Lightcem

FIRE PROTECTION FOR STEEL CONSTRUCTIONS

- Lightcems FIRESHIELD 1150 is ideal for use in offshore constructions, ship building, petrochemical applications and constructions where steel and concrete structures require protection from extreme temperatures (up to 1150°C) or where reduced material density is required.
- Lightcems FIRESHIELD 1150 offers an effective durable insulation,
- Lightcems FIRESHIELD 1150 can be applied to most clean surfaces and with a thickness of 10mm to 100mm.

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The correct material thickness for a given fire resistance period

With exception of road tunnels, the majority of passive fire protection products are applied to structural steelwork. In the calculation examples below, we have therefore used a structural steel section to illustrate the method of establishing the correct product thickness required for a given fire resistance time period.

Each piece of steel has some natural ability to absorb heat - its "heat sink" characteristics. The larger the area of steel exposed to fire is, the greater amount of heat will affect the steels strength. Therefore a shallow thick section has a greater ability to resist fire than a deep thin section. This ability is expressed as the steel section's Hp/A factor, where Hp is the heated perimeter (in linear meters) exposed to fire, and A is the corresponding cross sectional area of steel (in square meters),

The concept derives from the fact that the greater the mass and smaller the perimeter of a steel section, the better the inherent heat sink. In other words, a section with a high Hp/A factor will heat up more rapidly than one with a low Hp/A, and so may require a higher fire protection to achieve the same level of fire resistance.

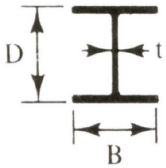
Step 1. Calculating the Hp/A factor

Using a 457 x 191 x 67 kg/m serial size section where actual dimension values are:

A (areal) = 0,00854 m²

B = 189.9 mm

D = 453.6 mm t = 8.5 mm.



Note that the cross-sectional area can be obtained by dividing the weight of the section per linear meter by the weight of 1m³ of steel (7850 kg). Thus : 67 /7850 = 0,00854 m²

If the protection follows the profile of a section, as would occur with sprayed coatings, the following Hp/A factors will result:

Example 1 **Profile protection, 4 sides exposed**
Hp = 4B + 2D – 2t
Hp = 4 x 189.9mm + 2 x 453.6mm – 2 x 8.5mm
Hp = 759.6 + 907.2 –17.0 = 1649.8mm (1,650m)

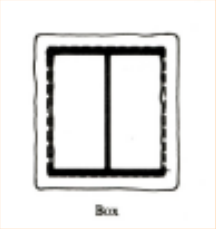
Therefore, Hp/A = 1.650m / 0.00854m² = **193.2(m⁻¹)**

Example 2 **Profile protection, 3 sides exposed**
Hp = 3B + 2D – 2t
Hp = 3 x 189.9mm + 2 x 453.6mm – 2 x 8.5mm
Hp = 569.7 + 907.2 – 17.0 = 1459.9mm (1.460m)

Therefore, Hp/A = 1.460m / 0.00854m² = **171,0(m⁻¹)**

Example 3 **Boxed protection, 4 sides exposed**
Hp = 2B + 2D
Hp = 2 x 189.9mm + 2 x 453.6mm
Hp = 379.8 + 907.2 = 1287mm (1.287m)

Therefore, Hp/A = 1.287m / 0.00854m² = **150.7(m⁻¹)**



Example 4 **Boxed protection, 3 sides exposed**
Hp = B + 2D
Hp = 189.9mm + 2 x 453.6mm
Hp = 379.8 + 907.2 = 1097mm (1.097m)

Therefore, Hp/A = 1.097m / 0.00854m² = **128.5(m⁻¹)**

Step 2. Finding the correct thickness of materials tables using the Hp/A values.

As an example, using Fireshield 1150 sprayed coating to five 120 minutes fire resistance;

The values below are taken from an extensive table of thickness.

LOSS PREVENTION COUNCIL DATA FOR FIRESHIELD 1150 CRITICAL TEMPERATURE OF 620°C APPLICABLE TO BEAMS						
Hp/A	Dry thickness in mm to achieve fire resistance of:-					
	30 min	60 min	90 min	120 min	180 min	240 min
40	15	15	16	20	29	37
60	15	15	19	24	34	43
80	15	16	21	26	37	47
100	15	17	23	28	39	50
120	15	18	24	29	41	53
140	15	18	24	30	42	54
160	15	19	25	31	43	56
180	15	19	25	32	44	57
200	15	19	26	33	45	58
220	15	20	26	33	45	58
240	15	20	26	33	46	59
260	15	20	27	33	46	60
280	15	20	27	33	47	60
300	15	20	27	34	47	60
320	15	20	27	34	47	61

