



FIRE ASSESSMENT REPORT

FC12651-001

**ASSESSMENT OF MONOKOTE Z146 FOR PERFORMANCE IN ACCORDANCE WITH
AS 4100-1998 (R2016) FOR STRUCTURAL STEEL BEAMS AND COLUMNS AND
HOLLOW COLUMNS**

CLIENT

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ASSESSMENT OBJECTIVE

This report gives BRANZ's assessment of structural steel members using a cementitious coating identified as Monokote Z146 for I and H-section beams and columns and square/rectangular and circular hollow section columns depending on the size of the steel section and thickness of coating in accordance with AS 4100, Steel Structures, Section 12, Fire (R2016).

CONCLUSION

It is considered that Monokote Z146 would provide a fire resistance for universal I and H section beams and columns and circular and square/rectangular hollow columns for various thicknesses and critical temperatures as shown in Table 1 to Table 16 in accordance with AS 4100-1998 (R2016), Steel Structures, Section 12.

The results from the for I and H-section beams (three sided protection) and columns (four sided protection) are also applicable to any re-entrant section, e.g. T sections, angles, C sections etc, depending on the number of sides protected.

LIMITATION

This report is subject to the accuracy and completeness of the information supplied.

BRANZ reserves the right to amend or withdraw this assessment if information becomes available which indicates the stated fire performance may not be achieved.

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The results reported here relate only to the item/s described in this report.



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1. INTRODUCTION

This report gives BRANZ's assessment of structural steel members and hollow columns using the cementitious fire protection coating Monokote Z146 as a three sided and four sided protection, with a fire resistance of 30, 60, 90, 120, 150, 180, 210 and 240 minutes for I and H-section beams and columns and circular and square/rectangular columns depending on the size of the steel section and thickness of the protection in accordance with AS 4100-1998 (R2016), Steel Structures, Section 12, Fire. It considers a range of critical steel temperatures between 350°C and 750°C.

The methodology used in the analysis is the numerical regression approach defined in Annex E.5 of EN 13381-4: 2013.

2. BACKGROUND

Underwriters Laboratories LLC test report Nos. 4788753225A, 4788753225B and 4789155666 detail a series of fire resistance tests of a cementitious fire protection coating identified as Monokote Z146 in accordance with BS 476: Part 21: 1987

The specimens included in the tests comprised two 4.1 m long loaded beams and two 1 m long unloaded reference beams with nominal thicknesses of 8.5 mm and 45.5 mm which was three-sided contoured protection. In addition, a 1 m long unloaded deep web beam and thirteen, 1 m tall unloaded columns with three and four sided contoured protection respectively ranging from 10.1 mm to 45.7 mm. The specimens included in the tests covered section factors, "exposed surface area to volume ratio" (A/V), from 31.7 m⁻¹ to 330.0 m⁻¹.

3. DISCUSSION

3.1 The Standards

Australian Standard AS 4100-1998 requires fire resistance tests, in accordance with AS 1530.4 Section 5 for columns and Section 6 for beams, on at least two loaded beams/columns with the minimum and maximum thickness of protection and a further seven tests on short unloaded specimens to obtain the temperature of the steel sections for a range of protection thicknesses and a range of exposed surface area to mass ratio (S/M) of the steel members. The required thicknesses of protection for alternative steel sections can be determined by regression analysis or by methods in accordance with EN 13381-4 or EN 13381-8.

Underwriters Laboratories LLC test report Nos. 4788753225A, 4788753225B and 4789155666 evaluated the fire protection of I and H section beams protected with Monokote Z146 when tested in accordance with BS 476: Part 21: 1987 for loaded beams, additional guidance with respect to furnace control and performance criteria comes from BS 476: Part 20: 1987.

Fire resistance tests of loaded beams in accordance with BS 476: Part 21: 1987 or AS 1530.4:2014 are essentially the same with respect to furnace conditions and failure criteria. The only significant difference is that the BS 476: Part 21 test uses a 1.5 mm diameter mineral insulated metal sheathed thermocouples (MIMS) in the furnace compared with a 3 mm diameter mineral insulated metal sheathed thermocouples (MIMS) for AS 1530.4 tests.



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Although it is accepted that the smaller diameter thermocouple will heat up more rapidly, the difference between the two diameters thermocouples after 5 minutes would be minimal and therefore it is expected that the test results would be no less if the specimens had been tested in accordance with AS 1530.4.

BS 476: Part 21: 1987 does not provide direction for instrumentation of the steel sections. For the three UL tests referenced in Section 2, the instrumentation of the steel sections was in accordance with EN 13381-4: 2013. The placement of the specimen thermocouples between that tested and AS 1530.4:2014 are slightly different. For loadbearing beams, AS 1530.4:2014 specifies a minimum of two thermocouples positioned at four locations along the length of the beam. The tested specimens had three measuring stations each comprising five thermocouples over the length of the beam. In each measuring station, two thermocouples were positioned on the upper and lower flanges and one thermocouple was positioned at mid height of the web. The measuring stations were located at mid span of the beam and 1,000 mm either side of mid span, a further two lower flange thermocouples were installed 250 mm either side of mid span on opposite sides.

The short section thermocouples were also not as defined in AS 1530.4 however they were positioned on the upper and lower flanges and web of the beams and flanges and web of the short columns. The thermocouples were not grouped as defined in AS 1530.4 but were located in similar positions.

Although the thermocouple locations were not grouped as defined in AS 1530.4 they were positioned as suggested in the test standard and complied with the minimum number of thermocouples required. Based on this it is considered that the measured temperatures would be sufficiently similar had they been positioned in accordance with AS1530.4 to be used in this analysis.

3.2 Assessment Procedure

The assessment method used is that specified in EN 13381-4: 2013 “*Test methods for determining the contribution to the fire resistance of structural members Part 4: Applied passive protection to steel members*” section E.5 Numerical regression analysis. This requires a fit to an expression, based on calculations using least squares regression as:

$$t = a_0 + a_1 d_p + a_2 \frac{d_p}{A_m/V} + a_3 \phi_a + a_4 d_p \phi_a + a_5 d_p \frac{\phi_a}{A_m/V} + a_6 \frac{\phi_a}{A_m/V} + a_7 \frac{1}{A_m/V}$$

where:

t = the corrected time to design temperature ϕ_a , in minutes

$a_0, a_1, a_2, a_3, a_4, a_5, a_6$ & a_7 = regression coefficients

d_p = thickness of fire protection material (reactive coating only), in millimetres

A_m/V = section factor, (heated perimeter to surface area), in m^{-1} .

ϕ_a = the design steel temperature, in $^{\circ}C$

The regression analysis based on the tests resulted in the following coefficients:

Coefficients	Calculated	Modified
a_0	-53.46298	-48.13507
a_1	2.65250	2.38816
a_2	117.81087	106.07030
a_3	0.03736	0.03364
a_4	0.00515	0.00463
a_5	-0.21870	-0.19690
a_6	10.31065	9.28313
a_7	-1506.46119	-1356.33313

The predicted results have been compared with the actual corrected test results. As required by EN 13381-4: 2013 the following conditions must be met:

- For each short section the predicted time to reach the design temperature shall not exceed the corrected time by more than 15%.
- The mean value of all percentage differences as calculated in a) shall be less than zero.
- A maximum of 30% of individual values of all percentage differences as calculated in a) shall be more than zero.

