

# Promat



Structural fire protection

# Passive Fire Protection

## Structural steel protection

Handbook

Hong Kong version



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# Structural steel protection

Numerous research programmes show that some types of fully stressed steel sections can achieve a 30 minute fire resistance without any additional protection materials being applied. However, these apply to a limited number of steel sections only, based on the allowable Section Factor  $H_p/A$ . Section Factor is a common term used in fire protection for steelwork and is discussed in detail below.

Typical building regulations usually require certain elements of structure to be fire resistant for more than 30 minutes and up to a specified minimum period of time. The thickness of any fire protection material depends on a number of factors, such as:

- Duration of fire resistance specified
- Type of protection used, e.g. board, paint, spray etc
- Perimeter of the part of steel section exposed to fire
- Shape and dimensions of the steel section

To determine how these various factors affect the fire resistance, all Promat products and systems have been tested at nationally accredited laboratories around the world to a variety of standards, e.g. BS 476: Part 21, ASTM E119 and BS EN 13381.

Tests carried out in accordance with the above standards are performed on both loaded and unloaded beams and columns which are clad with fire protection material. Steel surface temperatures are monitored with thermocouples to assess the performance of the cladding. Steel that is fully stressed in accordance with the design guides BS 449 or BS 5950: Part 1, begin to lose their design margin of safety at temperatures around 550°C.

The table below shows how the strength of steel reduces as temperatures rise, i.e. variation of effective yield strength factor of normal structural steels with temperature.

Temperature (°C)	20	100	200	300	400	500	600	700	800
Effective yield strength factor	1.00	1.00	1.00	1.00	1.00	0.78	0.47	0.23	0.11

For example, at 700°C, the effective yield strength of Grade 43 (S275) steel is  $0.23 \times 275 = 63.25\text{N/mm}^2$ .

A range of unloaded sections are also tested to obtain data for analytical calculation, to measure exactly how much protection is needed for the most common steel sections and for providing fire resistance for different time periods.

**IMPORTANT:** When using Promat protection systems for structural steelwork, conservative limiting temperatures of 550°C and 620°C are referred to for columns and beams respectively and are in general use throughout this brochure. Apart from temperature data, the fire tests also need to demonstrate the ability of cladding to remain in place, usually described as the "stickability" of the material, for the maximum duration for which the protection may be required. The availability of thin materials and the low weight of Promat systems, plus the possibility of prefabrication, ensure maximum cost efficiency.

## Section factor (Hp/A)

The degree of fire protection provided depends on the Hp/A Section Factor for the steel section. The Hp/A factor is a function of the area of the steel exposed to the fire and the mass of the steel section. The higher the Hp/A, the faster the steel section heats up and so the greater the thickness of fire protection material required.

It should be noted that in European design standards, the section factor is presented as A/V which has the same numerical value as Hp/A. A/V measures the rate of temperature increase of a steel cross section by the ratio of the heated surface area to the volume. It is likely to gradually replace the use of Hp/A.

Depending on type of material used for protection, the calculation method for Hp/A value may differ. Generally there are two methods of construction for the protection materials: box protection and profile protection.

### Box protection using board materials

For box protection, Hp is the sum of the inside dimensions of the smallest possible rectangular or square encasement of the steel section. One exception is circular hollow sections.

Where a steel section abuts or is built into a fire resisting wall or floor, the surface in contact with or the surface within the wall or floor is ignored when calculating Hp. See [page 7](#).

However, the value A is always the total cross sectional area of the whole steel section.

### Profile protection using spray/ paint materials

Encasements following the profile of the steel section will generally have a higher Hp/A section factor than a box encasement. One exception is circular hollow sections. See [page 8](#).

The serial size and mass per metre of most steel sections are available in tables from steel manufacturers. Sometimes such tables also provide Hp/A values calculated for three or four sided box protection.

Following is an example of a calculation for a steel beam section of 406mm x 178mm x 54kg/m serial size to be encased on 3 sides using box protection method:

Serial size	= 406mm x 178mm
Actual size	= 402.6mm x 177.6mm
Hp	= B + 2D = 177.6 + 2 x 402.6 = 982.8mm (0.9828m)
A	= 68.4cm <sup>2</sup> (0.00684m <sup>2</sup> )
Hp/A	= 0.9828 ÷ 0.00684 = 144.7m <sup>-1</sup> ≈ 144m <sup>-1</sup>

The value of A, the cross sectional area, can be obtained either from steelwork tables or by accurate measurement. However, if the mass per metre is known then the Hp/A value can be calculated as follows:

$$\frac{H_p}{A} = \frac{7850 \times W}{W}$$

Where W = Mass of per metre (kg/m)

Where 7850 = Nominal density of steel

Sample calculation using the previous example:

$$\frac{H_p}{A} = \frac{7850 \times 0.9828}{54}$$

$$= 142.87\text{m}^{-1}$$

$$\approx 143\text{m}^{-1}$$

The shape of the steel section can also play an important role when determining the required thickness of a protection material. Following are some notes for reference. For details on steel profiles not outlined here, please consult Promat.

### Castellated sections /cellform beams

These steel members heat up more quickly than the original section from which they were produced. Common practice is that protection thickness should therefore be 20% greater than those calculated from the Hp/A value of the original section from which the castellated section is formed.

However, it should be noted that the above information is now superseded by a new, more scientific approach for the protection of castellated sections. The following is taken from "Fire Protection for Structural Steel in Buildings", 4th Edition, published by the ASFP (see [www.asfp.org.uk](http://www.asfp.org.uk)).

The recently amended method of obtaining the section factor (Hp/A) for castellated sections is now specific. In fact, the recommendation from the Steel Construction Institute, published as RT 1085, for castellated sections and cellular beams manufactured from all rolled steel sections and from welded plate, the Section Factor for passive protection system is calculated as:

$$\text{Section factor (m}^{-1}\text{)} = 1400/t$$

Where t = the thickness (mm) of the lower steel web and applies for beams made from all steel rolled sections and from welded steel plate.

It should be noted that there are a number of conditions attached to the use of this calculation method, which are detailed in the ASFP "Yellow Book" publication.

Individual protection products, normally quite similar in performance when compared on the basis of rolled steel sections, may require radically different thickness for the same cellular beam.

### Structural hollow section

The same thickness of board materials can be used on square, rectangular and circular hollow sections as on 'I' sections of the same Hp/A value.

## Bracing

Bracing is included in a structure to give resistance to wind forces and provide overall stiffness. Masonry walls and steel cladding contribute to a structure's rigidity but these are rarely taken into account in design. Also, the probability of a major fire occurrence concurrent with maximum wind load is remote (see BS 5950: Part 8). It seems unreasonable therefore to apply the 550°C steel temperature criteria to bracing. While each case must be judged on individual merits, protection to bracing is generally not necessary, but where it is required the  $H_p/A$  value of the bracing section or  $200\text{m}^{-1}$  should be used, whichever is the lesser.

## Lattice members

As the determination of the protection necessary to protect lattice members requires broad consideration of the lattice design, please consult Promat concerning such steel sections.

## Partially exposed members

Where columns or beams are partly built into or are in close contact with walls or floors, the protection afforded to the steelwork by the wall or floor should be taken into account. In those instances where the steel section sits within or against masonry or concrete constructions, this will give protection to the adjacent surface of the steelwork. Thus, for the purpose of determining the heated perimeter ( $H_p$ ), this should be taken as only that part of the steel section which is exposed. It should be noted that where the steelwork penetrates both sides of a fire resisting construction, e.g. a wall protruding into a space which has an open end, simultaneous attack from fire on both sides may occur on columns partially exposed within the wall. In such an instance, the section factor should be calculated based upon the sum of the areas exposed to fire on either side of the wall and the total volume of the steel section.

Note that separating elements are generally required to offer a performance including the insulation criteria of 140°C or 180°C. Therefore, where a steel section passes through a separating element and is exposed on both sides, consideration must also be given to providing sufficient protection not only to maintain the temperature of the steel section below 550°C but also to ensure the surface temperature on the unexposed face does not exceed the 140°C or 180°C insulation criteria of the separating element. Due allowance for any expected building movement should also be considered.

## External lightweight walls

Where the structural elements form portal legs supporting a lightweight external wall, the insulation performance required of the wall may contribute to the protection of any column flange falling within the thickness of the wall. In such cases, please consult Promat to confirm the board thickness and which areas of such columns should be protected.

## Internal lightweight partitions/walls

Where a column or beam is built into a fire resistant lightweight wall or partition, the protection to the steelwork can generally be designed on the assumption that only one side of the wall or partition will be exposed to fire at any one time. The wall or partition should be adequately secured to the column in such a way as to ensure the wall or partition will not apply stress on the protection encasement. Due allowance for any expected building movement should be considered.

## Floors

Where beams are wholly within the cavity of a timber floor protected by a PROMATECT®-H ceiling, test evidence shows that the cavity air temperature of the floor is such that the beam will be adequately protected to the same fire resistance by the ceiling that protects the floor. Where the beam is wholly or partly below the line of the PROMATECT®-H ceiling then  $H_p$  should be based upon the portion of the steel beam that is below ceiling level.

## Beams supporting composite floors with profiled metal decking

A series of fire resistance tests has demonstrated that it is not always necessary to fill the void formed between the top flange of a beam and the underside of a profiled steel deck. Recommendations based on the research have been published by the Steel Construction Institute (UK) and for decks running perpendicular to the beams, are as follows:

### Dovetail decks

Voids may be left unfilled for all fire resistance period, unless a fire resisting wall or partition is located beneath the beam.

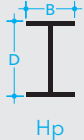









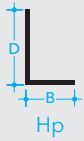







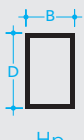




### Trapezoidal decks

Generally, voids may be left unfilled for up to 60 minutes fire resistance. Also, for 90 minutes if the board thickness used is appropriate for the  $H_p/A + 15\%$ . Care should be taken to ensure that if the voids are unfilled, the main encasement will need to be adequately secured. For periods over 90 minutes the voids should be filled.

In all instances, voids should also be filled if a fire wall is located beneath the beam, for all fire resistance periods. These recommendations apply to board encasements. The trapezoidal steel deck slab should be designed to act structurally with the beam. If this is not the case, the voids should be filled for all fire resistance periods.

### Various box protection

Protection configurations with values of perimeter Hp for use in the calculation of section factor Hp/A (A/V)

Steel section	Profile protection				
<b>Universal beams, columns and joists (plain and castellated)</b> 	Four sides  $2B + 2D$	Three sides  $B + 2D$	Three sides (partially exposed)  $B + 2d$	Two sides  $B + D$	One side (partially exposed)  $B$
<b>Structural and rolled tees</b> 	Four sides  $2B + 2D$	Three sides (flange to soffit)  $B + 2D$	Three sides (toe of web to soffit)  $B + 2D$		
<b>Angles</b> 	Four sides  $2B + 2D$	Three sides (flange to soffit)  $B + 2D$	Three sides (toe of flange soffit)  $B + 2D$		
<b>Channels</b> 	Four sides  $2B + 2D$	Three sides (web to soffit)  $2B + D$	Three sides (flange to soffit)  $B + 2D$		
<b>Square or rectangular hollow sections</b> 	Four sides  $2B + 2D$	Three sides  $B + 2D$			
<b>Circular hollow sections</b> 	Four sides  $2B + 2D$	NOTE: The air space created in boxing a circular section improves the insulation and the value of Hp/A. Therefore, Hp higher than profile protection (p) would be anomalous. Hence, Hp is taken as the circumference of the circular section and not 4D.			

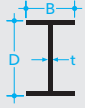


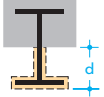


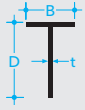



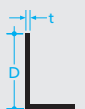



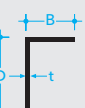



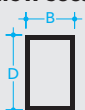




Following is an example of calculation for a universal beam section using profile protection of 305mm x 305mm x 240kg/m serial size to be encased on three or four sides when  $A = 305.6\text{cm}^2$ ,  $B = 317.9\text{mm}$ ,  $D = 352.6\text{mm}$ ,  $t = 23\text{mm}$ .

Four sided profile protection:		Three sided profile protection:	
Hp	$= 2B + 2D$ $= (2 \times 317.9) + (2 \times 352.6)$ $= 1341\text{mm} (1.341\text{m})$	Hp	$= B + 2D$ $= 317.9 + (2 \times 352.6)$ $= 1023.1\text{mm} (1.023\text{m})$
Hp/A	$= 1.341 \div 0.03056$ $= 43.9\text{m}^{-1}$	Hp/A	$= 1.023 \div 0.03056$ $= 33.5\text{m}^{-1}$

The above calculated values are approximate in that radii at corners and roots of all sections are ignored. In these figures,  $\text{Hp}/A = A/V$ .

### Various profile protection

Protection configurations with values of perimeter Hp for use in the calculation of section factor Hp/A (A/V)

Steel section	Profile protection				
<b>Universal beams, columns and joists (plain and castellated)</b>  $H_p$	Four sides  $2B + 2D + 2(B - t)$ $= 4B + 2D - 2t$	Three sides  $B + 2D + 2(B - t)$ $= 3B + 2D - 2t$	Three sides (partially exposed)  $B + 2d + (B - t)$ $= 2B + 2d - t$	Two sides  $B + D + 2(B - t)/2$ $= 2B + D - t$	One side (partially exposed)  $B$
<b>Structural and rolled tees</b>  $H_p$	Four sides  $2B + 2D$	Three sides (flange to soffit)  $B + 2D$	Three sides (toe of web to soffit)  $B + 2D + (B - t)$ $= 2B + 2D - t$		
<b>Angles</b>  $H_p$	Four sides  $2B + 2D$	Three sides (flange to soffit)  $B + 2D$	Three sides (toe of flange soffit)  $B + 2D + (B - t)$ $= 2B + 2D - t$		
<b>Channels</b>  $H_p$	Four sides  $2B + 2D + 2(B - t)$ $= 4B + 2D - 2t$	Three sides (web to soffit)  $2B + D + 2(B - t)$ $= 4B + D - 2t$	Three sides (flange to soffit)  $B + 2D + 2(B - t)$ $= 3B + 2D - 2t$		
<b>Square or rectangular hollow sections</b>  $H_p$	Four sides  $2B + 2D$	Three sides  $B + 2D$			
<b>Circular hollow sections</b>  $H_p$	Four sides  $\pi D$				

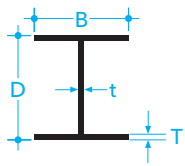
Following is an example of calculation for a universal beam section using profile protection of 305mm x 305mm x 240kg/m serial size to be encased on three or four sides when  $A = 305.6\text{cm}^2$ ,  $B = 317.9\text{mm}$ ,  $D = 352.6\text{mm}$ ,  $t = 23\text{mm}$ .

Four sided profile protection:		Three sided profile protection:	
$H_p$	$= 4B + 2D - 2t$ $= (4 \times 317.9) + (2 \times 352.6) - (2 \times 23)$ $= 1930.8\text{mm} (1.931\text{m})$	$H_p$	$= 3B + 2D - 2t$ $= (3 \times 317.9) + (2 \times 352.6) - (2 \times 23)$ $= 1612.9\text{mm} (1.613\text{m})$
$H_p/A$	$= 1.931 \div 0.03056$ $= 63.1\text{m}^{-1}$	$H_p/A$	$= 1.613 \div 0.03056$ $= 52.8\text{m}^{-1}$

The above calculated values are approximate in that radii at corners and roots of all sections are ignored. In these figures,  $H_p/A = A/V$ .



