500 AA	81.8	101.5	129.8	151.7	90.9	112.8
HE 500 A	58.3	72.0	91.6	106.8	64.8	80.0
HE 500 B	49.0	60.4	76.5	89.1	54.5	67.1
HE 500 M	35.4	43.4	54.5	63.4	39.3	48.2
HE 550 AA	79.2	96.8	122.7	142.3	88.0	107.6
HE 550 A	58.6	71.4	90.1	104.3	65.2	79.3
HE 550 B	49.6	60.2	75.7	87.5	55.1	66.9
HE 550 M	36.8	44.6	55.7	64.3	40.9	49.5
HE 600 AA	79.1	95.5	120.2	138.5	87.9	106.2
HE 600 A	58.8	70.7	88.7	101.9	65.3	78.6
HE 600 B	50.0	60.0	74.9	86.0	55.6	66.7
HE 600 M	38.2	45.8	56.8	65.2	42.5	50.9
HE 600 x 337	33.0	39.5	48.9	56.1	36.7	43.9
HE 600 x 399	28.5	34.1	42.0	48.2	31.7	37.9
HE 650 AA	78.8	94.2	117.7	134.8	87.6	104.7
HE 650 A	58.9	70.0	87.2	99.6	65.4	77.8
HE 650 B	50.3	59.7	74.1	84.6	55.9	66.4
HE 650 M	39.5	46.9	57.9	66.0	43.9	52.1
HE 650 x 343	34.3	40.7	50.1	57.1	38.1	45.2
HE 650 x 407	29.6	35.0	43.0	49.0	32.9	38.9
HE 700 AA	77.3	91.5	113.6	129.3	85.9	101.6
HE 700 A	58.0	68.4	84.6	96.2	64.5	76.0
HE 700 B	49.9	58.7	72.5	82.2	55.5	65.3
HE 700 M	40.8	47.9	58.9	66.8	45.3	53.3
HE 700 x 352	35.4	41.6	50.9	57.8	39.3	46.2
HE 700 x 418	30.5	35.8	43.7	49.5	33.9	39.7
HE 800 AA	75.8	88.1	108.0	121.7	84.2	97.9
HE 800 A	59.2	68.6	83.9	94.4	65.8	76.3
HE 800 B	51.2	59.2	72.2	81.2	56.9	65.8
HE 800 M	43.0	49.7	60.4	67.9	47.8	55.3
HE 800 x 373	37.2	43.0	52.1	58.6	41.3	47.8
HE 800 x 444	31.8	36.7	44.4	49.9	35.3	40.8

# E. SECTION FACTORS OF EUROPEAN HOT ROLLED IPE AND HE PROFILES

Designation HE	Unprotected sections		Protected sections			
						
	$k_{sh} A_m/V$		$A_p/V$			
	3 sides	4 sides	contour 3 sides	contour 4 sides	hollow 3 sides	hollow 4 sides
HE 900 AA	72.8	83.5	101.4	113.3	80.9	92.8
HE 900 A	58.4	66.8	81.0	90.4	64.9	74.3
HE 900 B	50.9	58.2	70.3	78.4	56.6	64.6
HE 900 M	45.1	51.5	62.1	69.3	50.1	57.2
HE 900 x 391	38.9	44.4	53.5	59.7	43.2	49.4
HE 900 x 466	33.2	37.9	45.5	50.7	36.9	42.1
HE 1000 AA	71.4	81.0	97.7	108.3	79.4	90.0
HE 1000 x 249	64.2	72.7	87.8	97.2	71.3	80.8
HE 1000 A	59.2	67.0	80.6	89.2	65.7	74.4
HE 1000 B	51.8	58.5	70.3	77.8	57.5	65.0
HE 1000 M	47.0	53.1	63.7	70.5	52.2	59.0
HE 1000 x 393	42.0	47.5	56.7	62.8	46.7	52.7
HE 1000 x 415	39.9	45.1	53.8	59.6	44.3	50.1
HE 1000 x 438	38.2	43.1	51.5	57.0	42.4	47.9
HE 1000 x 494	34.1	38.5	45.8	50.7	37.8	42.8
HE 1000 x 584	29.4	33.2	39.3	43.6	32.6	36.8