To ensure the predicted results meet these conditions the regression coefficients have been modified by a factor of 0.900. All three conditions are complied with. The coefficients above have been modified to include this factor.

3.3 Use of Data in Tables 1 to 16

The results of the analysis are given in Table 1 to Table 16. The data has been extended in accordance with EN 13381-4: 2013 *“Test methods for determining the contribution to the fire resistance of structural members Part 4: Applied passive protection to steel members”* section 15 as follows:

- Maximum/minimum permitted protection thickness for beams from loaded test specimens $\pm 5\%$
- Maximum/minimum permitted section factor for beams from tested $\pm 10\%$

These limitations apply concurrently. The tables are rounded down to the nearest section factor (A/V) of 5 m^{-1} .

The limits of the data for beams and columns is therefore as follows:

	Section factor A/V [m^{-1}]	Thickness [mm]
Max	360	48.0
Min	30	8.1

Where the thickness has been calculated as less than 8.1 mm, a value of 8.1 has been given to sections down to an A/V of 30 m^{-1} .

Where the thickness has been calculated as greater than 48.0 mm, no extension has been given.

3.4 Test Data Used in the Analysis

Loaded sections and reference sections used for determining correction factors.

Test No.	Section	Section Dimensions	Section factor A/V [m ⁻¹]	Z146 Thickness [mm]
4788753225B	LB MIN	305 x 102 x 28	256.1	8.5
4788753225B	RB MIN	305 x 102 x 28	256.2	8.3
4789145666	LB MAX	305 x 102 x 28	256.8	45.5
4789145666	RB MAX	305 x 102 x 28	255.3	45.5

Sections used in the regression analysis.

Test No.	Section	Section Dimensions	Section factor A/V [m ⁻¹]	Z146 Thickness [mm]
4788753225B	SC1	356 x 406 x 634	31.7	10.1
4788753225A	SC2	356 x 406 x 634	32.2	35.8
4788753225B	SC4	305 x 305 x 97	154.6	10.3
4788753225B	SC7	152 x 152 x 30	234.7	10.1
4788753225B	SC8	152 x 152 x 30	232.1	36
4788753225B	SC11	IPE160	330	36.1
4789145666	SC14	356 x 406 x 634	32.9	21.8
4789145666	SC15	305 x 305 x 97	155.8	35.7
4789145666	SC16	305 x 305 x 97	154.9	45.7
4789145666	SC17	152 x 152 x 30	232.9	22.2
4789145666	SC18	152 x 152 x 30	249.6	44.8
4789145666	SC19	IPE160	312.5	22.2
4789145666	SC20	IPE160	327.4	45.3
4788753225A	DWB	610 x 305 x 179	106.6	36.1

3.5 Hollow Columns

The method described in EN 13381-4:2013 permits the assessment of hollow columns utilising the assessment data generated from the open section (universal beams and columns) test points. For profiled protection such as Monokote Z146, a correction to the thickness is required based on the A/V value of the section as follows:

- Establish the A_m/V value of the structural hollow section
- Determine the thickness d_p , in mm of the fire protection material based on the 'I' or 'H' section data in accordance with Formulae (A.1) or (A.2);
- For A_p/V values upto 250 m⁻¹ increase the thickness as follows:

$$\text{Modified thickness} = I + \frac{A_p/V}{100} \quad (\text{A.1})$$

- For A_p/V values higher than 250 m⁻¹, increase the thickness as follows:

$$\text{Modified thickness} = 1,25 d_p \quad (\text{A.2})$$

3.6 Angles, Channels and T-Sections

Results for I or H sections are directly applicable to angles, channels and T-sections for the same section factor, whether used as individual elements or as bracing.

4. CONCLUSION

It is considered that Monokote Z146 would provide a fire resistance for universal I and H section beams and columns and circular and square/rectangular hollow columns for various thicknesses and critical temperatures as shown in Table 1 to Table 16 in accordance with AS 4100-1998 (R2016), Steel Structures, Section 12.

The results from the for I and H-section beams (three sided protection) and columns (four sided protection) are also applicable to any re-entrant section, e.g. T sections, angles, C sections etc, depending on the number of sides protected.



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Table 1: I-Section Beams and Columns: Fire Protection Period 30 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 30 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