LOSS PREVENTION COUNCIL DATA FOR FIRESHIELD 1150 CRITICAL TEMPERATURE OF 550°C APPLICABLE TO COLUMNS						
Hp/A	Dry thickness in mm to achieve fire resistance of:-					
	30 min	60 min	90 min	120 min	180 min	240 min
40	15	15	18	23	31	40
60	15	16	21	26	37	47
80	15	17	23	29	40	51
100	15	18	24	30	42	54
120	15	19	25	31	44	56
140	15	20	26	32	45	57
160	15	20	27	33	46	59
180	15	20	27	34	47	60
200	15	21	27	34	47	60
220	15	21	28	34	48	61
240	15	21	28	35	48	62
260	15	21	8	35	49	62
280	15	22	28	35	49	63
300	15	22	29	35	49	63
320	15	22	29	36	50	63

Table 1: Fireshield 1150 thickness for I and H section columns, giving a required period of 120 minutes fire resistance. Critical temperature 550°C.

Hp/A (m^{-1})	Minimum Fireshield 1150 thickness (mm) BS 476 Part 21
Ex 1: 193.2	34
Ex 2: 171.0	34
Ex 3: 150,7	34
Ex 4: 128.5	27

Each HP/A value above should be revised upward to the nearest value shown on the extensive tables, i.e.. Read 200 for 193.2.

For the «boxed», solid fill, protection in example 3 and 4, the thickness refers to the material applied to the outside faced of the flanges only.

Although steel sections have their own specific Hp/A factor, thickness values will vary depending on the type of fire protective material specified and also whether the material is used on a beam or column.

Calculation of thickness of Fireshield 1150 on closed structural hollow sections (RHS-sections) or (box-protection)

Thickness of **Fireshield** 1150 on closed structural hollow sections (RHS-sections) can be calculated according to Annex B.1.1.3 of ENV 13381-4:2002 (E)[1], using the design curves established for open H/I-sections as follows:

Where thicknesses of the fire protection material have been assessed from 'I' or 'H' sections with profiled protection, a correction to the thickness is required based on the A_p/V value of the section as follows:

a) establish the A_p/V value of the Structural Hollow Section,

b) determine the thickness of the fire protection material based on the 'I' or 'H' section data. This is the thickness, d_p, in mm.

c) increase the thickness as follows:

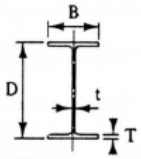
i) for A_p/V values up to 250 m^{-1},

$$\text{Modified thickness} = d_p\left(1+\frac{A_p/V}{1000}\right)$$

[1] ENV 13381-4:2002 (E): Test methods for determining the contribution to the fire resistance of structural members - Part 4: Applied protection to steel members. Annex B(normative) The applicability of the results of the assessment to sections other than 'I' or 'H' section

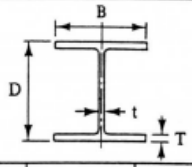
F/A = Ai/Vs = Hp/A for the most used Steel profiles in England.

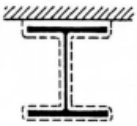
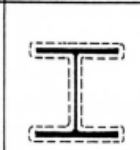
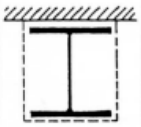
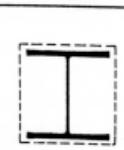
Table 1.1
Universal beams