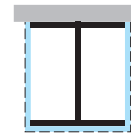
### Universal columns



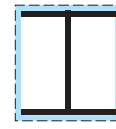
Three sides



Four sides



Three sides



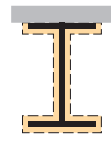
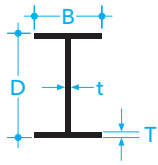
Four sides

Profile protection

Box protection

Designation		Depth of section D (mm)	Width of section B (mm)	Thickness		Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Serial size (mm)	Mass (kg/m)			Web t (mm)	Flange T (mm)		Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
356 x 406	634	474.7	424.1	47.6	77.0	808.1	25	30	15	20
	551	455.7	418.5	42.0	67.5	701.8	30	35	20	25
	467	436.6	412.4	35.9	58.0	595.5	35	40	20	30
	393	419.1	407.0	30.6	49.2	500.9	40	45	25	35
	340	406.4	403.0	26.5	42.9	432.7	45	55	30	35
	287	363.7	399.0	22.6	36.5	366.0	50	65	30	45
	235	381.0	395.0	18.5	30.2	299.8	65	75	40	50
356 x 368	202	374.7	374.4	16.8	27.0	257.9	70	85	45	60
	177	368.3	372.1	14.5	23.8	255.7	80	95	50	65
	153	362.0	370.2	12.6	20.7	195.2	90	110	55	75
	129	355.6	368.3	10.7	17.5	164.9	105	130	65	90
305 x 305	283	365.3	321.8	26.9	44.1	360.4	45	55	30	40
	240	352.6	317.9	23.0	37.7	305.6	50	60	35	45
	198	339.9	314.1	19.2	31.4	252.3	60	75	40	50
	158	327.6	310.6	15.7	25.0	201.2	75	90	50	65
	137	320.5	308.7	13.8	21.7	174.6	85	105	55	70
	118	314.5	306.8	11.9	18.7	149.8	100	120	60	85
	97	307.8	304.8	9.9	15.4	123.3	120	145	75	100
254 x 254	167	289.1	264.5	19.2	31.7	212.4	60	75	40	50
	132	276.4	261.0	15.6	25.3	167.7	75	90	50	65
	107	266.7	258.3	13.0	20.5	136.6	90	110	60	75
	89	260.4	255.9	10.5	17.3	114.0	110	130	70	90
	73	254.0	254.0	8.6	14.2	92.9	130	160	80	110
203 x 203	127	241.4	213.9	18.1	30.1	162.0	65	80	45	55
	113	235.0	212.1	16.3	26.9	145.0	75	90	45	60
	100	228.6	210.3	14.5	23.7	127.0	80	100	55	70
	86	222.3	208.8	13.0	20.5	110.1	95	115	60	80
	71	215.9	206.2	10.3	17.3	91.1	110	135	70	95
	60	209.6	205.2	9.3	14.2	75.8	130	160	80	110
	52	206.2	203.9	8.0	12.5	66.4	150	180	95	125
	46	203.2	203.2	7.3	11.0	58.8	170	200	105	140
152 x 152	51	170.2	157.4	11.0	15.7	65.2	120	145	75	100
	44	166.0	155.9	9.5	13.6	56.1	132	165	85	115
	37	161.8	154.4	8.1	11.5	47.4	160	195	100	135
	30	157.5	152.9	6.6	9.4	38.2	195	235	120	160
	23	152.4	152.4	6.1	6.8	29.8	245	305	155	205

### Universal beams



Three sides



Four sides



Three sides



Four sides

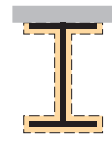
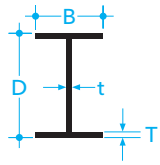
Profile protection

Box protection

Designation		Depth of section D (mm)	Width of section B (mm)	Thickness		Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Serial size (mm)	Mass (kg/m)			Web t (mm)	Flange T (mm)		Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
1016 x 305	487	1036.1	308.5	30.0	54.1	619.9	45	50	40	45
	438	1025.9	305.4	26.9	49.0	556.6	50	55	40	50
	393	1016.0	303.0	24.4	43.9	500.2	55	65	45	55
	349	1008.1	302.0	21.1	40.0	445.2	65	70	50	60
	314	1000.0	300.0	19.1	35.9	400.4	70	80	55	65
	272	990.1	300.0	16.5	31.0	346.9	80	90	65	75
	249	980.2	300.0	16.5	26.0	316.9	90	95	70	80
914 x 419	222	970.3	300.0	16.0	21.1	282.8	95	110	80	90
	388	920.5	420.5	21.5	36.6	494.5	60	70	45	55
914 x 305	343	911.4	418.5	19.4	32.0	437.5	70	80	50	60
	289	926.6	307.8	19.6	32.0	368.8	75	80	60	65
914 x 305	253	918.5	305.5	17.3	27.9	322.8	85	95	65	75
	224	910.3	304.1	15.9	23.9	285.3	95	105	75	85
	201	903.0	303.4	15.2	20.2	256.4	105	115	80	95
838 x 292	226	850.9	293.8	16.1	26.8	288.7	85	95	70	80
	194	840.7	292.4	14.7	21.7	247.2	100	115	80	90
	176	834.9	291.6	14.0	18.8	224.1	110	125	90	100
762 x 267	197	769.6	268.0	15.6	25.4	250.8	90	100	70	85
	173	762.0	266.7	14.3	21.6	220.5	105	115	80	95
	147	753.9	265.3	12.9	17.5	188.1	120	135	95	110
	134	750.0	264.4	12.0	15.5	170.6	130	145	105	120
686 x 254	170	692.9	255.8	14.5	23.7	216.6	95	110	75	90
	152	687.6	254.5	13.2	21.0	193.8	105	120	85	95
	140	683.5	253.7	12.4	19.0	178.6	115	130	90	105
	125	677.9	253.0	11.7	16.2	159.6	130	145	100	115
610 x 305	238	633.0	311.5	18.6	31.4	303.8	70	80	50	60
	179	617.5	307.0	14.1	23.6	227.9	90	105	70	80
	149	609.6	304.8	11.9	19.7	190.1	110	125	80	95
610 x 229	140	617.0	230.1	13.1	22.1	178.4	105	120	80	95
	125	611.9	229.0	11.9	19.6	159.6	115	130	90	105
	113	607.3	228.2	11.2	17.3	144.5	130	145	100	115
	101	602.2	227.6	10.6	14.8	129.2	140	160	110	130
610 x 178	100	607.4	179.2	11.3	17.2	128.0	135	150	110	125
	92	603.0	178.8	10.9	15.0	117.0	145	160	120	135
	82	598.6	177.9	10.0	12.8	104.0	160	180	130	150
533 x 312	273	577.1	320.2	21.1	37.6	348.0	60	70	40	50
	219	560.3	317.4	18.3	29.2	279.0	70	85	50	65
	182	550.7	314.5	15.2	24.4	231.0	85	100	60	75
	151	542.5	312.0	12.7	20.3	192.0	105	120	75	90
533 x 210	138	549.1	213.9	14.7	23.6	176.0	95	110	75	85
	122	544.6	211.9	12.8	21.3	155.8	110	120	85	95
	109	539.5	210.7	11.6	18.8	138.6	120	135	95	110
	101	536.7	210.1	10.9	17.4	129.3	130	145	100	115
	92	533.1	209.3	10.2	15.6	117.8	140	160	110	125
	82	528.3	208.7	9.6	13.2	104.4	155	175	120	140
533 x 165	85	534.9	166.5	10.3	16.5	108.0	140	155	115	130
	75	529.1	165.9	9.7	13.6	95.2	160	175	130	145
	66	524.7	165.1	8.9	11.4	83.7	180	200	145	165

Continued on next page

### Universal beams Continued from previous page



Three sides



Four sides



Three sides



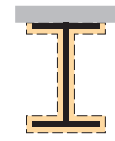
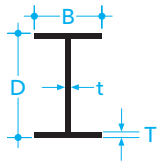
Four sides

Profile protection

Box protection

Designation		Depth of section D (mm)	Width of section B (mm)	Thickness		Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Serial size (mm)	Mass (kg/m)			Web t (mm)	Flange T (mm)		Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
457 x 191	161	492.0	199.4	18.0	32.0	206.0	75	85	60	65
	133	480.6	196.7	15.3	26.3	170.0	90	100	70	80
	106	469.2	194.0	12.6	20.6	135.0	110	125	85	100
	98	467.4	192.8	11.4	19.6	125.3	120	135	90	105
	89	463.6	192.0	10.6	17.7	113.9	130	145	100	115
	82	460.2	191.3	9.9	16.0	104.5	140	160	105	125
	74	457.2	190.5	9.1	14.5	95.0	150	175	115	135
67	453.6	189.9	8.5	12.7	85.4	170	190	130	150	
475 x 152	82	465.1	153.5	10.7	18.9	104.5	130	145	105	120
	74	461.3	152.7	9.9	17.0	95.0	140	155	115	130
	67	457.2	151.9	9.1	15.0	85.4	155	175	125	145
	60	454.7	152.9	8.0	13.3	75.9	175	195	140	160
	52	449.8	152.4	7.6	10.9	66.5	200	220	160	180
406 x 178	85	417.2	181.9	10.9	18.2	109.0	125	140	95	110
	74	412.8	179.7	9.7	16.0	95.0	140	160	105	125
	67	409.4	178.8	8.8	14.3	85.5	155	175	115	140
	60	406.4	177.8	7.8	12.8	76.0	175	195	130	155
	54	402.6	177.6	7.6	10.9	68.4	190	215	145	170
406 x 140	53	406.6	143.3	7.9	12.9	67.9	180	200	140	160
	46	402.3	142.4	6.9	11.2	59.0	205	230	160	185
	39	397.3	141.8	6.3	8.6	49.4	240	270	190	220
356 x 171	67	364.0	173.2	9.1	15.7	85.4	140	160	105	125
	57	358.6	172.1	8.0	13.0	72.2	165	190	125	145
	51	355.6	171.5	7.3	11.5	64.6	185	210	135	165
	45	352.0	171.0	6.9	9.7	57.0	210	240	155	185
356 x 127	39	352.8	126.0	6.5	10.7	49.4	215	240	170	195
	33	348.5	125.4	5.9	8.5	41.8	250	280	195	225
305 x 165	54	310.9	166.8	7.7	13.7	68.4	160	185	115	140
	46	307.1	165.7	6.7	11.8	58.9	185	210	130	160
	40	303.8	165.1	6.1	10.2	51.5	210	240	150	180
305 x 127	48	310.4	125.2	8.9	14.0	60.8	160	180	125	145
	42	306.6	124.3	8.0	12.1	53.2	180	200	140	160
	37	303.8	123.5	7.2	10.7	47.5	200	225	155	180
305 x 102	33	312.7	102.4	6.6	10.8	41.8	215	240	175	200
	28	308.9	101.9	6.1	8.9	36.3	245	275	200	225
	25	304.8	101.6	5.8	6.8	31.4	285	315	255	260
254 x 146	43	259.6	147.3	7.3	12.7	55.1	170	195	120	150
	37	256.0	146.4	6.4	10.9	47.5	195	225	140	170
	31	251.5	146.1	6.1	8.6	40.0	230	265	160	200
254 x 102	28	260.4	102.1	6.4	10.0	36.2	220	250	170	200
	25	257.0	101.9	6.1	8.4	32.2	245	280	190	220
	22	254.0	101.6	5.8	6.8	28.4	275	315	215	250
203 x 133	30	206.8	133.8	6.3	9.6	38.0	210	245	143	180
	25	203.2	133.4	5.8	7.8	32.3	240	285	165	210
203 x 102	23	203.2	101.8	5.4	9.3	29.4	235	270	175	205
178 x 102	19	177.8	101.2	4.8	7.9	24.3	260	305	190	230
152 x 89	16	152.4	88.7	4.5	7.7	20.3	270	315	195	235
127 x 76	13	127.0	76.0	4.0	7.6	16.5	280	326	200	245

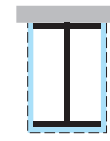
### Joists



Three sides



Four sides



Three sides



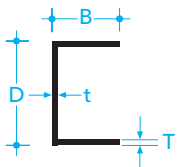
Four sides

Profile protection

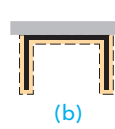
Box protection

Designation		Depth of section D (mm)	Width of section B (mm)	Thickness		Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Serial size (mm)	Mass (kg/m)			Web t (mm)	Flange T (mm)		Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
254 x 203	81.9	254.0	203.2	10.2	19.9	104.4	95	115	70	90
254 x 114	37.2	254.0	114.3	7.6	12.8	47.4	165	190	130	155
203 x 152	52.1	203.2	152.4	8.9	16.5	66.4	115	140	85	105
203 x 102	25.3	203.2	101.6	5.8	10.4	32.3	205	235	155	190
178 x 102	21.5	177.8	101.6	5.3	9.0	27.4	225	260	165	205
152 x 127	37.2	152.4	127.0	10.4	13.2	47.5	130	155	90	120
152 x 89	17.1	152.4	88.9	4.9	8.3	21.8	245	285	180	220
152 x 768	17.9	152.4	76.2	5.8	9.6	22.8	215	245	165	200
127 x 114	29.8	127.0	114.3	10.2	11.5	37.3	140	175	100	130
127 x 114	26.8	127.0	114.3	7.4	11.4	34.1	155	190	110	140
127 x 76	16.4	127.0	76.2	5.6	9.6	21.0	205	245	155	195
127 x 76	13.4	127.0	76.2	4.5	7.6	17.0	265	310	195	240
114 x 114	26.8	114.3	114.3	9.5	10.7	34.4	145	180	100	135
102 x 102	23.1	101.6	101.6	9.5	10.3	29.4	150	185	105	140
102 x 64	9.7	101.6	63.5	4.1	6.6	12.3	295	345	215	270
102 x 44	7.4	101.6	44.4	4.3	6.1	9.5	320	365	260	305
89 x 89	19.4	88.9	88.6	9.5	9.9	24.9	155	190	105	145
76 x 76	14.7	76.2	80.0	8.9	8.4	19.1	175	220	120	165
76 x 76	12.7	76.2	76.2	5.1	8.4	16.3	205	250	140	185

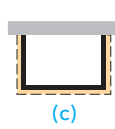
### Channels



(a)



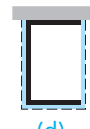
(b)



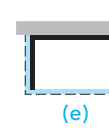
(c)



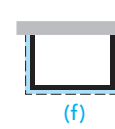
Four sides



(d)



(e)



(f)



Four sides

Examples of three sides

Four sides

Examples of three sides

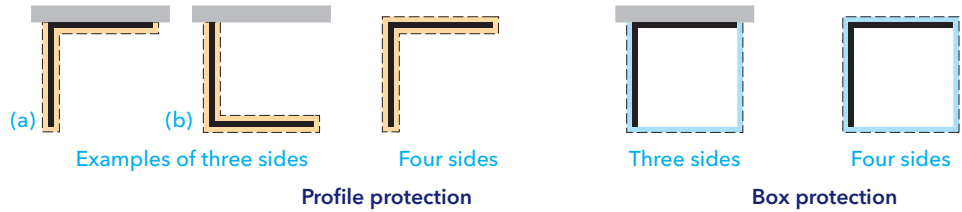
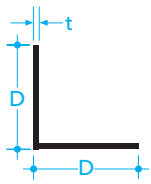
Four sides

Profile protection

Box protection

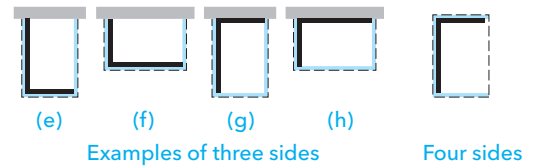
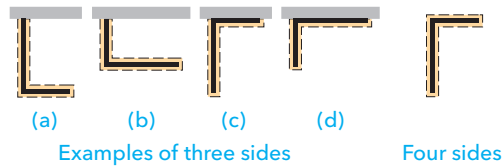
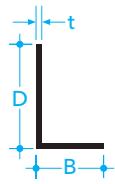
Designation		Depth of section D (mm)	Width of section B (mm)	Thickness		Area of section (cm <sup>2</sup> )	Profile protection				Box protection			
Serial size (mm)	Mass (kg/m)			Web t (mm)	Flange T (mm)		(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	(c) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	(c) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
430 x 100	64.4	430	100	11.0	19.0	82.1	135	95	75	150	115	75	75	130
380 x 100	54.0	380	100	9.5	17.5	68.7	150	110	85	165	125	85	85	140
300 x 100	45.5	300	100	9.0	16.5	58.0	150	115	85	165	120	85	85	140
300 x 90	41.4	300	90	9.0	15.5	52.8	160	120	90	175	130	90	90	150
260 x 90	34.8	260	90	8.0	14.0	44.4	170	135	100	190	135	100	100	160
260 x 75	27.6	260	75	7.0	12.0	35.1	205	150	115	225	170	115	115	190
230 x 90	32.2	230	90	7.5	14.0	41.0	170	140	100	195	135	100	100	155
230 x 75	25.7	230	75	6.5	12.5	32.7	200	155	115	225	165	115	115	185
200 x 90	29.7	200	90	7.0	14.0	37.9	170	140	100	195	130	100	100	155
200 x 75	23.4	200	75	6.0	12.5	29.9	200	160	115	225	160	115	115	185
180 x 90	26.1	180	90	6.5	12.5	33.2	185	155	110	210	135	110	110	165
180 x 75	20.3	180	75	6.0	10.5	25.9	215	175	125	245	170	125	125	195
150 x 90	23.9	150	90	6.5	12.0	30.4	180	160	110	210	130	110	110	160
150 x 75	17.9	150	75	5.5	10.0	22.8	220	190	130	255	165	130	130	200
125 x 65	14.8	125	65	5.5	9.5	18.8	225	195	135	260	170	135	135	200
100 x 50	10.2	100	50	5.0	8.5	13.0	225	215	155	295	190	155	155	230