40	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
45	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
50	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
55	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
60	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
65	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
70	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
75	9.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
80	9.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
85	9.9	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
90	10.2	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
95	10.6	8.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
100	10.8	9.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
105	11.1	9.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
110	11.3	9.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
115	11.5	9.9	8.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
120	11.7	10.1	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
125	11.9	10.3	8.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
130	12.1	10.5	9.0	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
135	12.2	10.6	9.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
140	12.4	10.8	9.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
145	12.5	10.9	9.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
150	12.6	11.1	9.6	8.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
155	12.7	11.2	9.8	8.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
160	12.9	11.3	9.9	8.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
165	13.0	11.4	10.0	8.7	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1
170	13.1	11.5	10.1	8.8	8.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1
175	13.2	11.6	10.3	9.0	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1
180	13.2	11.7	10.4	9.1	8.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1
185	13.3	11.8	10.5	9.2	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1
190	13.4	11.9	10.5	9.3	8.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1
195	13.5	12.0	10.6	9.4	8.9	8.2	8.1	8.1	8.1	8.1	8.1	8.1
200	13.6	12.1	10.7	9.5	9.0	8.3	8.1	8.1	8.1	8.1	8.1	8.1
205	13.6	12.2	10.8	9.5	9.1	8.4	8.1	8.1	8.1	8.1	8.1	8.1
210	13.7	12.2	10.9	9.6	9.2	8.5	8.1	8.1	8.1	8.1	8.1	8.1
215	13.8	12.3	11.0	9.7	9.2	8.6	8.1	8.1	8.1	8.1	8.1	8.1
220	13.8	12.4	11.0	9.8	9.3	8.6	8.1	8.1	8.1	8.1	8.1	8.1
225	13.9	12.4	11.1	9.9	9.4	8.7	8.1	8.1	8.1	8.1	8.1	8.1
230	13.9	12.5	11.2	9.9	9.5	8.8	8.2	8.1	8.1	8.1	8.1	8.1
235	14.0	12.5	11.2	10.0	9.5	8.9	8.2	8.1	8.1	8.1	8.1	8.1
240	14.0	12.6	11.3	10.1	9.6	8.9	8.3	8.1	8.1	8.1	8.1	8.1
245	14.1	12.6	11.3	10.1	9.7	9.0	8.4	8.1	8.1	8.1	8.1	8.1
250	14.1	12.7	11.4	10.2	9.7	9.1	8.4	8.1	8.1	8.1	8.1	8.1
255	14.2	12.7	11.4	10.2	9.8	9.1	8.5	8.1	8.1	8.1	8.1	8.1
260	14.2	12.8	11.5	10.3	9.8	9.2	8.6	8.1	8.1	8.1	8.1	8.1
265	14.3	12.8	11.5	10.3	9.9	9.2	8.6	8.2	8.1	8.1	8.1	8.1
270	14.3	12.9	11.6	10.4	9.9	9.3	8.7	8.3	8.1	8.1	8.1	8.1
275	14.3	12.9	11.6	10.4	10.0	9.3	8.7	8.3	8.1	8.1	8.1	8.1
280	14.4	13.0	11.7	10.5	10.0	9.4	8.8	8.4	8.1	8.1	8.1	8.1
285	14.4	13.0	11.7	10.5	10.1	9.4	8.8	8.4	8.1	8.1	8.1	8.1
290	14.5	13.0	11.7	10.6	10.1	9.5	8.9	8.5	8.1	8.1	8.1	8.1
295	14.5	13.1	11.8	10.6	10.2	9.5	8.9	8.5	8.1	8.1	8.1	8.1
300	14.5	13.1	11.8	10.6	10.2	9.6	9.0	8.6	8.2	8.1	8.1	8.1
305	14.6	13.1	11.9	10.7	10.2	9.6	9.0	8.6	8.2	8.1	8.1	8.1
310	14.6	13.2	11.9	10.7	10.3	9.6	9.0	8.6	8.3	8.1	8.1	8.1
315	14.6	13.2	11.9	10.8	10.3	9.7	9.1	8.7	8.3	8.1	8.1	8.1
320	14.6	13.2	12.0	10.8	10.4	9.7	9.1	8.7	8.4	8.1	8.1	8.1
325	14.7	13.3	12.0	10.8	10.4	9.8	9.2	8.8	8.4	8.1	8.1	8.1
330	14.7	13.3	12.0	10.9	10.4	9.8	9.2	8.8	8.4	8.1	8.1	8.1
335	14.7	13.3	12.1	10.9	10.5	9.8	9.2	8.8	8.5	8.1	8.1	8.1
340	14.8	13.4	12.1	10.9	10.5	9.9	9.3	8.9	8.5	8.1	8.1	8.1
345	14.8	13.4	12.1	11.0	10.5	9.9	9.3	8.9	8.5	8.1	8.1	8.1
350	14.8	13.4	12.1	11.0	10.5	9.9	9.3	8.9	8.6	8.1	8.1	8.1
355	14.8	13.4	12.2	11.0	10.6	10.0	9.4	9.0	8.6	8.1	8.1	8.1
360	14.9	13.5	12.2	11.0	10.6	10.0	9.4	9.0	8.6	8.1	8.1	8.1