Designation		Depth of section	Width of section	Thickness		Area of section	Section factor H_p/A			
							Profile		Box	
							3 sides	4 sides	3 sides	4 sides
Serial size	Mass per metre	D	B	Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm²	m⁻¹	m⁻¹	m⁻¹	m⁻¹
914×419	388	920.5	420.5	21.5	36.6	494.4	60	70	45	55
	343	911.4	418.5	19.4	32.0	437.4	70	80	50	60
914×305	289	926.6	307.8	19.6	32.0	368.8	75	80	60	65
	253	918.5	305.5	17.3	27.9	322.8	85	95	65	75
	224	910.3	304.1	15.9	23.9	285.2	95	105	75	85
	201	903	303.4	15.2	20.2	256.4	105	115	80	95
838×292	226	850.9	293.8	16.1	26.8	288.7	85	95	70	80
	194	840.7	292.4	14.7	21.7	247.1	100	115	80	90
	176	834.9	291.6	14	18.8	224.1	110	125	90	100
762×267	197	769.6	268	15.6	25.4	250.7	90	100	70	85
	173	762	266.7	14.3	21.6	220.4	105	115	80	95
	147	753.9	265.3	12.9	17.5	188.0	120	135	95	110
686×254	170	692.9	255.8	14.5	23.7	216.5	95	110	75	90
	152	687.6	254.5	13.2	21.0	193.8	110	120	85	95
	140	683.5	253.7	12.4	19.0	178.6	115	130	90	105
	125	677.9	253	11.7	16.2	159.6	130	145	100	115
610×305	238	633	311.5	18.6	31.4	303.7	70	80	50	60
	179	617.5	307	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
610×229	140	617	230.1	13.1	22.1	178.3	105	120	80	95
	125	611.9	229	11.9	19.6	159.5	115	130	90	105
	113	607.3	228.2	11.2	17.3	144.4	130	145	100	115
	101	602.2	227.6	10.6	14.8	129.1	145	160	110	130
533×210	122	544.6	211.9	12.8	21.3	155.7	110	120	85	95
	109	539.5	210.7	11.6	18.8	138.5	120	135	95	110
	101	536.7	210.1	10.9	17.4	129.7	130	145	100	115
	92	533.1	209.3	10.2	15.6	117.7	140	160	110	125
	82	528.3	208.7	9.6	13.2	104.4	155	175	120	140
457×191	98	467.4	192.8	11.4	19.6	125.2	120	135	90	105
	89	463.6	192	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	94.98	155	175	115	135
	67	453.6	189.9	8.5	12.7	85.44	170	190	130	150
457×152	82	465.1	153.5	10.7	18.9	104.4	130	145	105	120
	74	461.3	152.7	9.9	17.0	94.99	140	155	115	130
	67	457.2	151.9	9.1	15.0	85.41	155	175	125	145
	60	454.7	152.9	8.0	13.3	75.93	175	195	140	160
	52	449.8	152.4	7.6	10.9	66.49	200	220	160	180
406×178	74	412.8	179.7	9.7	16.0	94.95	140	160	105	125
	67	409.4	178.8	8.8	14.3	85.49	155	175	115	140
	60	406.4	177.8	7.8	12.8	76.01	175	195	130	155
	54	402.6	177.6	7.6	10.9	68.42	190	215	145	170
406×140	46	402.3	142.4	6.9	11.2	58.96	205	230	160	185
	39	397.3	141.8	6.3	8.6	49.40	240	270	190	220
356×171	67	364	173.2	9.1	15.7	85.42	140	160	105	125
	57	358.6	172.1	8	13.0	72.18	165	190	125	145
	51	355.6	171.5	7.3	11.5	64.58	185	210	135	165
	45	352	171	6.9	9.7	56.96	210	240	155	185
356×127	39	352.8	126	6.5	10.7	49.40	215	240	170	195
	33	348.5	125.4	5.9	8.5	41.83	250	280	195	225
305×165	54	310.9	166.8	7.7	13.7	68.38	160	185	115	140
	46	307.1	165.7	6.7	11.8	58.90	185	210	130	160
	40	303.8	165.1	6.1	10.2	51.50	210	240	150	180
305×127	48	310.4	125.2	9.9	14.0	60.83	160	180	125	145
	42	306.6	124.3	8	12.1	53.18	180	205	140	160
	37	303.8	123.5	7.2	10.7	47.47	200	225	155	180
305×102	33	312.7	102.4	6.6	10.8	41.77	215	240	175	200
	28	308.9	101.9	6.1	8.9	36.30	245	275	200	225
	25	304.8	101.6	5.8	6.8	31.39	285	315	225	260
254×146	43	259.6	147.3	7.3	12.7	55.10	170	195	120	150
	37	256	146.4	6.4	10.9	47.45	195	225	140	170
	31	251.5	146.1	6.1	8.6	40.00	230	265	160	200
254×102	28	260.4	102.1	6.4	10.0	36.19	220	250	170	200
	25	257	101.9	6.1	8.4	32.17	245	280	190	225
	22	254	101.6	5.8	6.8	28.42	275	315	215	250
203×133	30	206.8	133.8	6.3	9.6	38.00	210	245	145	180
	25	203.2	133.4	5.8	7.8	32.31	240	285	165	210
203×102	23	203.2	101.6	5.2	9.3	29	235	270	175	210
178×102	19	177.8	101.6	4.7	7.9	24.2	265	305	190	230
152×89	16	152.4	88.9	4.6	7.7	20.5	270	310	190	235
127×76	13	127	76.2	4.2	7.6	16.8	275	320	195	240

Table 1.2
Universal columns



Designation		Depth of section	Width of section	Thickness		Area of section	Section factor H_p/A			
							Profile		Box	
							3 sides	4 sides	3 sides	4 sides
Serial size	Mass per metre	D	B	Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm²	m⁻¹	m⁻¹	m⁻¹	m⁻¹
356 × 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	393.7	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 × 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	225.7	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 × 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	327.2	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 × 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 × 203	86	222.3	208.8	13.0	20.5	110.1	95	110	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	165	200	105	140
152 × 152	37	161.8	154.4	8.1	11.5	47.4	160	190	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	300	155	205