## **Annex F**

# **CROSS-SECTIONAL CLASSIFICATION OF EUROPEAN HOT ROLLED IPE AND HE PROFILES**

This annex gives tables with the cross-sectional classification of European hot rolled IPE and HE profiles subjected to pure compression, pure bending about strong axis ( $M_y$ ), pure bending about weak axis ( $M_z$ ) and combined compression and bending moment, on steel grades S235, S275, S355 and S460 under normal and high temperatures, according to EN 1993-1-1 and EN 1993-1-2.



# F. CROSS-SECTIONAL CLASSIFICAT. OF EU HOT ROLLED IPE AND HE PROFILES

## F.1. CROSS-SECTIONAL CLASSIFICATION FOR PURE COMPRESSION AND PURE BENDING

Designation IPE	Pure Bending y-y				Pure Bending z-z				Compression			
	Normal Temperature		High Temperatures		Normal Temperature		High Temperatures		Normal Temperature		High Temperatures	
	S235	S275	S355	S460	S235	S275	S355	S460	S235	S275	S355	S460
IPE AA 80	1	1	1	1	1	1	1	1	1	1	1	1
IPE A 80	1	1	1	1	1	1	1	1	1	1	1	1
IPE 80	1	1	1	1	1	1	1	1	1	1	1	1
IPE AA 100	1	1	1	1	1	1	1	1	1	1	1	2
IPE A 100	1	1	1	1	1	1	1	1	1	1	1	2
IPE 100	1	1	1	1	1	1	1	1	1	1	1	1
IPE AA 120	1	1	1	1	1	1	1	1	1	1	2	3
IPE A 120	1	1	1	1	1	1	1	1	1	1	2	3
IPE 120	1	1	1	1	1	1	1	1	1	1	1	2
IPE AA 140	1	1	1	1	1	1	1	1	1	2	3	4
IPE A 140	1	1	1	1	1	1	1	1	1	2	3	4
IPE 140	1	1	1	1	1	1	1	1	1	1	2	3
IPE AA 160	1	1	1	2	1	1	1	1	1	2	3	4
IPE A 160	1	1	1	1	1	1	1	1	1	2	3	4
IPE 160	1	1	1	1	1	1	1	1	1	1	2	3
IPE AA 180	1	1	1	2	1	1	1	1	2	2	3	4
IPE A 180	1	1	1	1	1	1	1	1	2	2	3	4
IPE 180	1	1	1	1	1	1	1	1	1	1	2	3
IPE O 180	1	1	1	1	1	1	1	1	1	1	2	3
IPE AA 200	1	1	1	1	1	1	1	1	2	3	4	4
IPE A 200	1	1	1	1	1	1	1	1	2	3	4	4
IPE 200	1	1	1	1	1	1	1	1	1	1	2	3
IPE O 200	1	1	1	1	1	1	1	1	1	1	2	4
IPE AA 220	1	1	1	2	1	1	1	1	2	2	3	4
IPE A 220	1	1	1	1	1	1	1	1	2	3	4	4
IPE 220	1	1	1	1	1	1	1	1	1	1	2	4
IPE O 220	1	1	1	1	1	1	1	1	1	1	2	4
IPE AA 240	1	1	1	1	1	1	1	1	3	4	4	4
IPE A 240	1	1	1	1	1	1	1	1	2	3	4	4
IPE 240	1	1	1	1	1	1	1	1	1	2	2	4
IPE O 240	1	1	1	1	1	1	1	1	1	1	2	4
IPE A 270	1	1	1	2	1	1	1	1	3	4	4	4
IPE 270	1	1	1	1	1	1	1	1	2	2	3	4