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 2: I-Section Beams and Columns: Fire Protection Period 60 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 60 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	8.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
40	9.9	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
45	11.2	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
50	12.3	9.9	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
55	13.2	10.9	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
60	14.0	11.8	9.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
65	14.7	12.5	10.5	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
70	15.3	13.2	11.2	9.2	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1
75	15.8	13.7	11.8	9.9	9.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1
80	16.2	14.2	12.3	10.5	9.8	8.7	8.1	8.1	8.1	8.1	8.1	8.1
85	16.7	14.7	12.8	11.0	10.3	9.3	8.3	8.1	8.1	8.1	8.1	8.1
90	17.0	15.1	13.2	11.4	10.8	9.8	8.8	8.2	8.1	8.1	8.1	8.1
95	17.4	15.4	13.6	11.9	11.2	10.2	9.3	8.6	8.1	8.1	8.1	8.1
100	17.7	15.7	13.9	12.2	11.6	10.6	9.7	9.1	8.5	8.1	8.1	8.1
105	18.0	16.0	14.3	12.6	11.9	11.0	10.1	9.5	8.9	8.1	8.1	8.1
110	18.2	16.3	14.5	12.9	12.2	11.3	10.4	9.8	9.2	8.4	8.1	8.1
115	18.4	16.6	14.8	13.2	12.5	11.6	10.7	10.1	9.6	8.8	8.1	8.1
120	18.7	16.8	15.0	13.4	12.8	11.9	11.0	10.4	9.9	9.1	8.1	8.1
125	18.9	17.0	15.3	13.6	13.0	12.1	11.3	10.7	10.1	9.3	8.1	8.1
130	19.0	17.2	15.5	13.9	13.2	12.4	11.5	10.9	10.4	9.6	8.4	8.1
135	19.2	17.4	15.7	14.1	13.5	12.6	11.7	11.2	10.6	9.9	8.6	8.1
140	19.4	17.5	15.8	14.3	13.6	12.8	11.9	11.4	10.9	10.1	8.9	8.1
145	19.5	17.7	16.0	14.4	13.8	13.0	12.1	11.6	11.1	10.3	9.1	8.1
150	19.7	17.8	16.2	14.6	14.0	13.1	12.3	11.8	11.2	10.5	9.3	8.2
155	19.8	18.0	16.3	14.7	14.2	13.3	12.5	11.9	11.4	10.7	9.5	8.4
160	19.9	18.1	16.4	14.9	14.3	13.4	12.6	12.1	11.6	10.8	9.7	8.5
165	20.0	18.2	16.6	15.0	14.4	13.6	12.8	12.2	11.7	11.0	9.8	8.7
170	20.2	18.4	16.7	15.2	14.6	13.7	12.9	12.4	11.9	11.1	10.0	8.9
175	20.3	18.5	16.8	15.3	14.7	13.9	13.0	12.5	12.0	11.3	10.1	9.0
180	20.4	18.6	16.9	15.4	14.8	14.0	13.2	12.7	12.1	11.4	10.3	9.2
185	20.5	18.7	17.0	15.5	14.9	14.1	13.3	12.8	12.3	11.5	10.4	9.3
190	20.5	18.8	17.1	15.6	15.0	14.2	13.4	12.9	12.4	11.7	10.5	9.5
195	20.6	18.8	17.2	15.7	15.1	14.3	13.5	13.0	12.5	11.8	10.6	9.6
200	20.7	18.9	17.3	15.8	15.2	14.4	13.6	13.1	12.6	11.9	10.8	9.7
205	20.8	19.0	17.4	15.9	15.3	14.5	13.7	13.2	12.7	12.0	10.9	9.8
210	20.9	19.1	17.5	16.0	15.4	14.6	13.8	13.3	12.8	12.1	11.0	9.9
215	20.9	19.2	17.5	16.0	15.5	14.7	13.9	13.4	12.9	12.2	11.1	10.0
220	21.0	19.2	17.6	16.1	15.5	14.7	14.0	13.5	13.0	12.3	11.2	10.1
225	21.1	19.3	17.7	16.2	15.6	14.8	14.0	13.5	13.0	12.3	11.2	10.2
230	21.1	19.4	17.7	16.3	15.7	14.9	14.1	13.6	13.1	12.4	11.3	10.3
235	21.2	19.4	17.8	16.3	15.8	15.0	14.2	13.7	13.2	12.5	11.4	10.4
240	21.2	19.5	17.9	16.4	15.8	15.0	14.2	13.8	13.3	12.6	11.5	10.5
245	21.3	19.5	17.9	16.4	15.9	15.1	14.3	13.8	13.3	12.6	11.6	10.5
250	21.3	19.6	18.0	16.5	15.9	15.1	14.4	13.9	13.4	12.7	11.6	10.6
255	21.4	19.6	18.0	16.6	16.0	15.2	14.4	13.9	13.5	12.8	11.7	10.7
260	21.4	19.7	18.1	16.6	16.1	15.3	14.5	14.0	13.5	12.8	11.8	10.8
265	21.5	19.7	18.1	16.7	16.1	15.3	14.6	14.1	13.6	12.9	11.8	10.8
270	21.5	19.8	18.2	16.7	16.2	15.4	14.6	14.1	13.6	13.0	11.9	10.9
275	21.6	19.8	18.2	16.8	16.2	15.4	14.7	14.2	13.7	13.0	11.9	10.9
280	21.6	19.9	18.3	16.8	16.3	15.5	14.7	14.2	13.8	13.1	12.0	11.0
285	21.7	19.9	18.3	16.9	16.3	15.5	14.8	14.3	13.8	13.1	12.1	11.1
290	21.7	20.0	18.4	16.9	16.4	15.6	14.8	14.3	13.9	13.2	12.1	11.1
295	21.7	20.0	18.4	16.9	16.4	15.6	14.9	14.4	13.9	13.2	12.2	11.2
300	21.8	20.0	18.4	17.0	16.4	15.6	14.9	14.4	13.9	13.3	12.2	11.2
305	21.8	20.1	18.5	17.0	16.5	15.7	14.9	14.5	14.0	13.3	12.3	11.3
310	21.9	20.1	18.5	17.1	16.5	15.7	15.0	14.5	14.0	13.4	12.3	11.3
315	21.9	20.1	18.6	17.1	16.6	15.8	15.0	14.5	14.1	13.4	12.3	11.4
320	21.9	20.2	18.6	17.1	16.6	15.8	15.1	14.6	14.1	13.4	12.4	11.4
325	22.0	20.2	18.6	17.2	16.6	15.8	15.1	14.6	14.1	13.5	12.4	11.4
330	22.0	20.2	18.7	17.2	16.7	15.9	15.1	14.6	14.2	13.5	12.5	11.5
335	22.0	20.3	18.7	17.2	16.7	15.9	15.2	14.7	14.2	13.6	12.5	11.5
340	22.0	20.3	18.7	17.3	16.7	15.9	15.2	14.7	14.3	13.6	12.5	11.6
345	22.1	20.3	18.7	17.3	16.8	16.0	15.2	14.8	14.3	13.6	12.6	11.6
350	22.1	20.4	18.8	17.3	16.8	16.0	15.3	14.8	14.3	13.7	12.6	11.6
355	22.1	20.4	18.8	17.4	16.8	16.0	15.3	14.8	14.4	13.7	12.6	11.7
360	22.1	20.4	18.8	17.4	16.8	16.1	15.3	14.8	14.4	13.7	12.7	11.7