### Equal angles



Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection	
Size D x D (mm)	Mass (kg/m)			(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
200 x 200	71.1	24	90.6	65	85	85	65	90
	59.9	20	76.3	75	100	105	80	105
	54.2	18	69.1	85	110	115	85	115
	48.5	16	61.8	95	125	125	95	130
150 x 150	40.1	18	51.0	85	110	115	90	115
	33.8	15	43.0	100	135	135	105	140
	27.3	12	34.8	125	165	170	130	170
	23.0	10	29.3	150	200	200	155	205
120 x 120	26.6	15	33.9	105	135	140	105	140
	21.6	12	27.5	125	170	170	130	175
	18.2	10	23.2	150	200	200	155	205
	14.7	8	18.7	185	250	250	190	255
100 x 100	21.9	15	27.9	105	135	140	105	145
	17.8	12	22.7	130	170	170	130	175
	15.0	10	19.2	150	200	205	155	210
	12.2	8	15.5	185	250	250	195	260
90 x 90	15.9	12	20.3	130	170	175	135	175
	13.4	10	17.1	150	200	205	155	210
	10.9	8	13.9	190	245	250	195	260
	9.6	7	12.2	215	280	285	220	295
80 x 80	11.9	10	15.1	155	205	205	160	210
	9.6	8	12.3	190	250	255	195	260
	7.3	6	9.4	250	330	335	255	340
70 x 70	10.3	10	13.1	155	205	210	160	215
	8.4	8	10.6	190	250	255	195	260
	6.4	6	8.1	250	330	335	255	340
60 x 60	8.7	10	11.1	155	205	210	160	215
	7.1	8	9.0	190	250	260	200	265
	5.4	6	6.9	250	330	335	260	345
	4.6	5	5.8	300	395	400	305	410
50 x 50	5.8	8	7.4	195	255	260	200	270
	4.5	6	5.7	255	335	340	260	350
	3.8	5	4.8	300	400	405	310	415
45 x 45	4.0	6	5.1	255	335	340	265	350
	3.4	5	4.3	300	400	405	310	415
	2.7	4	3.5	370	490	495	385	510
40 x 40	3.5	6	4.5	255	340	345	265	355
	3.0	5	3.8	305	400	410	315	420
	2.4	4	3.1	375	495	500	390	515
25 x 25	1.8	5	2.3	315	415	430	335	445
	1.5	4	1.9	390	515	525	405	545
	1.1	3	1.4	505	680	685	530	710

### Unequal angles

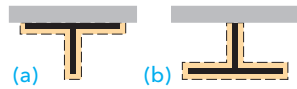
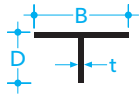


Profile protection

Box protection

Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection					Box protection				
Size D x B (mm)	Mass (kg/m)			(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	(c) Three sides (m <sup>-1</sup> )	(d) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	(c) Three sides (m <sup>-1</sup> )	(d) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
200 x 150	47.1	18	60.0	110	110	90	80	115	90	85	90	85	115
	39.6	15	50.5	135	135	105	95	135	110	100	110	100	140
	32.0	12	40.8	165	165	130	120	170	135	120	135	120	170
200 x 100	33.7	15	43.0	135	135	115	90	135	115	95	115	95	140
	27.3	12	34.8	165	165	140	110	170	145	115	145	115	170
	23.0	10	29.2	195	195	165	135	200	170	135	170	135	205
150 x 90	26.6	15	33.9	135	135	110	95	140	115	95	115	95	140
	21.6	12	27.5	165	165	140	115	170	140	120	140	120	175
	18.2	10	23.2	200	200	165	140	205	170	140	170	140	205
150 x 75	24.8	15	31.6	135	135	115	90	140	120	95	120	95	140
	20.2	12	25.7	165	165	140	115	170	145	115	145	115	175
	17.0	10	21.6	200	200	170	135	205	175	140	175	140	210
125 x 75	17.8	12	22.7	165	165	140	115	170	145	120	145	120	175
	15.0	10	19.1	200	200	165	140	205	170	145	170	145	210
	12.2	8	15.5	245	245	205	170	250	210	175	210	175	260
100 x 75	15.4	12	19.7	170	170	135	125	175	140	125	140	125	180
	13.0	10	16.6	200	200	160	145	205	165	150	165	150	210
	10.6	8	13.5	250	250	200	180	255	205	185	205	185	260
100 x 65	12.3	10	15.6	200	200	165	140	205	170	145	170	145	210
	9.9	8	12.7	245	245	200	175	255	210	180	210	180	260
	8.8	7	11.2	280	280	230	200	290	235	205	235	205	295
80 x 60	8.3	8	10.6	250	250	200	180	255	210	190	210	190	265
	7.4	7	9.4	285	285	225	205	290	235	215	235	215	300
	6.4	6	8.1	330	330	265	240	335	270	250	270	250	345
75 x 50	7.4	8	9.4	250	250	205	180	260	210	185	210	185	265
	5.7	6	7.2	330	330	270	235	340	275	240	275	240	345
65 x 50	6.8	8	8.6	250	250	205	185	260	210	190	210	190	265
	5.2	6	6.6	335	335	265	245	340	275	250	275	250	350
	4.4	5	5.5	395	395	315	290	405	325	295	325	295	415

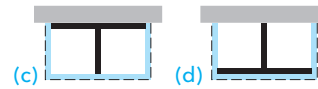
### Structural tees of universal columns



Examples of three sides



Four sides



Examples of three sides



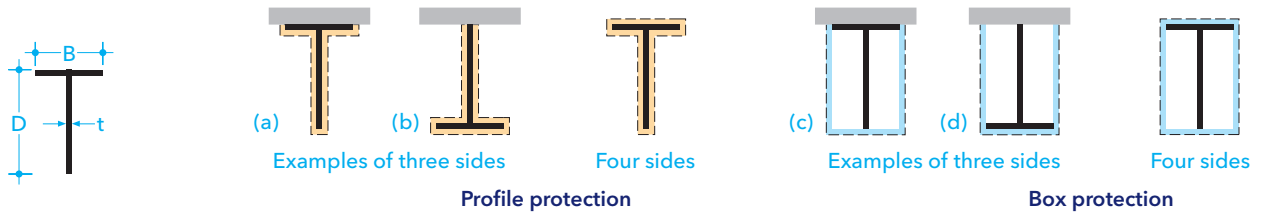
Four sides

Profile protection

Box protection

Designation		Depth of section D (mm)	Width of section B (mm)	Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection		
Serial size (mm)	Mass (kg/m)					(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
406 x 178	118	190.5	395.0	18.5	149.9	50	75	75	50	50	80
368 x 178	101	187.3	374.4	16.8	129.0	55	85	85	60	60	85
	89	184.2	372.1	14.5	112.9	65	95	95	65	65	100
	77	181.0	370.2	12.6	97.6	75	110	110	75	75	115
	65	177.8	368.3	10.7	82.5	85	130	130	90	90	130
305 x 152	79	163.6	310.6	15.7	100.6	60	90	95	65	65	95
	69	160.3	308.7	13.8	87.3	70	105	105	70	70	110
	59	157.2	306.8	11.9	74.9	80	120	120	85	85	125
254 x 127	49	153.9	304.8	9.9	61.6	95	145	145	100	100	150
	84	144.5	265.2	19.2	106.0	50	75	75	50	50	75
	66	138.2	261.0	15.6	84.5	65	90	95	65	65	95
	54	133.4	258.3	13.0	68.3	75	110	115	75	75	115
	45	130.2	255.9	10.5	57.0	90	130	135	90	90	135
203 x 102	37	127.0	254.0	8.6	46.4	105	160	160	110	110	165
	64	120.7	213.9	18.1	81.2	55	80	80	55	55	80
	57	117.5	212.1	16.3	72.3	60	90	90	60	60	90
	50	114.3	210.3	14.5	63.4	70	100	100	70	70	100
	43	111.1	208.8	13.0	55.0	75	110	115	80	80	115
	36	108.0	206.2	10.3	45.5	90	135	135	95	95	140
	30	104.8	205.2	9.3	37.9	105	160	160	110	110	165
	26	103.1	203.9	8.0	33.2	120	180	180	125	125	185
	23	101.6	203.2	7.3	29.4	135	200	205	140	140	205
152 x 76	26	85.1	157.4	11.0	32.6	100	145	145	100	100	150
	22	83.0	155.9	9.5	28.0	110	165	170	115	115	170
	19	80.9	154.4	8.1	23.7	130	195	195	135	135	200
	15	78.7	152.9	6.6	19.1	160	235	240	160	160	240
	12	76.2	152.4	6.1	14.9	200	300	305	205	205	310

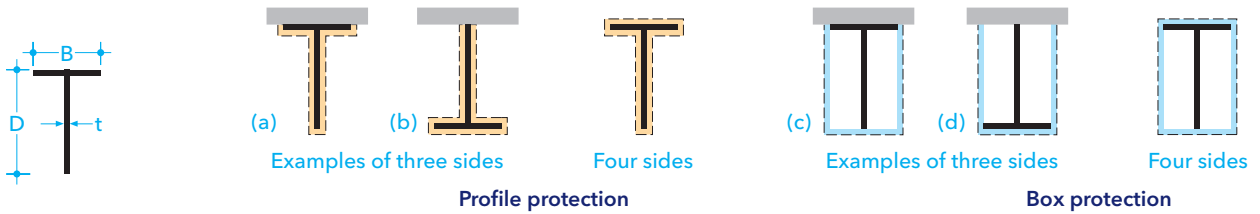
### Structural tees of universal beams



Designation		Depth of section D (mm)	Width of section B (mm)	Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection		
Serial size (mm)	Mass (kg/m)					(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
305 x 457	127	459.2	305.5	17.3	161.4	75	95	95	75	75	95
	112	455.2	304.1	15.9	142.6	85	105	105	85	85	105
	101	451.5	303.4	15.2	128.2	95	115	115	95	95	120
292 x 419	113	425.5	293.8	16.1	144.4	80	100	100	80	80	100
	97	420.4	292.4	14.7	123.6	90	115	115	90	90	115
	88	417.4	291.6	14.0	112.1	100	125	125	100	100	125
267 x 381	99	384.8	268.0	15.6	125.4	80	100	105	85	85	105
	87	381.0	266.7	14.3	110.2	90	115	115	90	90	120
	74	376.9	265.3	12.9	94.0	105	135	135	110	110	135
254 x 343	85	346.5	255.8	14.5	108.3	85	10	110	90	90	110
	76	343.8	254.5	13.2	96.9	95	120	120	95	95	125
	70	341.8	253.7	12.4	89.3	105	130	130	105	105	135
	63	339.0	253.0	11.7	79.8	115	145	145	115	115	150
305 x 305	119	316.5	311.8	18.6	151.9	60	80	80	60	60	85
	90	308.7	307.0	14.1	114.0	80	105	102	80	80	110
	75	304.8	304.8	11.9	95.1	95	125	125	95	95	130
229 x 305	70	308.5	230.1	13.1	89.2	95	120	120	95	95	120
	63	305.9	229.0	11.9	79.8	105	130	135	105	105	135
	57	303.7	228.2	11.2	72.2	115	145	145	115	115	145
	51	301.1	227.6	10.6	64.6	125	160	160	130	130	165
210 x 267	61	272.3	211.9	12.8	77.9	95	120	125	95	95	125
	55	269.7	210.7	11.6	69.3	105	135	135	110	110	140
	51	268.4	210.1	10.9	64.6	115	145	145	115	115	150
	46	266.6	209.3	10.2	58.9	125	160	160	125	125	160
165 x 267	41	264.2	208.7	9.6	52.2	140	175	180	140	140	180
	42	267.1	166.5	10.3	54.0	130	155	160	130	130	160
	37	264.5	165.9	9.7	47.6	145	175	180	145	145	180
191 x 229	33	262.4	165.1	8.9	41.9	160	200	200	165	165	205
	81	246.0	199.4	18.0	103.0	65	85	85	65	65	85
	67	240.3	196.7	15.3	84.9	80	100	100	80	80	105
	53	234.6	194.0	12.6	67.4	95	125	125	100	100	125
	49	233.7	192.8	11.4	62.6	105	135	135	105	105	135
	45	231.8	192.0	10.6	57.0	115	145	145	115	115	150
	41	230.1	191.3	9.9	52.3	125	160	160	125	125	160
	37	228.6	190.5	9.1	47.5	135	175	180	135	135	175
152 x 229	34	226.8	189.9	8.5	42.7	150	135	135	150	150	195
	41	232.5	153.5	10.7	52.2	115	145	145	120	120	150
	37	230.6	152.7	9.9	47.5	125	155	160	130	130	160
	34	228.6	151.9	9.1	42.7	140	175	175	145	145	180
	30	227.3	152.9	8.0	38.0	150	190	195	160	160	200
178 x 203	26	224.9	152.4	7.6	33.2	180	220	225	180	180	225
	43	208.6	181.9	10.9	54.3	110	140	140	110	110	145
	37	206.4	179.7	9.7	47.5	120	160	160	125	125	160
	34	204.7	178.8	8.8	42.7	135	175	175	140	140	180
	30	203.2	177.8	7.8	38.0	150	195	200	155	155	200
140 x 203	27	201.3	177.6	7.6	34.2	165	215	220	170	170	220
	27	203.3	143.3	7.9	34.0	160	200	200	160	160	205
	23	201.2	142.4	6.9	29.5	180	230	230	185	185	235
	20	198.6	141.8	6.3	24.7	215	270	275	220	220	275

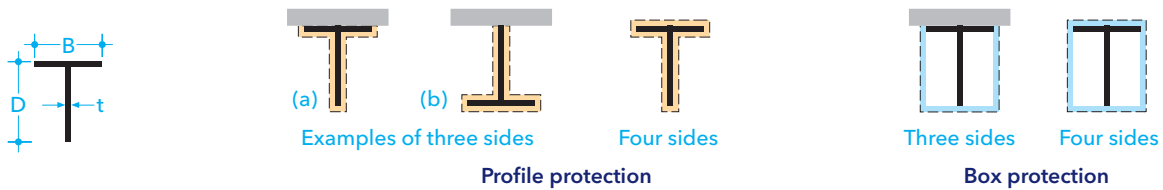


### Structural tees of universal beams Continued from previous page



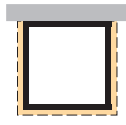
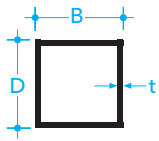
Designation		Depth of section D (mm)	Width of section B (mm)	Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection		
Serial size (mm)	Mass (kg/m)					(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
171 x 178	34	182.0	173.2	9.1	42.7	125	160	165	125	125	165
	29	179.3	172.1	8.0	36.1	145	190	190	145	145	195
	26	177.8	171.5	7.3	32.3	160	210	215	165	165	215
	23	176.0	171.0	6.9	28.5	180	240	240	185	185	245
127 x 178	20	176.4	126.0	6.5	24.7	190	240	240	195	195	245
	17	174.2	125.4	5.9	20.9	225	280	285	225	225	285
165 x 152	27	155.4	166.8	7.7	34.2	140	185	185	140	140	190
	23	153.5	165.7	6.7	29.5	160	210	215	160	160	215
	20	151.9	165.1	6.1	25.8	180	240	245	180	180	245
127 x 152	24	155.2	125.2	8.9	30.4	140	180	180	145	145	185
	21	153.3	124.3	8.0	26.6	160	200	205	160	160	210
	19	151.9	123.5	7.2	23.7	175	225	230	180	180	230
102 x 152	17	156.3	102.4	6.6	20.9	195	240	245	200	200	245
	14	154.5	101.9	6.1	18.2	220	275	280	225	225	280
	13	152.4	101.6	5.8	15.7	255	320	320	260	260	325
146 x 127	22	129.8	147.3	7.3	27.6	145	195	200	150	150	200
	19	128.0	146.4	6.4	23.7	165	225	230	170	170	230
	16	125.7	146.1	6.1	20.0	195	265	270	200	200	270
102 x 127	14	130.2	102.1	6.4	18.1	195	250	250	200	200	255
	13	128.5	101.9	6.1	16.1	220	280	280	220	220	285
	11	127.0	101.6	5.8	14.2	245	315	320	250	250	325
133 x 102	15	103.4	133.8	6.3	19.0	175	245	245	180	180	250
	13	101.6	133.4	5.8	16.1	205	285	290	210	210	290