# F.1. CROSS-SECTIONAL CLASSIFICATION FOR PURE COMPRESSION AND PURE BENDING

Designation IPE	Pure Bending y-y				Pure Bending z-z				Compression			
	Normal Temperature		High Temperatures		Normal Temperature		High Temperatures		Normal Temperature		High Temperatures	
	S235	S275	S355	S460	S235	S275	S355	S460	S235	S275	S355	S460
IPE O 270	1	1	1	1	1	1	1	1	1	1	2	3
IPE A 300	1	1	1	1	1	1	1	3	3	4	4	4
IPE 300	1	1	1	1	1	1	1	1	2	2	4	4
IPE O 300	1	1	1	1	1	1	1	1	1	2	3	4
IPE A 330	1	1	1	1	1	1	1	2	3	4	4	4
IPE 330	1	1	1	1	1	1	1	1	2	3	4	4
IPE O 330	1	1	1	1	1	1	1	1	1	2	3	4
IPE A 360	1	1	1	1	1	1	1	2	4	4	4	4
IPE 360	1	1	1	1	1	1	1	1	2	3	4	4
IPE O 360	1	1	1	1	1	1	1	1	1	2	3	4
IPE A 400	1	1	1	1	1	1	1	2	4	4	4	4
IPE 400	1	1	1	1	1	1	1	1	3	3	4	4
IPE O 400	1	1	1	1	1	1	1	1	2	2	3	4
IPE A 450	1	1	1	1	1	1	1	1	4	4	4	4
IPE 450	1	1	1	1	1	1	1	1	3	4	4	4
IPE O 450	1	1	1	1	1	1	1	1	2	2	4	4
IPE A 500	1	1	1	1	1	1	1	3	4	4	4	4
IPE 500	1	1	1	1	1	1	1	1	3	4	4	4
IPE O 500	1	1	1	1	1	1	1	1	2	3	4	4
IPE A 550	1	1	1	2	1	1	1	1	4	4	4	4
IPE 550	1	1	1	1	1	1	1	1	4	4	4	4
IPE O 550	1	1	1	1	1	1	1	1	2	3	4	4
IPE A 600	1	1	1	2	1	1	1	1	4	4	4	4
IPE 600	1	1	1	1	1	1	1	1	4	4	4	4
IPE O 600	1	1	1	1	1	1	1	1	2	2	4	4
IPE 750 x 137	1	1	2	3	1	1	1	1	4	4	4	4
IPE 750 x 147	1	1	1	2	1	1	1	1	4	4	4	4
IPE 750 x 173	1	1	1	1	1	1	1	1	4	4	4	4
IPE 750 x 196	1	1	1	1	1	1	1	1	4	4	4	4

# F. CROSS-SECTIONAL CLASSIFICAT. OF EU HOT ROLLED IPE AND HE PROFILES

Designation HE	Pure Bending y-y				Pure Bending z-z				Compression							
	Normal Temperature		High Temperatures		Normal Temperature		High Temperatures		Normal Temperature		High Temperatures					
	S235	S275	S355	S460	S235	S275	S355	S460	S235	S275	S355	S460				
HE 100 AA	1	1	1	2	1	1	2	3	1	1	1	2	1	1	2	3
HE 100 A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 100 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 100 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 100 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 120 AA	1	2	3	3	2	3	3	3	1	2	3	3	1	2	3	3
HE 120 A	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	2
HE 120 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 120 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 120 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 140 AA	2	3	3	3	3	3	3	4	2	3	3	3	3	3	3	4
HE 140 A	1	1	1	2	1	1	2	3	1	1	1	2	1	1	2	3
HE 140 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 140 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 140 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 160 AA	1	2	3	3	3	3	3	4	1	2	3	3	3	3	3	4
HE 160 A	1	1	1	2	1	1	2	3	1	1	1	2	1	1	2	3
HE 160 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 160 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 160 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 180 AA	2	3	3	3	3	3	3	4	2	3	3	3	3	3	3	4
HE 180 A	1	1	2	3	1	2	3	3	1	1	2	3	1	1	2	3
HE 180 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 180 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 180 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 200 AA	2	3	3	3	3	3	4	4	2	3	3	3	3	3	4	4
HE 200 A	1	1	2	3	2	3	3	3	1	1	2	3	2	3	3	3
HE 200 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 200 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 200 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 220 AA	3	3	3	4	3	3	4	4	3	3	3	4	3	3	4	4
HE 220 A	1	1	2	3	2	3	3	3	1	1	2	3	2	3	3	3
HE 220 B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 220 C	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HE 220 M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