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 3: I-Section Beams and Columns: Fire Protection Period 90 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 90 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	12.1	9.0	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	14.3	11.4	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
40	16.0	13.4	10.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
45	17.4	14.9	12.4	9.9	8.9	8.1	8.1	8.1	8.1	8.1	8.1	8.1
50	18.6	16.2	13.8	11.4	10.5	9.1	8.1	8.1	8.1	8.1	8.1	8.1
55	19.6	17.3	15.0	12.7	11.8	10.5	9.2	8.4	8.1	8.1	8.1	8.1
60	20.5	18.2	15.9	13.8	12.9	11.7	10.4	9.6	8.8	8.1	8.1	8.1
65	21.2	19.0	16.8	14.7	13.9	12.6	11.4	10.7	9.9	8.8	8.1	8.1
70	21.9	19.6	17.5	15.5	14.6	13.5	12.3	11.6	10.8	9.7	8.1	8.1
75	22.4	20.2	18.1	16.1	15.3	14.2	13.1	12.3	11.6	10.6	8.8	8.1
80	23.0	20.8	18.7	16.7	15.9	14.8	13.7	13.0	12.3	11.3	9.6	8.1
85	23.4	21.2	19.2	17.2	16.5	15.4	14.3	13.6	12.9	11.9	10.3	8.7
90	23.8	21.7	19.6	17.7	17.0	15.9	14.8	14.1	13.5	12.5	10.9	9.4
95	24.2	22.0	20.0	18.1	17.4	16.3	15.3	14.6	13.9	13.0	11.4	9.9
100	24.5	22.4	20.4	18.5	17.8	16.7	15.7	15.0	14.4	13.4	11.9	10.4
105	24.8	22.7	20.7	18.8	18.1	17.1	16.1	15.4	14.8	13.8	12.3	10.9
110	25.1	23.0	21.0	19.2	18.4	17.4	16.4	15.7	15.1	14.2	12.7	11.3
115	25.4	23.3	21.3	19.4	18.7	17.7	16.7	16.1	15.4	14.5	13.0	11.7
120	25.6	23.5	21.5	19.7	19.0	18.0	17.0	16.3	15.7	14.8	13.4	12.0
125	25.8	23.7	21.8	19.9	19.2	18.2	17.2	16.6	16.0	15.1	13.7	12.3
130	26.0	23.9	22.0	20.2	19.5	18.5	17.5	16.9	16.2	15.3	13.9	12.6
135	26.2	24.1	22.2	20.4	19.7	18.7	17.7	17.1	16.5	15.6	14.2	12.8
140	26.4	24.3	22.4	20.6	19.9	18.9	17.9	17.3	16.7	15.8	14.4	13.1
145	26.6	24.5	22.5	20.7	20.0	19.1	18.1	17.5	16.9	16.0	14.6	13.3
150	26.7	24.6	22.7	20.9	20.2	19.2	18.3	17.7	17.1	16.2	14.8	13.5
155	26.9	24.8	22.9	21.1	20.4	19.4	18.4	17.8	17.2	16.4	15.0	13.7
160	27.0	24.9	23.0	21.2	20.5	19.5	18.6	18.0	17.4	16.5	15.2	13.9
165	27.1	25.0	23.1	21.3	20.7	19.7	18.7	18.1	17.5	16.7	15.3	14.1
170	27.2	25.2	23.3	21.5	20.8	19.8	18.9	18.3	17.7	16.8	15.5	14.2
175	27.4	25.3	23.4	21.6	20.9	19.9	19.0	18.4	17.8	17.0	15.6	14.4
180	27.5	25.4	23.5	21.7	21.0	20.1	19.1	18.5	17.9	17.1	15.8	14.5
185	27.6	25.5	23.6	21.8	21.1	20.2	19.2	18.6	18.1	17.2	15.9	14.6
190	27.7	25.6	23.7	21.9	21.3	20.3	19.4	18.8	18.2	17.3	16.0	14.8
195	27.8	25.7	23.8	22.0	21.4	20.4	19.5	18.9	18.3	17.5	16.1	14.9
200	27.9	25.8	23.9	22.1	21.4	20.5	19.6	19.0	18.4	17.6	16.2	15.0
205	27.9	25.9	24.0	22.2	21.5	20.6	19.7	19.1	18.5	17.7	16.3	15.1
210	28.0	26.0	24.0	22.3	21.6	20.7	19.7	19.2	18.6	17.7	16.4	15.2
215	28.1	26.0	24.1	22.4	21.7	20.7	19.8	19.2	18.7	17.8	16.5	15.3
220	28.2	26.1	24.2	22.4	21.8	20.8	19.9	19.3	18.7	17.9	16.6	15.4
225	28.2	26.2	24.3	22.5	21.9	20.9	20.0	19.4	18.8	18.0	16.7	15.5
230	28.3	26.2	24.3	22.6	21.9	21.0	20.1	19.5	18.9	18.1	16.8	15.6
235	28.4	26.3	24.4	22.7	22.0	21.0	20.1	19.5	19.0	18.2	16.9	15.7
240	28.4	26.4	24.5	22.7	22.1	21.1	20.2	19.6	19.0	18.2	16.9	15.7
245	28.5	26.4	24.5	22.8	22.1	21.2	20.3	19.7	19.1	18.3	17.0	15.8
250	28.6	26.5	24.6	22.8	22.2	21.2	20.3	19.7	19.2	18.4	17.1	15.9
255	28.6	26.5	24.6	22.9	22.2	21.3	20.4	19.8	19.2	18.4	17.1	15.9
260	28.7	26.6	24.7	23.0	22.3	21.3	20.4	19.9	19.3	18.5	17.2	16.0
265	28.7	26.6	24.7	23.0	22.3	21.4	20.5	19.9	19.4	18.5	17.3	16.1
270	28.8	26.7	24.8	23.1	22.4	21.5	20.6	20.0	19.4	18.6	17.3	16.1
275	28.8	26.7	24.8	23.1	22.5	21.5	20.6	20.0	19.5	18.7	17.4	16.2
280	28.9	26.8	24.9	23.2	22.5	21.6	20.7	20.1	19.5	18.7	17.4	16.3
285	28.9	26.8	24.9	23.2	22.5	21.6	20.7	20.1	19.6	18.8	17.5	16.3
290	29.0	26.9	25.0	23.2	22.6	21.6	20.7	20.2	19.6	18.8	17.5	16.4
295	29.0	26.9	25.0	23.3	22.6	21.7	20.8	20.2	19.7	18.9	17.6	16.4
300	29.0	27.0	25.1	23.3	22.7	21.7	20.8	20.3	19.7	18.9	17.6	16.5
305	29.1	27.0	25.1	23.4	22.7	21.8	20.9	20.3	19.7	18.9	17.7	16.5
310	29.1	27.0	25.1	23.4	22.8	21.8	20.9	20.3	19.8	19.0	17.7	16.5
315	29.2	27.1	25.2	23.4	22.8	21.9	21.0	20.4	19.8	19.0	17.8	16.6
320	29.2	27.1	25.2	23.5	22.8	21.9	21.0	20.4	19.9	19.1	17.8	16.6
325	29.2	27.1	25.3	23.5	22.9	21.9	21.0	20.5	19.9	19.1	17.8	16.7
330	29.3	27.2	25.3	23.6	22.9	22.0	21.1	20.5	19.9	19.1	17.9	16.7
335	29.3	27.2	25.3	23.6	22.9	22.0	21.1	20.5	20.0	19.2	17.9	16.8
340	29.3	27.2	25.3	23.6	23.0	22.0	21.1	20.6	20.0	19.2	18.0	16.8
345	29.4	27.3	25.4	23.6	23.0	22.1	21.2	20.6	20.0	19.2	18.0	16.8
350	29.4	27.3	25.4	23.7	23.0	22.1	21.2	20.6	20.1	19.3	18.0	16.9
355	29.4	27.3	25.4	23.7	23.1	22.1	21.2	20.7	20.1	19.3	18.1	16.9
360	29.4	27.4	25.5	23.7	23.1	22.1	21.3	20.7	20.1	19.3	18.1	16.9