### Rolled tees

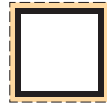


Designation		Depth of section D (mm)	Width of section B (mm)	Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection	
Serial size (mm)	Mass (kg/m)					(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
51 x 51	6.9	50.8	50.8	9.5	8.8	175	220	230	175	230
	4.8	50.8	50.8	6.4	6.1	250	325	335	250	335
44 x 44	4.1	44.4	44.4	6.4	5.2	255	325	340	255	340
	3.1	44.4	44.4	4.8	4.0	335	430	445	335	445

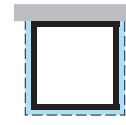
### Square hollow sections



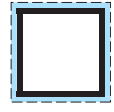
Three sides



Four sides



Three sides



Four sides

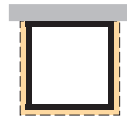
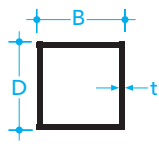
Profile protection

Box protection

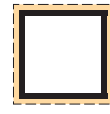
Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Size D x D (mm)	Mass (kg/m)			Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
20 x 20	1.1	2.0	1.4	425	565	425	565
	1.4	2.5	1.7	350	465	350	465
25 x 25	1.4	2.0	1.8	410	550	410	550
	1.7	2.5	2.2	340	450	340	450
	2.0	3.0	2.6	290	385	290	385
	2.2	3.2	2.7	275	365	275	365
30 x 30	2.1	2.5	2.7	330	440	330	440
	2.5	3.0	3.2	280	375	280	375
	2.6	3.2	3.4	265	355	265	355
40 x 40	2.9	2.5	3.7	325	430	325	430
	3.5	3.0	4.4	275	365	275	365
	3.7	3.2	4.7	260	345	260	345
	4.0	3.6	5.1	235	315	235	315
	4.5	4.0	5.7	210	280	210	280
	5.4	5.0	6.9	175	235	175	235
50 x 50	3.7	2.5	4.7	320	425	320	425
	4.4	3.0	5.6	270	355	270	355
	4.7	3.2	5.9	255	335	255	335
	5.1	3.6	6.5	230	305	230	305
	5.7	4.0	7.3	205	275	205	275
	7.0	5.0	8.9	170	225	170	225
	8.5	6.3	10.8	140	185	140	185
60 x 60	5.4	3.0	6.8	265	355	265	355
	5.7	3.2	7.2	250	330	250	330
	6.3	3.6	8.0	225	300	225	300
	7.0	4.0	8.9	205	270	205	270
	8.5	5.0	10.9	165	220	165	220
	10.5	6.3	13.3	135	180	135	180
	12.8	8.0	16.3	110	145	110	145
70 x 70	6.3	3.0	8.0	260	350	260	350
	6.6	3.2	8.4	250	335	250	335
	7.5	3.6	9.5	220	295	220	295
	8.2	4.0	10.4	205	270	205	270
	10.1	5.0	12.9	165	215	165	215
	12.5	6.3	15.9	130	175	130	175
	15.3	8.0	19.5	110	145	110	145
80 x 80	7.2	3.0	9.2	260	350	260	350
	7.6	3.2	9.7	250	330	250	330
	8.6	3.6	10.9	220	295	220	295
	9.4	4.0	12.0	200	270	200	270
	11.7	5.0	14.9	160	215	160	215
	14.4	6.3	18.4	130	175	130	175
	17.8	8.0	22.7	105	140	105	140
90 x 90	9.7	3.6	12.4	220	290	220	290
	10.7	4.0	13.6	200	265	200	265
	13.3	5.0	16.9	160	215	160	215
	16.4	6.3	20.9	130	170	130	170
	20.4	8.0	25.9	105	140	105	140

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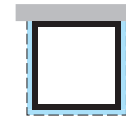
### Square hollow sections Continued from previous page



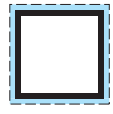
Three sides



Four sides



Three sides



Four sides

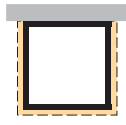
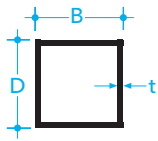
Profile protection

Box protection

Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Size D x D (mm)	Mass (kg/m)			Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
100 x 100	10.8	3.6	13.7	220	295	220	295
	12.0	4.0	15.3	195	260	195	260
	14.8	5.0	18.9	160	210	160	210
	18.4	6.3	23.4	130	170	130	170
	22.9	8.0	29.1	105	135	105	135
	27.9	10.0	35.5	85	115	85	115
120 x 120	14.4	4.0	18.4	195	260	195	260
	18.0	5.0	22.9	155	210	155	210
	22.3	6.3	28.5	125	170	125	170
	27.9	8.0	35.5	100	135	100	135
	34.2	10.0	43.5	85	110	85	110
	41.6	12.5	53.0	70	90	70	90
140 x 140	21.1	5.0	26.9	155	210	155	210
	26.3	6.3	33.5	125	165	125	165
	32.9	8.0	41.9	100	135	100	135
	40.4	10.0	51.5	80	110	80	110
	49.5	12.5	63.0	65	90	65	90
150 x 150	22.7	5.0	28.9	155	210	155	210
	28.3	6.3	36.0	125	165	125	165
	35.4	8.0	45.1	100	135	100	135
	43.6	10.0	55.5	80	110	80	110
	53.4	12.5	68.0	65	90	65	90
	66.4	16.0	84.5	55	70	55	70
160 x 160	24.1	5.0	30.7	160	210	160	210
	30.1	6.3	38.3	125	170	125	170
	37.6	8.0	48.0	100	135	100	135
	46.3	10.0	58.9	85	110	85	110
	56.6	12.5	72.1	70	90	70	90
	63.3	14.2	80.7	60	80	60	80
	70.2	16.0	89.4	55	75	55	75
180 x 180	27.3	5.0	34.7	155	210	155	210
	34.2	6.3	43.6	125	165	125	165
	43.0	8.0	54.7	100	130	100	130
	53.0	10.0	67.5	80	105	80	105
	65.2	12.5	83.0	65	85	65	85
	72.2	14.2	92.0	60	80	60	80
	81.4	16.0	104.0	50	70	50	70
200 x 200	30.4	5.0	38.7	155	210	155	210
	38.2	6.3	48.6	125	165	125	165
	48.0	8.0	61.1	100	130	100	130
	59.3	10.0	75.5	80	105	80	105
	73.0	12.5	93.0	65	85	65	85
	81.1	14.2	103.0	60	80	60	80
	91.5	16.0	117.0	50	70	50	70

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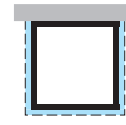
### Square hollow sections Continued from previous page



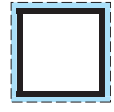
Three sides



Four sides



Three sides



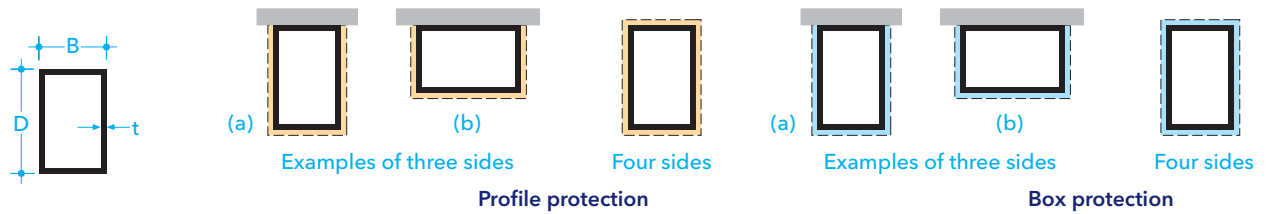
Four sides

Profile protection

Box protection

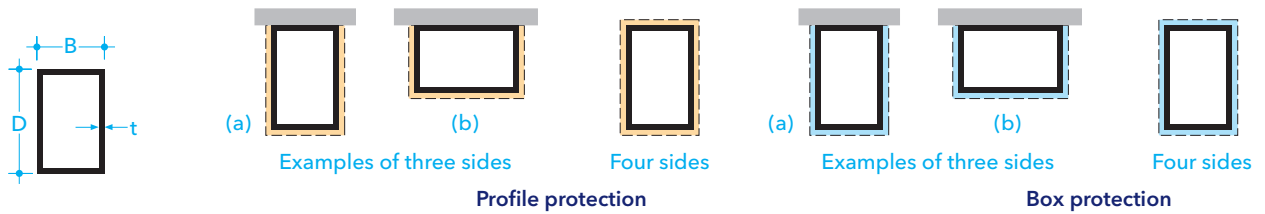
Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection		Box protection	
Size D x D (mm)	Mass (kg/m)			Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
250 x 250	48.1	6.3	61.2	125	165	125	165
	60.5	8.0	77.1	95	130	95	130
	75.0	10.0	95.5	80	105	80	105
	92.6	12.5	118.0	65	85	65	85
	117.0	16.0	149.0	50	65	50	65
260 x 260	49.9	6.3	63.5	125	165	125	165
	62.8	8.0	80.0	100	130	100	130
	77.7	10.0	98.9	80	105	80	105
	95.8	12.5	122.0	65	85	65	85
	108.0	14.2	137.0	60	75	60	75
300 x 300	57.8	6.3	73.6	125	165	125	165
	72.8	8.0	92.8	100	130	100	130
	90.7	10.0	116.0	80	105	80	105
	112.0	12.5	143.0	65	85	65	85
	126.0	14.2	160.0	60	75	60	75
350 x 350	85.4	8.0	109.0	100	130	100	130
	106.0	10.0	135.0	75	105	75	105
	132.0	12.5	168.0	60	85	60	85
	148.0	14.2	189.0	55	75	55	75
	167.0	16.0	213.0	50	65	50	65
400 x 400	97.9	8.0	125.0	100	130	100	130
	122.0	10.0	156.0	75	105	75	105
	152.0	12.5	193.0	60	85	60	85
	170.0	14.2	217.0	55	75	55	75
	192.0	16.0	245.0	50	65	50	65
	235.0	20.0	300.0	40	55	40	55

### Rectangular hollow sections



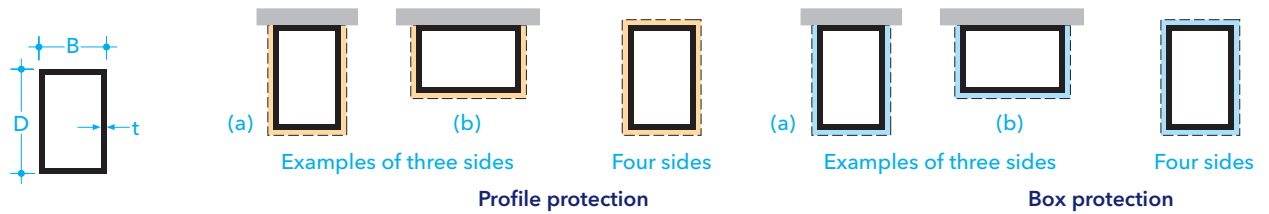
Designation		Thickness $t$ (mm)	Area of section ( $\text{cm}^2$ )	Profile protection			Box protection		
Size $D \times B$ (mm)	Mass (kg/m)			(a) Three sides ( $\text{m}^{-1}$ )	(b) Three sides ( $\text{m}^{-1}$ )	Four sides ( $\text{m}^{-1}$ )	(a) Three sides ( $\text{m}^{-1}$ )	(b) Three sides ( $\text{m}^{-1}$ )	Four sides ( $\text{m}^{-1}$ )
50 x 50	2.7	2.5	3.5	360	290	430	360	290	430
	3.2	3.0	4.1	305	245	365	305	245	365
	3.4	3.2	4.3	290	230	345	290	230	345
50 x 30	2.9	2.5	3.7	350	295	430	350	295	430
	3.5	3.0	4.4	290	250	365	290	250	365
	3.7	3.2	4.7	280	235	345	280	235	345
	4.0	3.6	5.1	255	215	315	255	215	315
	4.5	4.0	5.7	230	195	280	230	195	280
	5.4	5.0	6.9	190	160	235	190	160	235
60 x 40	3.7	2.5	4.7	340	295	425	340	295	425
	4.4	3.0	5.6	285	250	355	285	250	355
	4.7	3.2	5.9	270	235	335	270	235	335
	5.1	3.6	6.5	245	215	305	245	215	305
	5.7	4.0	7.3	220	190	275	220	190	275
	7.0	5.0	8.9	180	160	225	180	160	225
80 x 40	8.5	6.3	10.8	150	130	185	150	130	185
	5.3	3.0	6.8	295	235	355	295	235	355
	5.7	3.2	7.2	275	220	330	275	220	330
	6.3	3.6	8.0	250	200	300	250	200	300
	7.0	4.0	8.9	225	180	270	225	180	270
	8.5	5.0	10.9	185	145	220	185	145	220
	10.5	6.3	13.3	150	120	180	150	120	180
	12.8	8.0	16.3	125	100	145	125	100	145
90 x 50	6.3	3.0	8.0	290	240	350	290	240	350
	6.6	3.2	8.4	275	225	335	275	225	335
	7.5	3.6	9.5	240	200	295	240	200	295
	8.2	4.0	10.4	225	185	270	225	185	270
	10.1	5.0	12.9	180	145	215	180	145	215
	12.5	6.3	15.9	145	120	175	145	120	175
	15.3	8.0	19.5	120	95	145	120	95	145
100 x 50	6.8	3.0	8.6	290	235	350	290	235	350
	7.2	3.2	9.1	275	220	330	275	220	330
	8.0	3.6	10.1	250	200	300	250	200	300
	8.9	4.0	11.3	220	175	265	220	175	265
	10.9	5.0	13.9	180	145	215	180	145	215
	13.4	6.3	17.1	145	115	175	145	115	175
	16.6	8.0	21.1	120	95	145	120	95	145
100 x 60	7.2	3.0	9.2	285	240	350	285	240	350
	7.6	3.2	9.7	270	230	330	270	230	330
	8.6	3.6	10.9	240	200	295	240	200	295
	9.4	4.0	12.0	220	185	270	220	185	270
	11.7	5.0	14.9	175	150	215	175	150	215
	14.4	6.3	18.4	140	120	175	140	120	175
	17.8	8.0	22.7	115	95	140	115	95	140
120 x 60	9.7	3.6	12.4	240	195	290	240	195	290
	10.7	4.0	13.6	220	180	265	220	180	265
	13.3	5.0	16.9	180	140	215	180	140	215
	16.4	6.3	20.9	145	115	170	145	115	170
	20.4	8.0	25.9	115	95	140	115	95	140
	24.3	10.0	30.9	100	80	120	100	80	120