# F.1. CROSS-SECTIONAL CLASSIFICATION FOR PURE COMPRESSION AND PURE BENDING

Designation HE	Pure Bending y-y				Pure Bending z-z				Compression			
	Normal Temperature		High Temperatures		Normal Temperature		High Temperatures		Normal Temperature		High Temperatures	
	S235	S275	S355	S460	S235	S275	S355	S460	S235	S275	S355	S460
HE 240 AA	3	3	3	4	3	3	4	4	3	3	3	4
HE 240 A	1	1	2	3	2	3	3	3	1	1	2	3
HE 240 B	1	1	1	1	1	1	1	2	1	1	1	1
HE 240 C	1	1	1	1	1	1	1	1	1	1	1	1
HE 240 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 260 AA	3	3	3	4	3	3	4	4	3	3	3	4
HE 260 A	1	1	3	3	2	3	3	3	1	1	3	3
HE 260 B	1	1	1	1	1	1	1	2	1	1	1	1
HE 260 C	1	1	1	1	1	1	1	1	1	1	1	1
HE 260 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 280 AA	3	3	3	4	3	4	4	4	3	3	3	4
HE 280 A	1	2	3	3	3	3	3	4	1	2	3	3
HE 280 B	1	1	1	1	1	1	1	3	1	1	1	1
HE 280 C	1	1	1	1	1	1	1	1	1	1	1	1
HE 280 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 300 AA	3	3	3	4	3	4	4	4	3	3	3	4
HE 300 A	1	2	3	3	2	3	3	3	1	2	3	3
HE 300 B	1	1	1	1	1	1	1	3	1	1	1	1
HE 300 C	1	1	1	1	1	1	1	1	1	1	1	1
HE 300 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 320 AA	3	3	3	4	3	3	4	4	3	3	3	4
HE 320 A	1	1	2	3	1	2	3	3	1	1	2	3
HE 320 B	1	1	1	1	1	1	1	2	1	1	1	1
HE 320 C	1	1	1	1	1	1	1	1	1	1	1	1
HE 320 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 340 AA	3	3	3	4	3	3	4	4	3	3	3	4
HE 340 A	1	1	1	3	1	2	3	3	1	1	1	3
HE 340 B	1	1	1	1	1	1	1	1	1	1	1	1
HE 340 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 360 AA	2	3	3	3	3	3	4	4	2	3	3	3
HE 360 A	1	1	1	2	1	1	2	3	1	1	1	2
HE 360 B	1	1	1	1	1	1	1	1	1	1	1	1
HE 360 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 400 AA	2	2	3	3	3	3	3	4	2	2	3	4
HE 400 A	1	1	1	1	1	1	1	3	1	1	2	2
HE 400 B	1	1	1	1	1	1	1	1	1	1	1	1