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 4: I-Section Beams and Columns: Fire Protection Period 120 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 120 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	17.8	14.8	11.7	8.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	20.2	17.4	14.6	11.7	10.5	8.7	8.1	8.1	8.1	8.1	8.1	8.1
40	22.1	19.4	16.8	14.1	13.1	11.5	9.8	8.8	8.1	8.1	8.1	8.1
45	23.6	21.1	18.6	16.1	15.1	13.6	12.1	11.1	10.1	8.6	8.1	8.1
50	24.9	22.5	20.0	17.6	16.7	15.3	13.9	12.9	12.0	10.6	8.4	8.1
55	26.0	23.6	21.2	18.9	18.0	16.6	15.3	14.4	13.5	12.2	10.1	8.1
60	27.0	24.6	22.2	20.0	19.1	17.8	16.5	15.6	14.8	13.6	11.5	9.6
65	27.8	25.4	23.1	20.9	20.0	18.8	17.5	16.7	15.9	14.7	12.7	10.8
70	28.5	26.1	23.9	21.7	20.8	19.6	18.4	17.6	16.8	15.6	13.7	11.9
75	29.1	26.8	24.5	22.4	21.5	20.3	19.1	18.3	17.6	16.4	14.6	12.8
80	29.7	27.3	25.1	23.0	22.1	20.9	19.8	19.0	18.2	17.1	15.3	13.6
85	30.2	27.8	25.6	23.5	22.7	21.5	20.3	19.6	18.8	17.7	16.0	14.3
90	30.6	28.3	26.1	24.0	23.2	22.0	20.8	20.1	19.4	18.3	16.6	14.9
95	31.0	28.7	26.5	24.4	23.6	22.4	21.3	20.5	19.8	18.8	17.1	15.5
100	31.4	29.0	26.8	24.8	24.0	22.8	21.7	21.0	20.2	19.2	17.5	15.9
105	31.7	29.4	27.2	25.1	24.3	23.2	22.1	21.3	20.6	19.6	17.9	16.4
110	32.0	29.7	27.5	25.4	24.6	23.5	22.4	21.7	21.0	19.9	18.3	16.8
115	32.3	30.0	27.8	25.7	24.9	23.8	22.7	22.0	21.3	20.3	18.6	17.1
120	32.5	30.2	28.0	26.0	25.2	24.1	23.0	22.3	21.6	20.6	19.0	17.4
125	32.8	30.5	28.3	26.2	25.5	24.3	23.2	22.5	21.8	20.8	19.2	17.7
130	33.0	30.7	28.5	26.5	25.7	24.6	23.5	22.8	22.1	21.1	19.5	18.0
135	33.2	30.9	28.7	26.7	25.9	24.8	23.7	23.0	22.3	21.3	19.7	18.2
140	33.4	31.1	28.9	26.9	26.1	25.0	23.9	23.2	22.5	21.5	20.0	18.5
145	33.6	31.2	29.1	27.0	26.3	25.1	24.1	23.4	22.7	21.7	20.2	18.7
150	33.8	31.4	29.2	27.2	26.4	25.3	24.2	23.6	22.9	21.9	20.4	18.9
155	33.9	31.6	29.4	27.4	26.6	25.5	24.4	23.7	23.1	22.1	20.5	19.1
160	34.1	31.7	29.5	27.5	26.7	25.6	24.6	23.9	23.2	22.2	20.7	19.2
165	34.2	31.9	29.7	27.7	26.9	25.8	24.7	24.0	23.4	22.4	20.9	19.4
170	34.3	32.0	29.8	27.8	27.0	25.9	24.8	24.2	23.5	22.5	21.0	19.6
175	34.5	32.1	29.9	27.9	27.1	26.0	25.0	24.3	23.6	22.7	21.1	19.7
180	34.6	32.2	30.0	28.0	27.3	26.2	25.1	24.4	23.7	22.8	21.3	19.8
185	34.7	32.3	30.2	28.1	27.4	26.3	25.2	24.5	23.9	22.9	21.4	20.0
190	34.8	32.4	30.3	28.2	27.5	26.4	25.3	24.6	24.0	23.0	21.5	20.1
195	34.9	32.5	30.4	28.3	27.6	26.5	25.4	24.7	24.1	23.1	21.6	20.2
200	35.0	32.6	30.5	28.4	27.7	26.6	25.5	24.8	24.2	23.2	21.7	20.3
205	35.1	32.7	30.5	28.5	27.8	26.7	25.6	24.9	24.3	23.3	21.8	20.4
210	35.2	32.8	30.6	28.6	27.9	26.7	25.7	25.0	24.4	23.4	21.9	20.5
215	35.3	32.9	30.7	28.7	27.9	26.8	25.8	25.1	24.4	23.5	22.0	20.6
220	35.4	33.0	30.8	28.8	28.0	26.9	25.9	25.2	24.5	23.6	22.1	20.7
225	35.4	33.0	30.9	28.8	28.1	27.0	25.9	25.3	24.6	23.7	22.2	20.8
230	35.5	33.1	30.9	28.9	28.2	27.1	26.0	25.3	24.7	23.7	22.2	20.9
235	35.6	33.2	31.0	29.0	28.2	27.1	26.1	25.4	24.8	23.8	22.3	20.9
240	35.6	33.3	31.1	29.1	28.3	27.2	26.1	25.5	24.8	23.9	22.4	21.0
245	35.7	33.3	31.1	29.1	28.4	27.3	26.2	25.5	24.9	23.9	22.5	21.1
250	35.8	33.4	31.2	29.2	28.4	27.3	26.3	25.6	25.0	24.0	22.5	21.1
255	35.8	33.4	31.2	29.2	28.5	27.4	26.3	25.7	25.0	24.1	22.6	21.2
260	35.9	33.5	31.3	29.3	28.5	27.4	26.4	25.7	25.1	24.1	22.7	21.3
265	36.0	33.6	31.4	29.3	28.6	27.5	26.4	25.8	25.1	24.2	22.7	21.3
270	36.0	33.6	31.4	29.4	28.6	27.5	26.5	25.8	25.2	24.2	22.8	21.4
275	36.1	33.7	31.5	29.4	28.7	27.6	26.5	25.9	25.2	24.3	22.8	21.4
280	36.1	33.7	31.5	29.5	28.7	27.6	26.6	25.9	25.3	24.3	22.9	21.5
285	36.2	33.8	31.6	29.5	28.8	27.7	26.6	26.0	25.3	24.4	22.9	21.6
290	36.2	33.8	31.6	29.6	28.8	27.7	26.7	26.0	25.4	24.4	23.0	21.6
295	36.3	33.8	31.6	29.6	28.9	27.8	26.7	26.1	25.4	24.5	23.0	21.7
300	36.3	33.9	31.7	29.7	28.9	27.8	26.8	26.1	25.5	24.5	23.1	21.7
305	36.3	33.9	31.7	29.7	29.0	27.9	26.8	26.2	25.5	24.6	23.1	21.7
310	36.4	34.0	31.8	29.8	29.0	27.9	26.9	26.2	25.5	24.6	23.1	21.8
315	36.4	34.0	31.8	29.8	29.0	27.9	26.9	26.2	25.6	24.7	23.2	21.8
320	36.5	34.0	31.8	29.8	29.1	28.0	26.9	26.3	25.6	24.7	23.2	21.9
325	36.5	34.1	31.9	29.9	29.1	28.0	27.0	26.3	25.7	24.7	23.3	21.9
330	36.5	34.1	31.9	29.9	29.1	28.0	27.0	26.3	25.7	24.8	23.3	21.9
335	36.6	34.1	31.9	29.9	29.2	28.1	27.0	26.4	25.7	24.8	23.3	22.0
340	36.6	34.2	32.0	30.0	29.2	28.1	27.1	26.4	25.8	24.8	23.4	22.0
345	36.6	34.2	32.0	30.0	29.2	28.1	27.1	26.4	25.8	24.9	23.4	22.1
350	36.7	34.2	32.0	30.0	29.3	28.2	27.1	26.5	25.8	24.9	23.4	22.1
355	36.7	34.3	32.1	30.1	29.3	28.2	27.2	26.5	25.9	24.9	23.5	22.1
360	36.7	34.3	32.1	30.1	29.3	28.2	27.2	26.5	25.9	25.0	23.5	22.2