### Rectangular hollow sections Continued from previous page



Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection		
Size D x B (mm)	Mass (kg/m)			(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
120 x 80	10.8	3.6	13.7	235	205	295	235	205	295
	11.9	4.0	15.2	210	185	265	210	185	265
	14.8	5.0	18.9	170	150	210	170	150	210
	18.4	6.3	23.4	135	120	170	135	120	170
	22.9	8.0	29.1	110	95	135	110	95	135
	27.9	10.0	35.5	90	80	115	90	80	115
150 x 100	15.1	4.0	19.2	210	185	260	210	185	260
	18.7	5.0	23.9	165	145	210	165	145	210
	23.3	6.3	29.7	135	120	170	135	120	170
	29.1	8.0	37.1	110	95	135	110	95	135
	35.7	10.0	45.5	90	75	110	90	75	110
	43.6	12.5	55.5	70	65	90	70	65	90
150 x 125	16.6	4.0	21.2	200	190	260	200	190	260
	20.6	5.0	26.2	165	155	210	165	155	210
	25.6	6.3	32.6	130	125	170	130	125	170
	32.0	8.0	40.8	105	100	135	105	100	135
	39.2	10.0	49.9	85	80	110	85	80	110
	47.7	12.5	60.8	70	70	90	70	70	90
160 x 80	14.4	4.0	18.4	220	175	260	220	175	260
	18.0	5.0	22.9	175	140	210	175	140	210
	22.3	6.3	28.5	140	110	170	140	110	170
	27.9	8.0	35.5	115	90	135	115	90	135
	34.2	10.0	43.5	90	75	110	90	75	110
	41.6	12.5	53.0	75	60	90	75	60	90
200 x 100	22.6	5.0	28.7	175	140	210	175	140	210
	28.1	6.3	35.8	140	115	170	140	115	170
	35.1	8.0	44.8	110	90	135	110	90	135
	43.1	10.0	54.9	95	75	110	95	75	110
	52.7	12.5	67.1	75	60	90	75	60	90
	65.2	16.0	83.0	60	50	75	60	50	75
200 x 120	24.1	5.0	30.7	170	145	210	170	145	210
	30.1	6.3	38.3	140	115	170	140	115	170
	37.6	8.0	48.0	110	95	135	110	95	135
	46.3	10.0	58.9	90	75	110	90	75	110
	56.6	12.5	72.1	75	65	90	75	65	90
	63.3	14.2	80.7	65	55	80	65	55	80
200 x 150	26.5	5.0	33.7	165	150	210	165	150	210
	33.0	6.3	42.1	135	120	170	135	120	170
	41.4	8.0	52.8	105	95	135	105	95	135
	41.0	10.0	64.9	80	80	110	80	80	110
	62.5	12.5	79.6	70	65	90	70	65	90
	70.0	14.2	89.2	65	60	80	65	60	80
250 x 100	26.5	5.0	33.7	180	135	210	180	135	210
	33.0	6.3	42.1	145	110	170	145	110	170
	41.4	8.0	52.8	115	85	135	115	85	135
	51.0	10.0	64.9	95	70	110	95	70	110
	62.5	12.5	79.6	75	60	90	75	60	90
	70.0	14.2	89.2	70	50	80	70	50	80
250 x 100	77.7	16.0	99.0	65	45	70	65	45	70

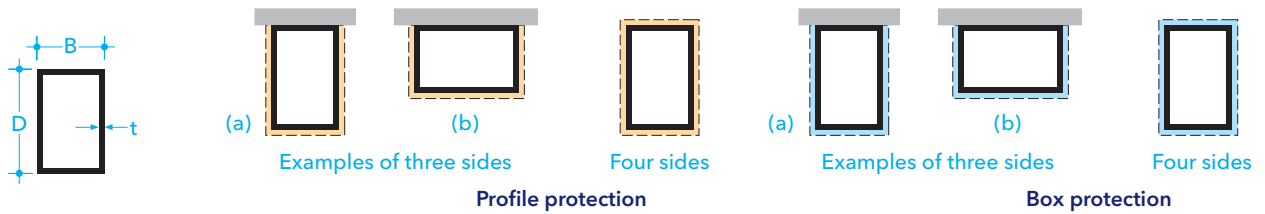
### Rectangular hollow sections Continued from previous page



Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection		
Size D x B (mm)	Mass (kg/m)			(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
250 x 150	30.4	5.0	38.7	170	145	210	170	145	210
	38.0	6.3	48.4	135	115	165	135	115	165
	47.7	8.0	60.8	110	90	135	110	90	135
	58.8	10.0	74.9	90	75	110	90	75	110
	72.3	12.5	92.1	75	60	90	75	60	90
	81.1	14.2	103.0	65	55	80	65	55	80
	90.3	16.0	115.0	60	50	70	60	50	70
250 x 200	66.7	10.0	84.9	85	80	110	85	80	110
	82.1	12.5	105.0	70	65	90	70	65	90
	92.3	14.2	118.0	60	55	80	60	55	80
260 x 140	30.4	5.0	38.7	170	140	210	170	140	210
	38.0	6.3	48.4	140	115	165	140	115	165
	47.7	8.0	60.8	110	90	135	110	90	135
	58.8	10.0	74.9	90	75	110	90	75	110
	72.3	12.5	92.1	75	60	90	75	60	90
	81.1	14.2	103.0	65	55	80	65	55	80
	90.3	16.0	115.0	60	50	70	60	50	70
300 x 100	30.4	5.0	38.7	180	130	210	180	130	210
	38.0	6.3	48.4	145	105	156	145	105	156
	47.7	8.0	60.8	115	85	135	115	85	135
	58.8	10.0	74.9	95	70	110	95	70	110
	72.3	12.5	92.1	80	55	90	80	55	90
	81.1	14.2	103.0	70	50	80	70	50	80
	90.3	16.0	115.0	65	45	70	65	45	70
300 x 150	54.0	8.0	68.8	110	90	130	110	90	130
	66.7	10.0	84.9	90	70	110	90	70	110
	82.1	12.5	105.0	75	60	90	75	60	90
	92.3	14.2	118.0	65	55	80	65	55	80
	103.0	16.0	131.0	60	50	70	60	50	70
300 x 200	38.3	5.0	48.7	165	145	205	165	145	205
	47.9	6.3	61.0	135	115	165	135	115	165
	60.3	8.0	76.8	105	95	130	105	95	130
	74.5	10.0	94.9	85	75	105	85	75	105
	91.9	12.5	117.0	70	60	85	70	60	85
	103.0	14.2	132.0	60	55	75	60	55	75
	115.0	16.0	147.0	55	50	70	55	50	70
300 x 250	52.8	6.3	67.3	130	120	165	130	120	165
	66.5	8.0	84.8	100	95	130	100	95	130
	82.4	10.0	105.0	85	80	105	85	80	105
	102.0	12.5	130.0	65	65	85	65	65	85
	115.0	14.2	146.0	60	55	75	60	55	75
	128.0	16.0	163.0	55	50	70	55	50	70
350 x 150	47.9	6.3	61.0	140	110	165	140	110	165
	60.3	8.0	76.8	110	85	130	110	85	130
	74.5	10.0	94.9	90	70	105	90	70	105
	91.9	12.5	117.0	75	55	85	75	55	85
	103.0	14.2	132.0	65	50	75	65	50	75
	115.0	16.0	147.0	60	45	70	60	45	70

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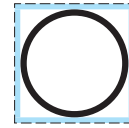
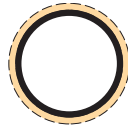
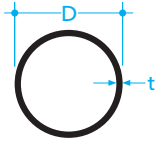
### Rectangular hollow sections Continued from previous page



Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection			Box protection		
Size D x B (mm)	Mass (kg/m)			(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )	(a) Three sides (m <sup>-1</sup> )	(b) Three sides (m <sup>-1</sup> )	Four sides (m <sup>-1</sup> )
350 x 250	57.8	6.3	73.6	130	115	165	130	115	165
	72.8	8.0	92.8	105	95	130	105	95	130
	90.2	10.0	115.0	85	75	105	85	75	105
	112.0	12.5	142.0	70	60	85	70	60	85
	126.0	14.2	160.0	60	55	75	60	55	75
	141.0	16.0	179.0	55	50	70	55	50	70
400 x 120	49.9	6.3	63.5	145	100	165	145	100	165
	62.8	8.0	80.0	115	80	130	115	80	130
	77.7	10.0	98.9	95	65	105	95	65	105
	95.8	12.5	122.0	75	55	85	75	55	85
	108.0	14.2	137.0	70	50	80	70	50	80
120.0	16.0	153.0	65	45	70	65	45	70	
400 x 150	52.8	6.3	67.3	145	105	165	145	105	165
	66.5	8.0	84.8	115	85	130	115	85	130
	82.4	10.0	105.0	90	70	105	90	70	105
	102.0	12.5	130.0	75	55	85	75	55	85
	115.0	14.2	146.0	65	50	75	65	50	75
	128.0	16.0	163.0	60	45	70	60	45	70
400 x 200	57.8	6.3	73.6	140	110	165	140	110	165
	72.8	8.0	92.8	110	90	130	110	90	130
	90.2	10.0	115.0	90	70	105	90	70	105
	112.0	12.5	142.0	70	60	85	70	60	85
	126.0	14.2	160.0	65	50	75	65	50	75
	141.0	16.0	179.0	60	45	70	60	45	70
400 x 300	85.4	8.0	109.0	105	95	130	105	95	130
	106.0	10.0	135.0	85	75	105	85	75	105
	131.0	12.5	167.0	70	60	85	70	60	85
	148.0	14.2	189.0	60	55	75	60	55	75
	166.0	16.0	211.0	55	50	70	55	50	70
450 x 250	85.4	8.0	109.0	105	90	130	105	90	130
	106.0	10.0	135.0	85	70	105	85	70	105
	131.0	12.5	167.0	70	60	85	70	60	85
	148.0	14.2	189.0	65	50	75	65	50	75
	166.0	16.0	211.0	55	45	70	55	45	70
500 x 200	85.4	8.0	109.0	110	85	130	110	85	130
	106.0	10.0	135.0	90	70	105	90	70	105
	131.0	12.5	167.0	75	55	85	75	55	85
	148.0	14.2	189.0	65	50	75	65	50	75
	166.0	16.0	211.0	60	45	70	60	45	70
500 x 300	97.9	8.0	125.0	105	90	130	105	90	130
	122.0	10.0	155.0	85	75	105	85	75	105
	151.0	12.5	192.0	70	60	85	70	60	85
	170.0	14.2	217.0	60	50	75	60	50	75
	191.0	16.0	249.0	55	45	70	55	45	70
	235.0	20.0	300.0	45	40	55	45	40	55



### Circular hollow sections



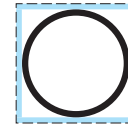
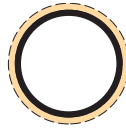
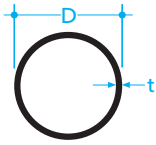
Profile protection

Box protection

Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection (m <sup>-1</sup> )	Box protection (m <sup>-1</sup> )
Outside diameter D (mm)	Mass (kg/m)				
21.3	1.2	2.6	1.5	440	440
	1.3	2.9	1.7	400	400
	1.4	3.2	1.8	370	370
26.9	1.6	2.9	2.0	425	425
	1.7	2.9	2.2	385	385
	1.9	3.2	2.4	355	355
33.7	2.0	2.6	2.5	415	415
	2.2	2.9	2.8	375	375
	2.4	3.2	3.1	345	345
	2.7	3.6	3.4	310	310
	2.9	4.0	3.7	285	285
42.4	2.6	2.6	3.3	410	410
	2.8	2.9	3.6	370	370
	3.1	3.2	3.9	340	340
	3.4	3.6	4.4	305	305
	3.8	4.0	4.8	275	275
	4.6	5.0	5.9	230	230
48.3	3.3	2.9	4.1	365	365
	3.6	3.2	4.5	355	355
	4.0	3.6	5.1	300	300
	4.4	4.0	5.6	275	275
	5.3	5.0	6.8	225	225
60.3	4.1	2.9	5.2	360	360
	4.5	3.2	5.7	330	330
	5.0	3.6	6.4	295	295
	5.6	4.0	7.1	270	270
	6.8	5.0	8.7	220	220
76.1	5.2	2.9	6.7	358	358
	5.8	3.2	7.3	325	325
	6.4	3.6	8.2	290	290
	7.1	4.0	9.1	265	265
	8.8	5.0	11.2	215	215
	10.8	6.3	13.8	175	175
88.9	6.2	2.9	7.8	355	355
	6.8	3.2	8.6	325	325
	7.6	3.6	9.7	290	290
	8.4	4.0	10.7	260	260
	10.3	5.0	13.2	210	210
	12.8	6.3	16.3	170	170
114.3	8.8	3.2	11.2	320	320
	9.8	3.6	12.5	285	285
	10.9	4.0	13.9	260	260
	13.5	5.0	17.2	210	210
	16.6	6.3	21.4	170	170

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### Circular hollow sections Continued from previous page



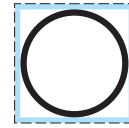
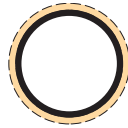
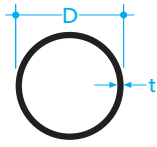
Profile protection

Box protection

Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection (m <sup>-1</sup> )	Box protection (m <sup>-1</sup> )
Outside diameter D (mm)	Mass (kg/m)				
139.7	10.8	3.2	13.7	320	320
	12.1	3.6	15.4	285	285
	13.4	4.0	17.1	255	255
	16.6	5.0	21.2	205	205
	20.7	6.3	26.4	165	165
	26.0	8.0	33.1	135	135
168.3	32.0	10.0	40.7	110	110
	20.1	5.0	25.7	205	205
	25.2	6.3	32.1	165	165
	31.6	8.0	40.3	130	130
	39.0	10.0	49.7	105	105
193.7	48.0	12.5	61.2	85	85
	23.3	5.0	29.6	205	205
	25.1	5.4	31.9	190	190
	29.1	6.3	37.1	165	165
	36.6	8.0	46.7	130	130
	45.3	10.0	57.7	105	105
219.1	55.9	12.5	71.2	85	85
	70.1	16.0	89.3	70	70
	26.4	5.0	33.6	205	205
	33.1	6.3	42.1	165	165
	41.6	8.0	53.1	130	130
	51.6	10.0	65.7	105	105
	63.7	12.5	81.1	85	85
244.5	71.8	14.2	91.4	75	75
	80.1	16.0	102.0	65	65
	98.2	20.0	125.0	55	55
	29.5	5.0	37.6	205	205
	37.0	6.3	47.1	165	165
	46.7	8.0	59.4	130	130
	57.8	10.0	73.7	105	105
	71.5	12.5	91.1	85	85
273	80.6	14.2	103.0	75	75
	90.2	16.0	115.0	65	65
	111.0	20.0	141.0	55	55
	33.0	5.0	42.1	205	205
	41.4	6.3	52.8	160	160
	52.3	8.0	66.6	130	130
	64.9	10.0	82.6	105	105
	80.3	12.5	102.0	85	85
90.6	14.2	115.0	75	75	
273	101.0	16.0	129.0	65	65
	125.0	20.0	159.0	55	55
	153.0	25.0	195.0	45	45

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### Circular hollow sections Continued from previous page



Profile protection

Box protection

Designation		Thickness t (mm)	Area of section (cm <sup>2</sup> )	Profile protection (m <sup>-1</sup> )	Box protection (m <sup>-1</sup> )
Outside diameter D (mm)	Mass (kg/m)				
323.9	39.3	5.0	50.1	205	205
	49.3	6.3	62.9	160	160
	62.3	8.0	79.4	130	130
	77.4	10.0	98.6	105	105
	96.0	12.5	122.0	85	85
	108.0	14.2	138.0	75	75
	121.0	16.0	155.0	65	65
	150.0	20.0	191.0	55	55
355.6	184.0	25.0	235.0	45	45
	54.3	6.3	69.1	160	160
	68.6	8.0	87.4	130	130
	85.2	10.0	109.0	100	100
	106.0	12.5	135.0	85	85
	120.0	14.2	152.0	75	75
	134.0	16.0	171.0	65	65
	166.0	20.0	211.0	55	55
406.4	204.0	25.0	260.0	45	45
	62.2	6.3	79.2	160	160
	78.6	8.0	100.0	130	130
	97.8	10.0	125.0	100	100
	121.0	12.5	155.0	80	80
	137.0	14.2	175.0	75	75
	154.0	16.0	196.0	65	65
	191.0	20.0	243.0	55	55
457.0	235.0	25.0	300.0	45	45
	295.0	32.0	376.0	35	35
	70.0	6.3	89.2	160	160
	88.6	8.0	113.0	130	130
	110.0	10.0	140.0	105	105
	137.0	12.5	175.0	80	80
	155.0	14.2	198.0	75	75
	174.0	16.0	222.0	65	65
	216.0	20.0	275.0	50	50
508.0	266.0	25.0	339.0	40	40
	335.0	32.0	427.0	35	35
	411.0	40.0	524.0	25	25
	77.9	6.3	99.3	160	160
	98.6	8.0	126.0	125	125
	123.0	10.0	156.0	100	100
508.0	153.0	12.5	195.0	80	80
	173.0	14.2	220.0	75	75
	194.0	16.0	247.0	65	65

## PROMATECT®-H structural steel fire protection Hp/A ratio

### Hp/A ratio table 1 - Lambda method

Upto 240/-/- fire resistance in accordance with the requirements of BS 476: Part 21: 1987 (reports no. 2014-Efectis-R00636 Rev.1 and R22F24-1A issue 1) for structural steel column and beam protection at critical temperature of 550°C.