# F. CROSS-SECTIONAL CLASSIFICAT. OF EU HOT ROLLED IPE AND HE PROFILES

Designation HE	Pure Bending y-y				Pure Bending z-z				Compression			
	Normal Temperature		High Temperatures		Normal Temperature		High Temperatures		Normal Temperature		High Temperatures	
	S235	S275	S355	S460	S235	S275	S355	S460	S235	S275	S355	S460
HE 400 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 450 AA	1	2	3	3	3	3	3	4	1	2	3	3
HE 450 A	1	1	1	1	1	1	1	2	1	1	1	2
HE 450 B	1	1	1	1	1	1	1	1	1	1	1	2
HE 450 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 500 AA	1	2	3	3	2	3	3	3	1	2	3	3
HE 500 A	1	1	1	1	1	1	1	1	1	1	1	1
HE 500 B	1	1	1	1	1	1	1	1	1	1	1	2
HE 500 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 550 AA	1	1	2	3	2	2	3	3	1	1	2	3
HE 550 A	1	1	1	1	1	1	1	1	1	1	1	1
HE 550 B	1	1	1	1	1	1	1	1	1	1	1	2
HE 550 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 600 AA	1	1	2	3	1	2	3	3	1	2	3	3
HE 600 A	1	1	1	1	1	1	1	1	1	1	1	1
HE 600 B	1	1	1	1	1	1	1	1	1	1	1	1
HE 600 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 600 x 337	1	1	1	1	1	1	1	1	1	1	1	1
HE 600 x 399	1	1	1	1	1	1	1	1	1	1	1	1
HE 650 AA	1	1	1	3	1	2	3	3	1	1	1	3
HE 650 A	1	1	1	1	1	1	1	1	1	1	1	1
HE 650 B	1	1	1	1	1	1	1	1	1	1	1	1
HE 650 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 650 x 343	1	1	1	1	1	1	1	1	1	1	1	1
HE 650 x 407	1	1	1	1	1	1	1	1	1	1	1	1
HE 700 AA	1	1	1	2	1	1	2	3	1	1	2	3
HE 700 A	1	1	1	1	1	1	1	1	1	1	1	1
HE 700 B	1	1	1	1	1	1	1	1	1	1	1	1
HE 700 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 700 x 352	1	1	1	1	1	1	1	1	1	1	1	1
HE 700 x 418	1	1	1	1	1	1	1	1	1	1	1	1
HE 800 AA	1	1	1	1	1	1	2	3	1	1	2	3
HE 800 A	1	1	1	1	1	1	1	1	1	1	1	1
HE 800 B	1	1	1	1	1	1	1	1	1	1	1	1
HE 800 M	1	1	1	1	1	1	1	1	1	1	1	1
HE 800 x 373	1	1	1	1	1	1	1	1	1	1	1	1

# F.1. CROSS-SECTIONAL CLASSIFICATION FOR PURE COMPRESSION AND PURE BENDING

Designation HE	Pure Bending y-y				Pure Bending z-z				Compression			
	Normal Temperature		High Temperatures		Normal Temperature		High Temperatures		Normal Temperature		High Temperatures	
	S235	S275	S355	S460	S235	S275	S355	S460	S235	S275	S355	S460
HE 800 x 444	1	1	1	1	1	1	1	1	1	1	1	2
HE 900 AA	1	1	1	1	1	1	2	3	4	4	4	4
HE 900 A	1	1	1	1	1	1	1	2	4	4	4	4
HE 900 B	1	1	1	1	1	1	1	1	3	4	4	4
HE 900 M	1	1	1	1	1	1	1	1	2	3	4	4
HE 900 x 391	1	1	1	1	1	1	1	1	1	2	2	4
HE 900 x 466	1	1	1	1	1	1	1	1	1	1	1	2
HE 1000 AA	1	1	1	2	1	1	2	3	4	4	4	4
HE 1000 x 249	1	1	1	2	1	1	1	1	4	4	4	4
HE 1000 A	1	1	1	2	1	1	1	1	4	4	4	4
HE 1000 B	1	1	1	1	1	1	1	2	4	4	4	4
HE 1000 M	1	1	1	1	1	1	1	1	3	4	4	4
HE 1000 x 393	1	1	1	1	1	1	1	1	2	3	4	4
HE 1000 x 415	1	1	1	1	1	1	1	1	2	2	3	4
HE 1000 x 438	1	1	1	1	1	1	1	1	1	2	3	4
HE 1000 x 494	1	1	1	1	1	1	1	1	1	1	2	3
HE 1000 x 584	1	1	1	1	1	1	1	1	1	1	1	2