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 5: I-Section Beams and Columns: Fire Protection Period 150 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 150 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	23.5	20.6	17.6	14.5	13.2	11.2	9.2	8.1	8.1	8.1	8.1	8.1
35	26.1	23.4	20.6	17.8	16.6	14.9	13.1	11.9	10.7	8.9	8.1	8.1
40	28.2	25.5	22.9	20.3	19.2	17.6	16.0	14.9	13.8	12.2	9.5	8.1
45	29.8	27.3	24.7	22.2	21.2	19.7	18.2	17.2	16.2	14.7	12.2	9.8
50	31.2	28.7	26.2	23.8	22.8	21.4	20.0	19.0	18.1	16.7	14.4	12.1
55	32.4	29.9	27.5	25.1	24.2	22.8	21.4	20.5	19.6	18.2	16.0	13.9
60	33.4	31.0	28.5	26.2	25.3	23.9	22.6	21.7	20.8	19.5	17.4	15.4
65	34.3	31.8	29.4	27.1	26.2	24.9	23.6	22.7	21.9	20.6	18.6	16.6
70	35.1	32.6	30.2	27.9	27.0	25.7	24.4	23.6	22.7	21.5	19.5	17.6
75	35.8	33.3	30.9	28.6	27.7	26.4	25.1	24.3	23.5	22.3	20.4	18.5
80	36.4	33.9	31.5	29.2	28.3	27.0	25.8	25.0	24.2	23.0	21.1	19.2
85	36.9	34.4	32.0	29.8	28.9	27.6	26.4	25.5	24.7	23.6	21.7	19.9
90	37.4	34.9	32.5	30.2	29.4	28.1	26.9	26.0	25.3	24.1	22.2	20.5
95	37.8	35.3	32.9	30.7	29.8	28.5	27.3	26.5	25.7	24.6	22.7	21.0
100	38.2	35.7	33.3	31.0	30.2	28.9	27.7	26.9	26.1	25.0	23.2	21.4
105	38.6	36.0	33.6	31.4	30.5	29.3	28.1	27.3	26.5	25.4	23.6	21.9
110	38.9	36.4	34.0	31.7	30.9	29.6	28.4	27.6	26.8	25.7	23.9	22.2
115	39.2	36.7	34.3	32.0	31.2	29.9	28.7	27.9	27.1	26.0	24.2	22.6
120	39.5	36.9	34.5	32.3	31.4	30.2	29.0	28.2	27.4	26.3	24.5	22.9
125	39.7	37.2	34.8	32.5	31.7	30.4	29.2	28.4	27.7	26.6	24.8	23.2
130	40.0	37.4	35.0	32.8	31.9	30.6	29.4	28.7	27.9	26.8	25.1	23.4
135	40.2	37.6	35.2	33.0	32.1	30.9	29.7	28.9	28.1	27.0	25.3	23.6
140	40.4	37.8	35.4	33.2	32.3	31.1	29.9	29.1	28.3	27.2	25.5	23.9
145	40.6	38.0	35.6	33.3	32.5	31.2	30.0	29.3	28.5	27.4	25.7	24.1
150	40.8	38.2	35.8	33.5	32.7	31.4	30.2	29.5	28.7	27.6	25.9	24.3
155	41.0	38.4	35.9	33.7	32.8	31.6	30.4	29.6	28.9	27.8	26.1	24.4
160	41.1	38.5	36.1	33.8	33.0	31.7	30.5	29.8	29.0	27.9	26.2	24.6
165	41.3	38.7	36.2	34.0	33.1	31.9	30.7	29.9	29.2	28.1	26.4	24.8
170	41.4	38.8	36.4	34.1	33.2	32.0	30.8	30.0	29.3	28.2	26.5	24.9
175	41.6	38.9	36.5	34.2	33.4	32.1	30.9	30.2	29.4	28.3	26.6	25.0
180	41.7	39.1	36.6	34.3	33.5	32.2	31.1	30.3	29.5	28.5	26.8	25.2
185	41.8	39.2	36.7	34.5	33.6	32.4	31.2	30.4	29.7	28.6	26.9	25.3
190	41.9	39.3	36.8	34.6	33.7	32.5	31.3	30.5	29.8	28.7	27.0	25.4
195	42.1	39.4	36.9	34.7	33.8	32.6	31.4	30.6	29.9	28.8	27.1	25.5
200	42.2	39.5	37.0	34.8	33.9	32.7	31.5	30.7	30.0	28.9	27.2	25.6
205	42.3	39.6	37.1	34.9	34.0	32.8	31.6	30.8	30.1	29.0	27.3	25.7
210	42.4	39.7	37.2	34.9	34.1	32.8	31.7	30.9	30.1	29.1	27.4	25.8
215	42.4	39.8	37.3	35.0	34.2	32.9	31.7	31.0	30.2	29.2	27.5	25.9
220	42.5	39.8	37.4	35.1	34.2	33.0	31.8	31.1	30.3	29.2	27.6	26.0
225	42.6	39.9	37.5	35.2	34.3	33.1	31.9	31.1	30.4	29.3	27.6	26.1
230	42.7	40.0	37.5	35.3	34.4	33.1	32.0	31.2	30.5	29.4	27.7	26.1
235	42.8	40.1	37.6	35.3	34.5	33.2	32.0	31.3	30.5	29.5	27.8	26.2
240	42.9	40.1	37.7	35.4	34.5	33.3	32.1	31.3	30.6	29.5	27.8	26.3
245	42.9	40.2	37.7	35.4	34.6	33.3	32.2	31.4	30.7	29.6	27.9	26.3
250	43.0	40.3	37.8	35.5	34.6	33.4	32.2	31.5	30.7	29.7	28.0	26.4
255	43.1	40.3	37.9	35.6	34.7	33.5	32.3	31.5	30.8	29.7	28.0	26.5
260	43.1	40.4	37.9	35.6	34.8	33.5	32.3	31.6	30.8	29.8	28.1	26.5
265	43.2	40.5	38.0	35.7	34.8	33.6	32.4	31.6	30.9	29.8	28.2	26.6
270	43.2	40.5	38.0	35.7	34.9	33.6	32.4	31.7	30.9	29.9	28.2	26.6
275	43.3	40.6	38.1	35.8	34.9	33.7	32.5	31.7	31.0	29.9	28.3	26.7
280	43.4	40.6	38.1	35.8	35.0	33.7	32.5	31.8	31.0	30.0	28.3	26.7
285	43.4	40.7	38.2	35.9	35.0	33.8	32.6	31.8	31.1	30.0	28.4	26.8
290	43.5	40.7	38.2	35.9	35.1	33.8	32.6	31.9	31.1	30.1	28.4	26.8
295	43.5	40.8	38.3	36.0	35.1	33.9	32.7	31.9	31.2	30.1	28.4	26.9
300	43.6	40.8	38.3	36.0	35.1	33.9	32.7	32.0	31.2	30.2	28.5	26.9
305	43.6	40.9	38.3	36.1	35.2	33.9	32.8	32.0	31.3	30.2	28.5	27.0
310	43.6	40.9	38.4	36.1	35.2	34.0	32.8	32.0	31.3	30.2	28.6	27.0
315	43.7	40.9	38.4	36.1	35.3	34.0	32.8	32.1	31.3	30.3	28.6	27.1
320	43.7	41.0	38.5	36.2	35.3	34.1	32.9	32.1	31.4	30.3	28.6	27.1
325	43.8	41.0	38.5	36.2	35.3	34.1	32.9	32.2	31.4	30.4	28.7	27.1
330	43.8	41.1	38.5	36.2	35.4	34.1	32.9	32.2	31.4	30.4	28.7	27.2
335	43.9	41.1	38.6	36.3	35.4	34.2	33.0	32.2	31.5	30.4	28.8	27.2
340	43.9	41.1	38.6	36.3	35.4	34.2	33.0	32.3	31.5	30.5	28.8	27.2
345	43.9	41.2	38.6	36.3	35.5	34.2	33.0	32.3	31.5	30.5	28.8	27.3
350	44.0	41.2	38.7	36.4	35.5	34.3	33.1	32.3	31.6	30.5	28.9	27.3
355	44.0	41.2	38.7	36.4	35.5	34.3	33.1	32.3	31.6	30.5	28.9	27.3
360	44.0	41.3	38.7	36.4	35.6	34.3	33.1	32.4	31.6	30.6	28.9	27.4