Section factor m <sup>1</sup>	PROMATECT®-H board thickness (mm)				
	60 min		120 min		240 min
	single lambda	multiple lambda	single lambda	multiple lambda	multiple lambda
50	12	23	15	23	35
60	12	23	20	23	39
70	12	23	25	23	43
80	12	23	25	24	46
90	12	23	25	26	49
100	12	23		28	51
110	15	23		30	53
120	15	23		31	
130	15	23		33	
140	20	23		34	
150	20	23		35	
160	20	23		36	
170	20	23		37	
180	20	23		37	
190	20	23		38	
200	20	23		39	
210	25	23		39	
220	25	23		40	
230	25	24		41	
240	25	24		41	
250	25	25		41	
260	25	25		42	
270	25	26		42	
280	25	26		42	
290	25	26		43	
300	25	27		43	
310	25	27		43	
320	25	27		43	
330	25	28		44	
340	25	28		44	
350	25	28		44	
360	25	28		44	

### Hp/A ratio table 2 - Numerical Regression Method

Upto 240/-/- fire resistance in accordance with the requirements of BS 476: Part 21: 1987 (reports no. 2014-Efectis-R00636 Rev.1 and R22F24-1A issue 1) for structural steel column and beam protection at critical temperature of 550°C.

Section factor m <sup>1</sup>	PROMATECT®-H board thickness (mm)				
	60 min		120 min		240 min
	single NR	multiple NR	single NR	multiple NR	multiple NR
50	12	23	15	23	38
60	12	23	20	23	43
70	12	23	20	23	47
80	12	23	25	25	50
90	12	23	25	27	
100	12	23		28	
110	15	23		30	
120	15	23		31	
130	15	23		32	
140	15	23		33	
150	20	23		34	
160	20	23		34	
170	20	23		35	
180	20	23		36	
190	20	23		36	
200	20	23		37	
210	20	23		37	
220	20	23		38	
230	25	23		38	
240	25	23		39	
250	25	23		39	
260	25	23		39	
270	25	23		40	
280	25	23		40	
290	25	23		40	
300	25	23		41	
310	25	23		41	
320	25	24		41	
330	25	24		41	
340	25	24		42	
350	25	24		42	
360	25	24		42	

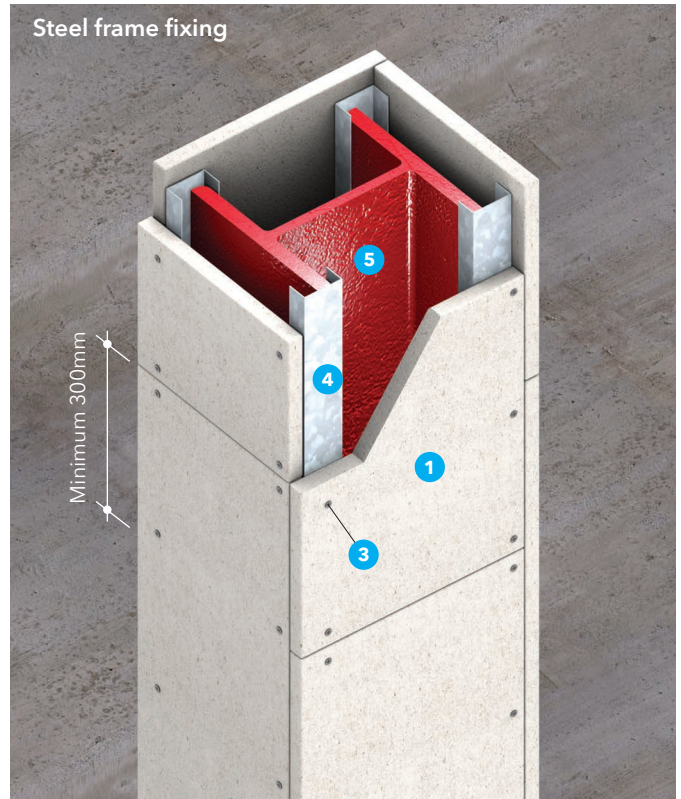
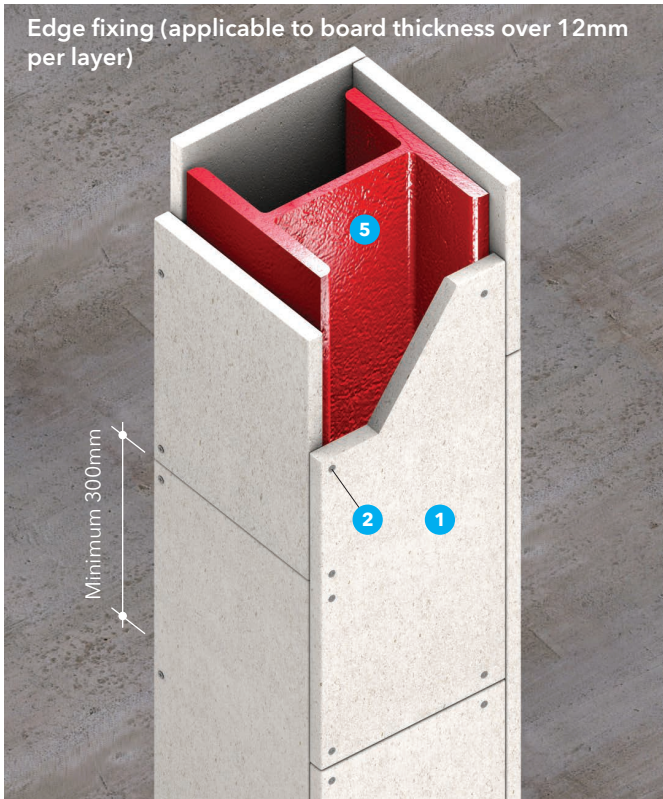
The thickness in above tables can be made up from a single layer or no more than two layers of PROMATECT®-H board. For two layer application, secure the thinner layer first and stagger all joints between layers at minimum 300mm centres. For four sided encasement of column, install the second layer separately from the first layer and no gap is required between layers.

For encasements of beam, screw the second layer to the first layer.

In a single project, we highly recommend user choose either Lambda or Numerical Regression method to determine the thickness. We decline any options chosen both method in a single project, or please consult Promat for further details.

## PROMATECT®-H – 1, 2 & 4-hour fire rated structural steel column cladding

FRR	Model number	Standard
60/-/-	PH.01.60	BS 476: Part 21: 1987
120/-/-	PH.01.12	BS 476: Part 21: 1987
240/-/-	PH.01.24	BS 476: Part 21: 1987



1. PROMATECT®-H board, thickness in accordance with the Hp/A ratio tables on page 28.
2. M4 self tapping screws at 200mm centres or steel staple as per table below.
3. M4 self tapping screws at nominal 200mm centres.
4. Steel channel min. 40 x 40 x 1.6mm thick.
5. Structural steel column.

### Fixing table: Single layer

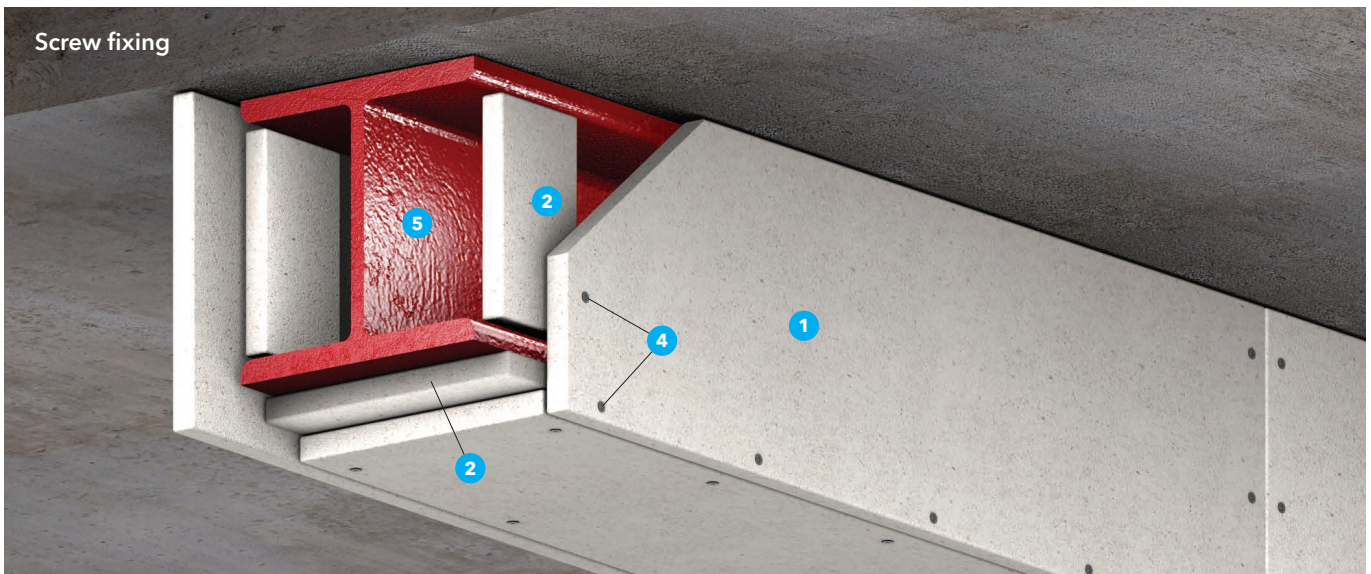
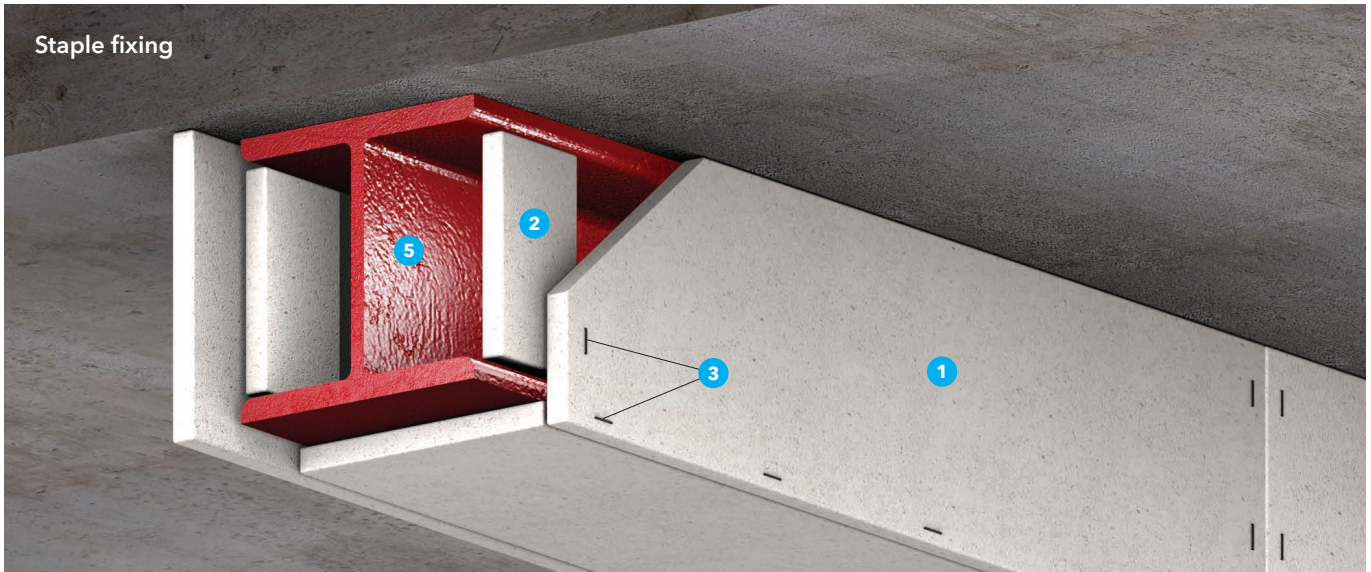
Board thickness	Staple			c. t. c. distance (mm)
	length (mm)	width (mm)	thickness (mm)	
12mm	25	5.85	1.27 x 1.05	100
15mm	35	10.5	1.45 x 1.30	100
20mm	50	10.5	1.45 x 1.30	100
25mm	50	10.5	1.45 x 1.30	100

### Fixing table: Double layer

Board thickness	1st layer			2nd layer			c. t. c. distance (mm)
	Staple			Staple			
	length (mm)	width (mm)	thickness (mm)	length (mm)	width (mm)	thickness (mm)	
2 x 12mm	25	5.85	1.27 x 1.05	25	5.85	1.27 x 1.05	100
25 + 12mm	50	10.5	1.45 x 1.30	25	5.85	1.27 x 1.05	100
2 x 20mm	50	10.5	1.45 x 1.30	50	10.5	1.45 x 1.30	100
2 x 25mm	50	10.5	1.45 x 1.30	50	10.5	1.45 x 1.30	100

## PROMATECT®-H – 1, 2 & 4-hour fire rated structural steel beam cladding

FRR	Model number	Standard
60/-/-	PH.02.60	BS 476: Part 21: 1987
120/-/-	PH.02.12	BS 476: Part 21: 1987
240/-/-	PH.02.24	BS 476: Part 21: 1987



1. PROMATECT®-H board, thickness in accordance with the Hp/A ratio tables on page 28.
2. 100mm wide PROMATECT®-H wedge soldier, thickness similar to the board thickness of ①.
3. Steel staple as per table below.
4. M4 Self tapping screws at nominal 200mm centres.
5. Structural steel beam.

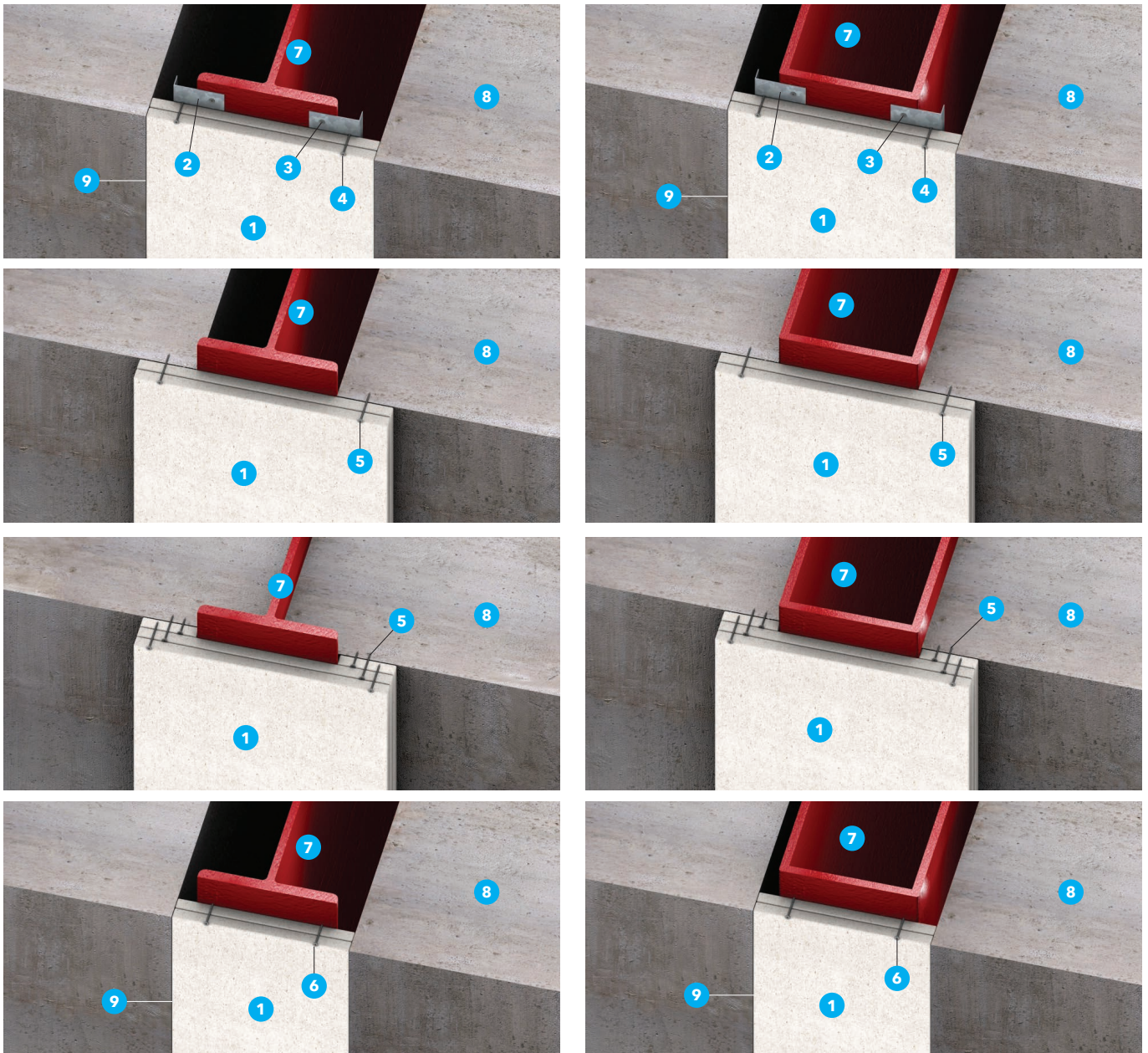
**Fixing table: Single layer**

Board thickness	Staple			c. t. c. distance (mm)
	length (mm)	width (mm)	thickness (mm)	
12mm	25	5.85	1.27 x 1.05	100
15mm	35	10.5	1.45 x 1.30	100
20mm	50	10.5	1.45 x 1.30	100
25mm	50	10.5	1.45 x 1.30	100

**Fixing table: Double layer**

Board thickness	1st layer			2nd layer			c. t. c. distance (mm)
	Staple			Staple			
	length (mm)	width (mm)	thickness (mm)	length (mm)	width (mm)	thickness (mm)	
2 x 12mm	25	5.85	1.27 x 1.05	25	5.85	1.27 x 1.05	100
25 + 12mm	50	10.5	1.45 x 1.30	50	5.85	1.27 x 1.05	100
2 x 20mm	50	10.5	1.45 x 1.30	40	10.5	1.45 x 1.30	100
2 x 25mm	50	10.5	1.45 x 1.30	50	10.5	1.45 x 1.30	100

**PROMATECT®-H board when connected to Brickwork/Gypsum/Masonry Concrete walls up to 240 minutes loadbearing capacity to BS476: part 21 and integrity and insulation to BS 476: part 22 (2014EfectisR000636Rev.1 and R21M21-1A issue 1)**



1. Minimum PROMATECT®-H board thickness on each side of the beams or columns as table below.
 

Fire resistance	PROMATECT®-H board thickness
60 minutes	18mm (2 x 9mm)
120 minutes	25mm (2 x 12mm)
240 minutes	40mm (2 x 20mm)
2. Steel angles, minimum 0.9mm thick fixed to steelwork.
3. M4 screws or shot-fired fixings at 300mm centres.
4. M4 self-tapping screws at 200mm centres; screw length to provide 10mm penetration through angle.
5. M4 screws at 200mm centres into metal plugs; screw length to provide minimum 30mm penetration into plug. Fixings to be minimum 50mm from edge of concrete wall.

6. M4 steel self-tapping screws or shot-fired nails. All fixings at 200 mm nominal centres and must be of such a length that they penetrate at least 10 mm beyond the interface of the board and steel flange. The screws and nails may be fitted with or without steel washers. Two vertical rows of fixings are used, each row between 25 mm and 85 mm from the adjacent vertical edge of the board.
7. Structural steel column.
8. Concrete wall substrate.
9. Caulk all edges between the board and the wall with PROMASEAL® Intumescent Acrylic Sealant, depth in accordance with the required board thickness.

## PROMATECT®-L structural steel fire protection Hp/A ratio

### Hp/A ratio table

Up to 240/-/- fire resistance in accordance with the requirements of BS 476: Part 21: 1987 (report no. 2015 Efectis R000320 Rev.2 and R22L15-1A issue 1) for structural steel column and beam protection at critical temperature of 550°C

Fire resistance	PROMATECT®-L thickness combination						
	20	25	30	40	45	50	55
30 minutes	359						
60 minutes	320	359					
90 minutes	140	210	310	359			
120 minutes	90	120	160	300	359		
180 minutes	50	60	80	120	150	180	
240 minutes	–	45	50	70	80	100	110

The thickness in above tables can be made up from a single layer or no more than two layers of PROMATECT®-L board.

For two layer application, secure the thinner layer first and stagger all joints between layers at minimum 300mm centres.

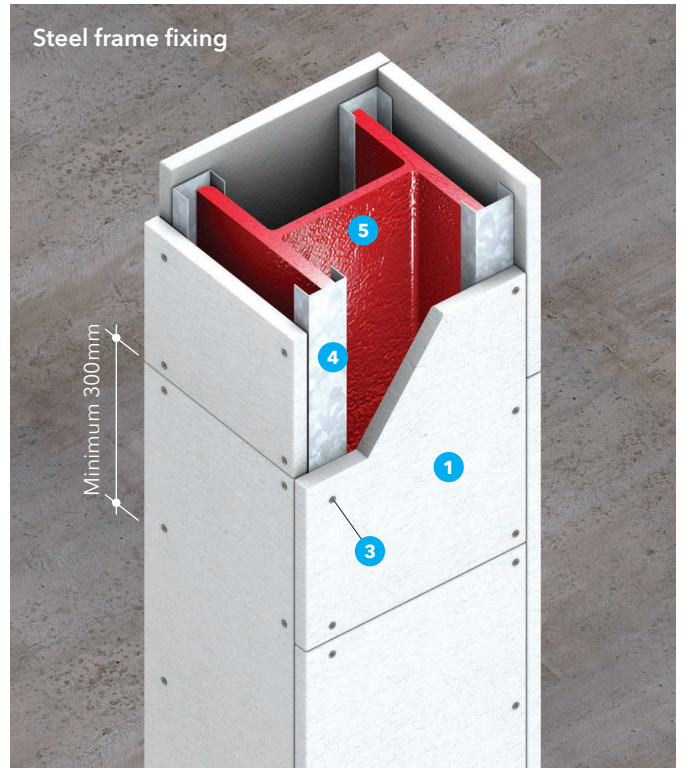
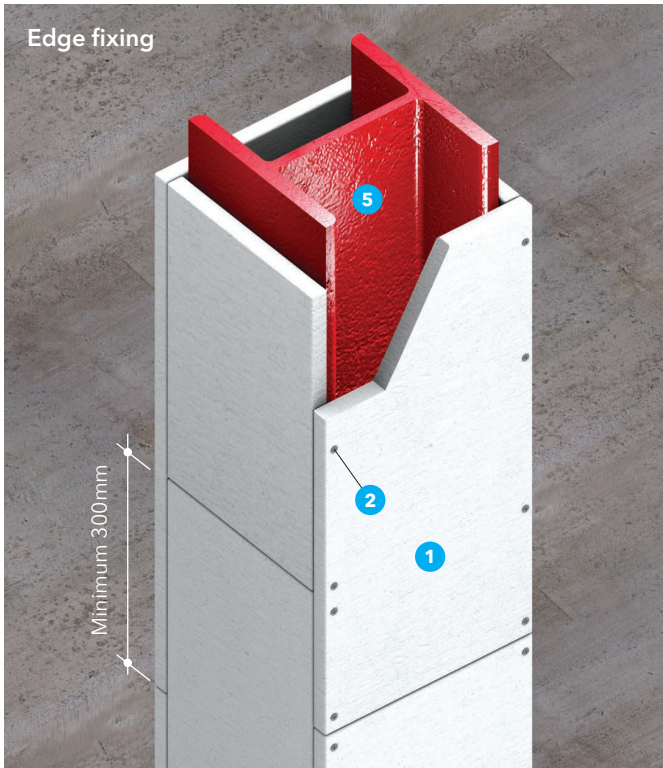
For four sided encasement of column, install the second layer separately from the first layer and no gap is required between layers.

For encasements of beam, screw the second layer to the first layer.



## PROMATECT®-L – 1, 2 & 4-hour fire rated structural steel column cladding

FRR	Model number	Standard
60/-/	PL.01.60	BS 476: Part 21: 1987
120/-/	PL.01.12	BS 476: Part 21: 1987
240/-/	PL.01.24	BS 476: Part 21: 1987

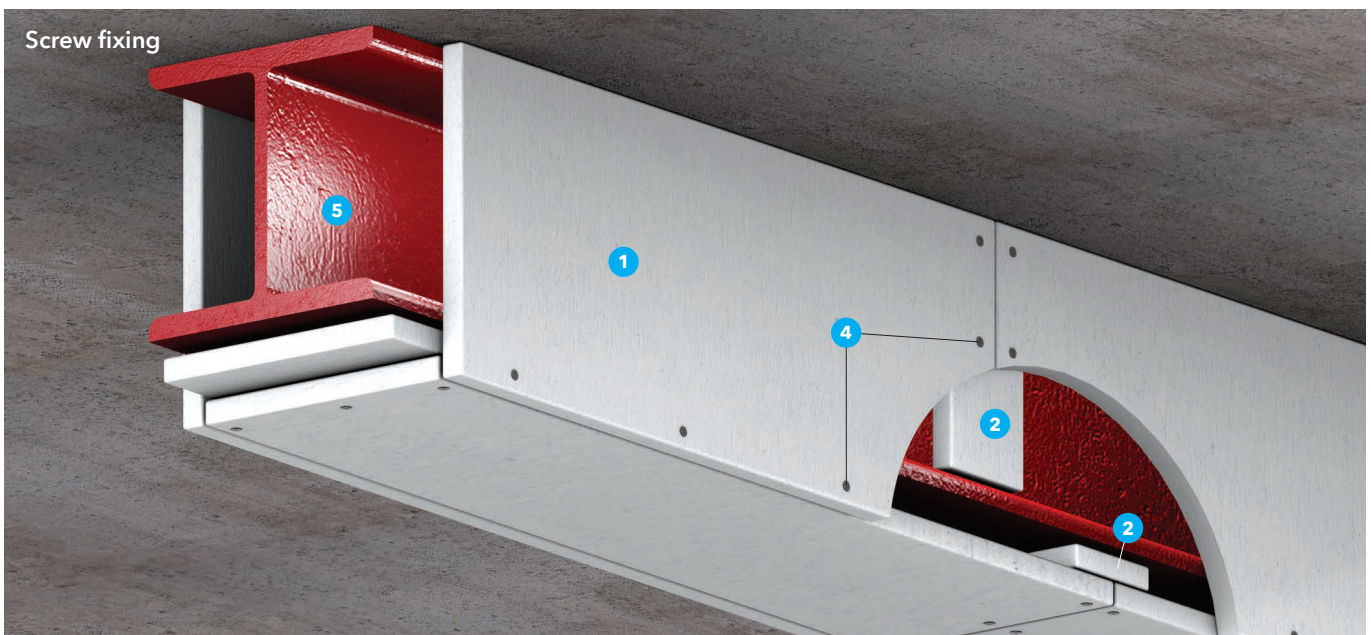
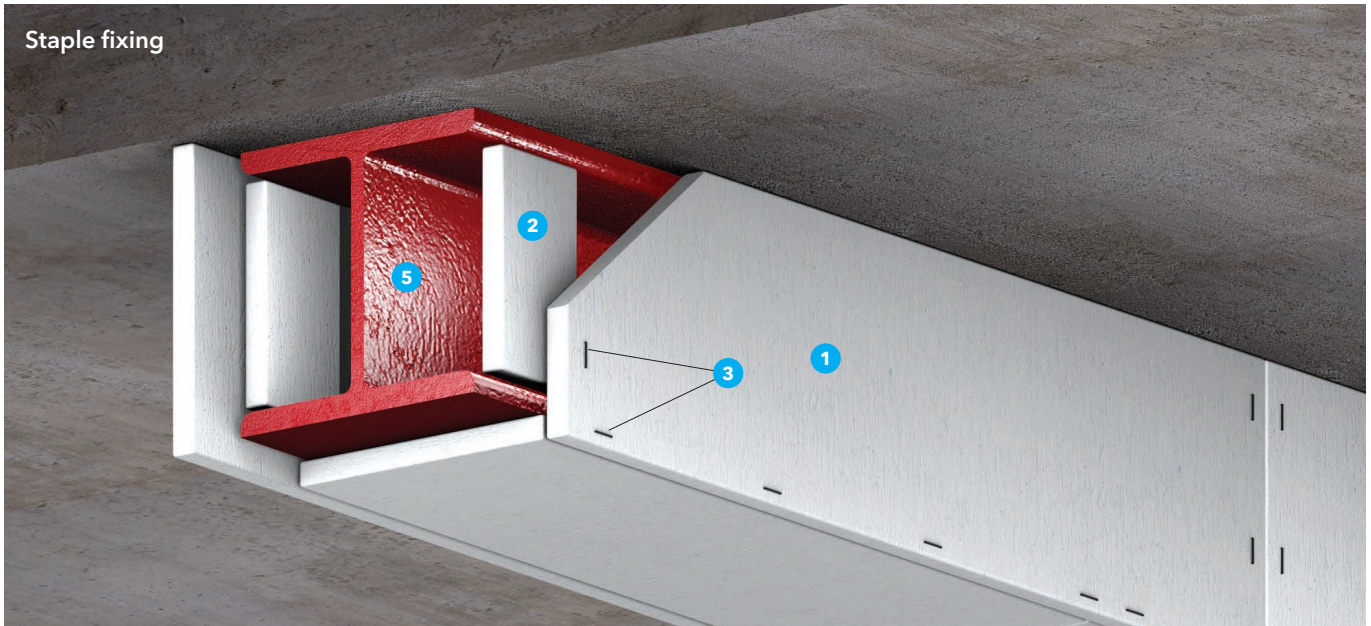


1. PROMATECT®-L board, thickness in accordance with the Hp/A ratio tables on page 32.
2. M4 self tapping screws at 200mm centres or steel staple as per table below.
3. M4 self tapping screws at nominal 200mm centres.
4. Steel channel min. 40 x 40 x 1.6mm thick.
5. Structural steel column.

Board thickness	Wedge soldier thickness	Staple			c. t. c. distance (mm)
		length (mm)	width (mm)	thickness (mm)	
15mm	15mm	30	10.5	1.45 x 1.30	100
25mm	25mm	50	10.5	1.45 x 1.30	100
40mm	40mm	80	10.5	1.45 x 1.30	100
50mm	50mm	90	10.5	1.45 x 1.30	100

## PROMATECT®-L – 1, 2 & 4-hour fire rated structural steel beam cladding

FRR	Model number	Standard
60/-/-	PL.02.60	BS 476: Part 21: 1987
120/-/-	PL.02.12	BS 476: Part 21: 1987
240/-/-	PL.02.24	BS 476: Part 21: 1987



1. PROMATECT®-L board, thickness in accordance with the Hp/A ratio tables on page 32.
2. 100mm wide PROMATECT®-L wedge soldier, thickness as per table below.
3. Steel staple as per table below.
4. M4 Self tapping screws at nominal 200mm centres.
5. Structural steel beam.

Board thickness	Wedge soldier thickness	Staple			c. t. c. distance (mm)
		length (mm)	width (mm)	thickness (mm)	
15mm	15mm	30	10.5	1.45 x 1.30	100
25mm	25mm	50	10.5	1.45 x 1.30	100
40mm	40mm	80	10.5	1.45 x 1.30	100
50mm	50mm	90	10.5	1.45 x 1.30	100

## VERMICULUX®-S structural steel fire protection Hp/A ratio

### Hp/A ratio table

Up to 240/-/- fire resistance in accordance with the requirements of BS 476: Part 21: 1987 (report no. WF407855) for structural steel column and beam protection at critical temperature of 550°C

Fire resistance	VERMICULUX®-S thickness combination												
	20	25	30	35	40	45	50	55	60	65	70	75	
30 minutes	275												
60 minutes	275												
90 minutes	150	210	275										
120 minutes	100	125	165	235	275								
180 minutes	60	70	75	90	110	140	195	275					
240 minutes	–	–	50	55	60	70	80	95	120	160	245	275	

The thickness in above tables can be made up from a single layer or no more than two layers of VERMICULUX®-S board.

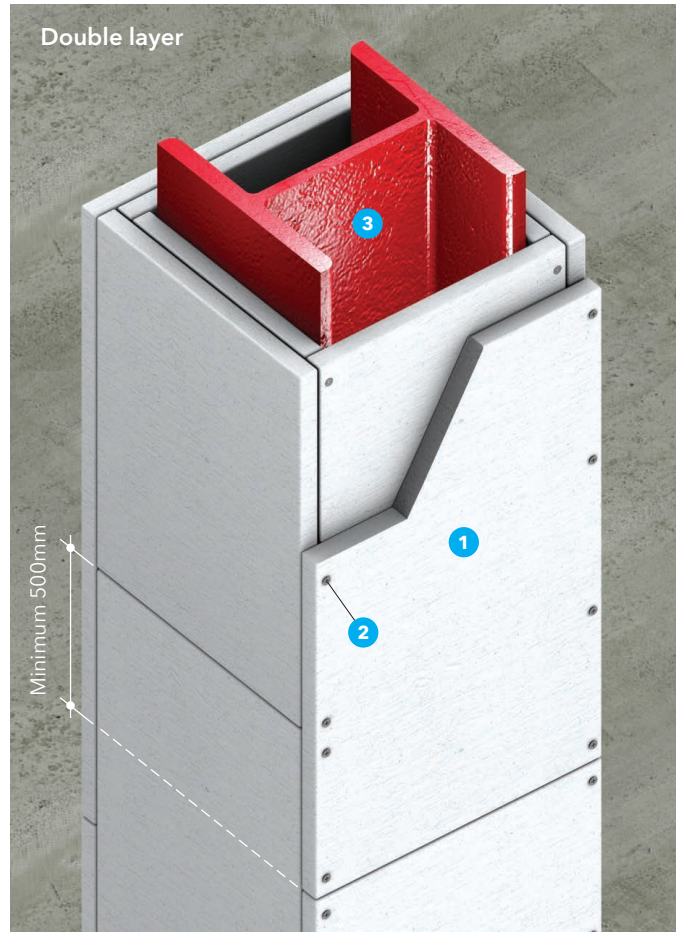
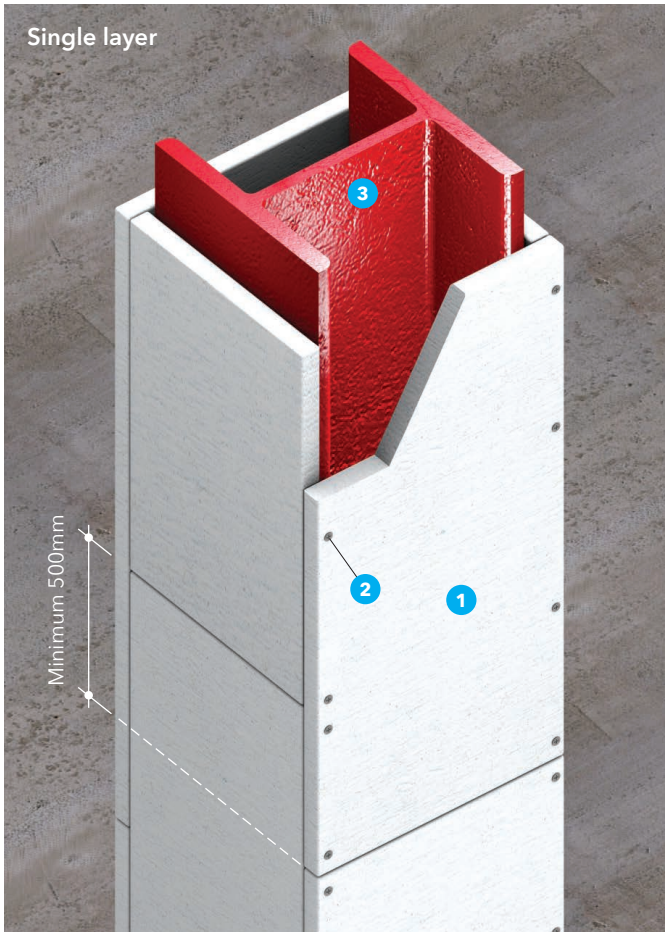
For two layer application, secure the thinner layer first and stagger all joints between layers at minimum 300mm centres.

For four sided encasement of column, install the second layer separately from the first layer and no gap is required between layers.

For encasements of beam, screw the second layer to the first layer.

## VERMICULUX®-S – Up to 4-hour fire rated structural steel column cladding

FRR	Model number	Standard
240/-/-	VML.01.24	BS 476: Part 21: 1987
180/-/-	VML.01.18	BS 476: Part 21: 1987
120/-/-	VML.01.12	BS 476: Part 21: 1987
90/-/-	VML.01.90	BS 476: Part 21: 1987
60/-/-	VML.01.60	BS 476: Part 21: 1987
30/-/-	VML.01.30	BS 476: Part 21: 1987



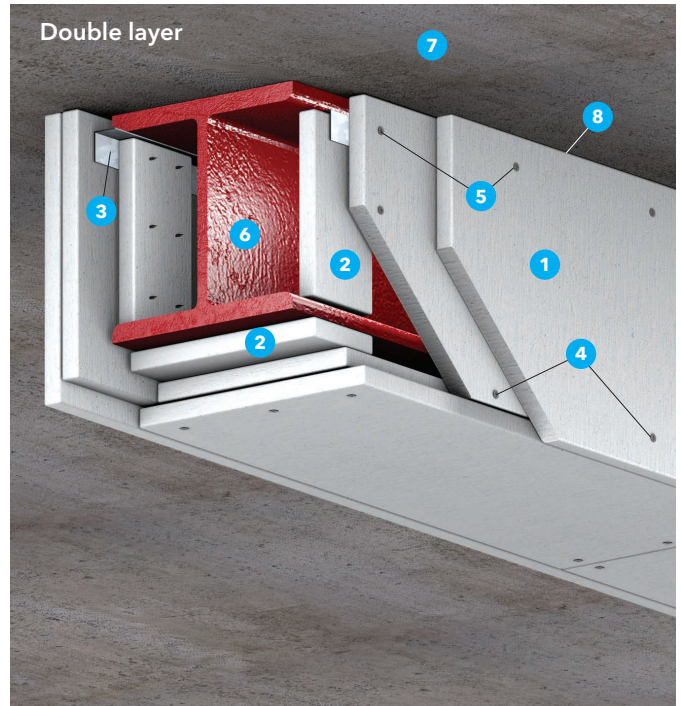
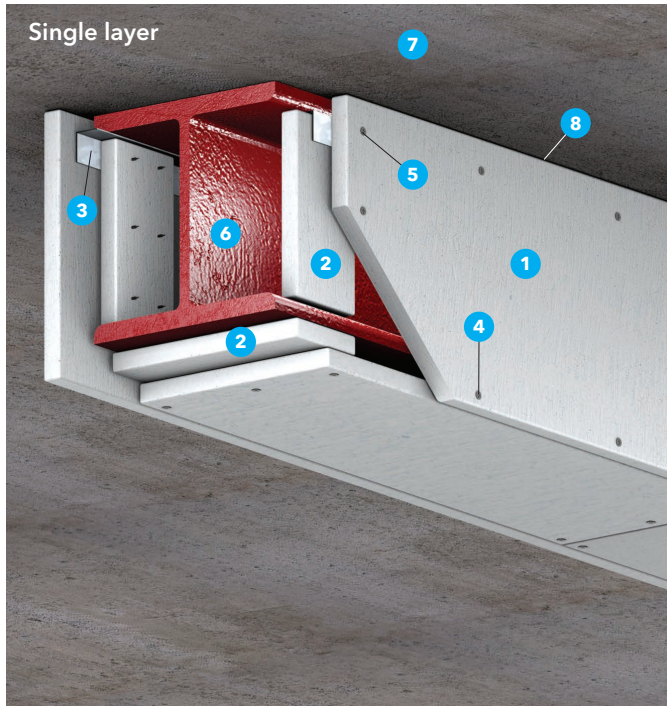
1. VERMICULUX®-S board, thickness in accordance with the Hp/A ratio tables on page 35.
2. Drywall high tread screw at 200mm centres as per fixing table. Joints on adjacent faces should be staggered by minimum of 500mm.
3. Structural steel column.

### Fixing table

Board thickness	Board to board - Drywall high tread screw	
	1st layer	2nd layer
20mm	50mm x M3.5	-
25mm	65mm x M4.2	-
30mm	65mm x M4.2	-
35mm	65mm x M4.2	-
40mm	75mm x M4.2	-
45mm	75mm x M4.2	-
50mm	90mm x M4.8	-
45mm (20 + 25)	50mm x M3.5	65mm x M4.2
50mm (25 + 25)	65mm x M4.2	65mm x M4.2
55mm (30 + 25)	65mm x M4.2	65mm x M4.2
60mm (30 + 30)	65mm x M4.2	65mm x M4.2
65mm (35 + 30)	65mm x M4.2	65mm x M4.2
70mm (35 + 35)	65mm x M4.2	65mm x M4.2
75mm (40 + 35)	75mm x M4.2	65mm x M4.2
80mm (40 + 40)	75mm x M4.2	75mm x M4.2

## VERMICULUX®-S – Up to 4-hour fire rated structural steel beam cladding

FRR	Model number	Standard
240/-/-	VML.02.24	BS 476: Part 21: 1987
180/-/-	VML.02.18	BS 476: Part 21: 1987
120/-/-	VML.02.12	BS 476: Part 21: 1987
90/-/-	VML.02.90	BS 476: Part 21: 1987
60/-/-	VML.02.60	BS 476: Part 21: 1987
30/-/-	VML.02.30	BS 476: Part 21: 1987



1. VERMICULUX®-S board, thickness in accordance with the Hp/A ratio tables on page 35.
2. 120mm wide x 20mm thick VERMICULUX®-S cover strip fitted behind all side board and soffit joints with drywall high thread screws.
3. Continuous steel angles 50mm x 25mm x 0.7mm, fixed to top flange on both sides of the web with 3.7 x 1.6mm shot-fired nails or 13mm x M4.2 self-drill, self-tapping wafer head screws at 300mm centres. Angles is offset from flange by 3mm.
4. High tread screws at 200mm centres as per fixing table, min. 30mm penetrate in to board.
5. Self-tapping screws at 200mm centres as per fixing table, min. 10mm penetrate through angle.
6. Structural steel beam.
7. Floor slab.
8. Caulk all edges between the board and the floor slab with PROMASEAL® Intumescent Acrylic Sealant, depth in accordance with the required board thickness.

### Fixing table

Board thickness	Board to angle - Drywall self-tapping screw		Board to board - Drywall high tread screw	
	1st layer	2nd layer	1st layer	2nd layer
20mm	32mm x M3.5	-	50mm x M3.5	-
25mm	38mm x M3.5	-	65mm x M4.2	-
30mm	42mm x M3.5	-	65mm x M4.2	-
35mm	50mm x M3.5	-	65mm x M4.2	-
40mm	50mm x M3.5	-	75mm x M4.2	-
45mm (20 + 25)	32mm x M3.5	65mm x M4.2	50mm x M3.5	65mm x M4.2
50mm (25 + 25)	38mm x M3.5	65mm x M4.2	65mm x M4.2	65mm x M4.2
55mm (30 + 25)	42mm x M3.5	65mm x M4.2	65mm x M4.2	65mm x M4.2
60mm (30 + 30)	42mm x M3.5	75mm x M4.2	65mm x M4.2	65mm x M4.2
65mm (35 + 30)	50mm x M3.5	75mm x M4.2	65mm x M4.2	65mm x M4.2
70mm (35 + 35)	50mm x M3.5	90mm x M4.8	65mm x M4.2	65mm x M4.2
75mm (40 + 35)	50mm x M3.5	90mm x M4.8	75mm x M4.2	65mm x M4.2
80mm (40 + 40)	50mm x M3.5	100mm x M4.8	75mm x M4.2	75mm x M4.2





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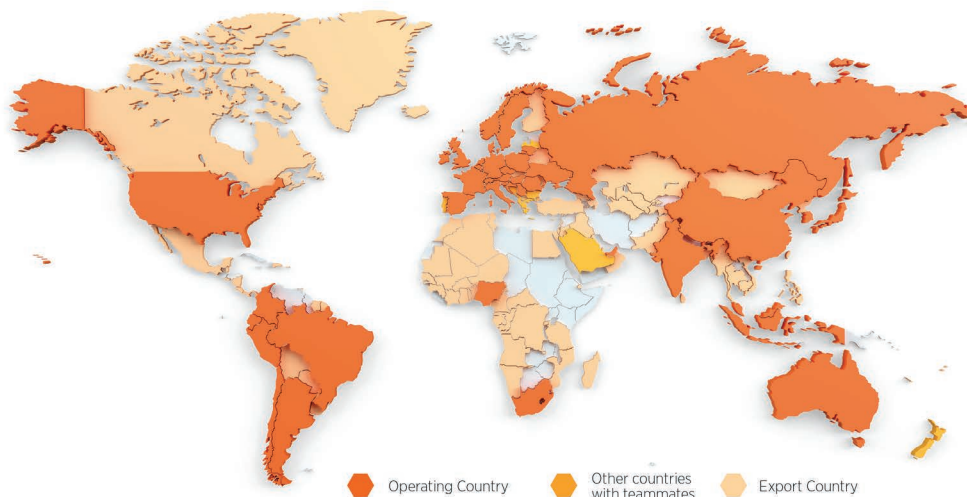
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## About Etex

Etex is a global building material manufacturer and pioneer in lightweight construction. Etex wants to inspire people around the world to build living spaces that are ever more safe, sustainable, smart and beautiful.

Founded in 1905, headquartered in Zaventem, Belgium, Etex is a family-owned company with more than 13,500 employees globally. It operates more than 140 sites in 45 countries and recorded a revenue of EUR 3.0 billion and a REBITDA of EUR 570 million in 2021. Etex fosters a collaborative and caring culture, a pioneering spirit and a passion to always do better for its customers.

Etex has five R&D centres supporting five global divisions:

- Building Performance: dry construction solutions including plasterboards and fibre cement boards, plasters and formulated products, passive fire protection and associated products.
- Exteriors: a range of aesthetic fibre cement materials for use in agriculture, architectural and residential exteriors.
- Industry: fire protection and high-performance insulation products for the construction and OEM (Original Equipment Manufacturer) industries.
- Insulation: glass mineral wool and extruded polystyrene (XPS) for thermal and acoustic insulation.
- New Ways: high-tech offsite modular solutions based on wood and steel framing.

Etex's global portfolio includes leading commercial brands such as Promat, Kalsi, Siniat, Equitone, Eternit, Cedral, Durlock, Gyplac, Pladur, Superboard and URSA.

Etex is Inspiring Ways of Living, for more information, please visit our website: [www.etexgroup.com](http://www.etexgroup.com)