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 6: I-Section Beams and Columns: Fire Protection Period 180 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 180 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	29.2	26.4	23.5	20.5	19.3	17.4	15.5	14.2	12.8	10.8	8.1	8.1
35	32.0	29.3	26.6	23.9	22.7	21.0	19.3	18.2	17.0	15.2	12.2	9.1
40	34.2	31.6	29.0	26.4	25.3	23.7	22.1	21.1	20.0	18.4	15.7	13.0
45	36.0	33.5	30.9	28.4	27.4	25.8	24.3	23.3	22.3	20.8	18.3	15.9
50	37.6	35.0	32.5	30.0	29.0	27.5	26.1	25.1	24.1	22.7	20.4	18.0
55	38.8	36.3	33.8	31.3	30.3	28.9	27.5	26.5	25.6	24.2	22.0	19.8
60	39.9	37.3	34.8	32.4	31.4	30.0	28.6	27.7	26.8	25.5	23.3	21.2
65	40.9	38.3	35.8	33.3	32.4	31.0	29.6	28.7	27.8	26.5	24.4	22.3
70	41.7	39.1	36.6	34.1	33.2	31.8	30.5	29.6	28.7	27.4	25.3	23.3
75	42.4	39.8	37.3	34.8	33.9	32.5	31.2	30.3	29.4	28.2	26.1	24.1
80	43.1	40.4	37.9	35.5	34.5	33.2	31.8	30.9	30.1	28.8	26.8	24.9
85	43.6	41.0	38.4	36.0	35.1	33.7	32.4	31.5	30.7	29.4	27.4	25.5
90	44.2	41.5	38.9	36.5	35.6	34.2	32.9	32.0	31.2	29.9	27.9	26.0
95	44.6	41.9	39.4	36.9	36.0	34.6	33.3	32.4	31.6	30.4	28.4	26.5
100	45.1	42.3	39.8	37.3	36.4	35.0	33.7	32.8	32.0	30.8	28.8	27.0
105	45.4	42.7	40.1	37.7	36.7	35.4	34.1	33.2	32.4	31.1	29.2	27.3
110	45.8	43.0	40.4	38.0	37.1	35.7	34.4	33.5	32.7	31.5	29.5	27.7
115	46.1	43.4	40.7	38.3	37.4	36.0	34.7	33.8	33.0	31.8	29.8	28.0
120	46.4	43.6	41.0	38.6	37.6	36.3	35.0	34.1	33.3	32.1	30.1	28.3
125	46.7	43.9	41.3	38.8	37.9	36.5	35.2	34.4	33.5	32.3	30.4	28.6
130	47.0	44.1	41.5	39.1	38.1	36.7	35.4	34.6	33.8	32.5	30.6	28.8
135	47.2	44.4	41.7	39.3	38.3	37.0	35.6	34.8	34.0	32.8	30.9	29.0
140	47.4	44.6	41.9	39.5	38.5	37.2	35.8	35.0	34.2	33.0	31.1	29.3
145	47.7	44.8	42.1	39.7	38.7	37.3	36.0	35.2	34.3	33.1	31.2	29.5
150	47.9	45.0	42.3	39.8	38.9	37.5	36.2	35.3	34.5	33.3	31.4	29.6
155		45.1	42.5	40.0	39.0	37.7	36.4	35.5	34.7	33.5	31.6	29.8
160		45.3	42.6	40.1	39.2	37.8	36.5	35.7	34.8	33.6	31.7	30.0
165		45.5	42.8	40.3	39.3	38.0	36.6	35.8	35.0	33.8	31.9	30.1
170		45.6	42.9	40.4	39.5	38.1	36.8	35.9	35.1	33.9	32.0	30.2
175		45.8	43.0	40.5	39.6	38.2	36.9	36.1	35.2	34.0	32.1	30.4
180		45.9	43.2	40.7	39.7	38.3	37.0	36.2	35.3	34.2	32.3	30.5
185		46.0	43.3	40.8	39.8	38.4	37.1	36.3	35.5	34.3	32.4	30.6
190		46.1	43.4	40.9	39.9	38.6	37.2	36.4	35.6	34.4	32.5	30.7
195		46.2	43.5	41.0	40.0	38.7	37.3	36.5	35.7	34.5	32.6	30.8
200		46.3	43.6	41.1	40.1	38.8	37.4	36.6	35.8	34.6	32.7	30.9
205		46.4	43.7	41.2	40.2	38.8	37.5	36.7	35.8	34.7	32.8	31.0
210		46.5	43.8	41.3	40.3	38.9	37.6	36.8	35.9	34.7	32.9	31.1
215		46.6	43.9	41.4	40.4	39.0	37.7	36.8	36.0	34.8	32.9	31.2
220		46.7	44.0	41.4	40.5	39.1	37.8	36.9	36.1	34.9	33.0	31.3
225		46.8	44.0	41.5	40.5	39.2	37.8	37.0	36.2	35.0	33.1	31.3
230		46.9	44.1	41.6	40.6	39.2	37.9	37.1	36.2	35.0	33.2	31.4
235		47.0	44.2	41.7	40.7	39.3	38.0	37.1	36.3	35.1	33.2	31.5
240		47.0	44.3	41.7	40.8	39.4	38.0	37.2	36.4	35.2	33.3	31.6
245		47.1	44.3	41.8	40.8	39.4	38.1	37.3	36.4	35.2	33.4	31.6
250		47.2	44.4	41.8	40.9	39.5	38.2	37.3	36.5	35.3	33.4	31.7
255		47.2	44.5	41.9	40.9	39.6	38.2	37.4	36.6	35.4	33.5	31.7
260		47.3	44.5	42.0	41.0	39.6	38.3	37.4	36.6	35.4	33.5	31.8
265		47.4	44.6	42.0	41.1	39.7	38.3	37.5	36.7	35.5	33.6	31.8
270		47.4	44.6	42.1	41.1	39.7	38.4	37.5	36.7	35.5	33.6	31.9
275		47.5	44.7	42.1	41.2	39.8	38.4	37.6	36.8	35.6	33.7	32.0
280		47.5	44.7	42.2	41.2	39.8	38.5	37.6	36.8	35.6	33.7	32.0
285		47.6	44.8	42.2	41.3	39.9	38.5	37.7	36.9	35.7	33.8	32.0
290		47.6	44.8	42.3	41.3	39.9	38.6	37.7	36.9	35.7	33.8	32.1
295		47.7	44.9	42.3	41.3	39.9	38.6	37.8	36.9	35.8	33.9	32.1
300		47.7	44.9	42.4	41.4	40.0	38.7	37.8	37.0	35.8	33.9	32.2
305		47.8	45.0	42.4	41.4	40.0	38.7	37.8	37.0	35.8	34.0	32.2
310		47.8	45.0	42.4	41.5	40.1	38.7	37.9	37.1	35.9	34.0	32.3
315		47.9	45.1	42.5	41.5	40.1	38.8	37.9	37.1	35.9	34.0	32.3
320		47.9	45.1	42.5	41.5	40.1	38.8	38.0	37.1	35.9	34.1	32.3
325		47.9	45.1	42.5	41.6	40.2	38.8	38.0	37.2	36.0	34.1	32.4
330		48.0	45.2	42.6	41.6	40.2	38.9	38.0	37.2	36.0	34.1	32.4
335		48.0	45.2	42.6	41.6	40.2	38.9	38.1	37.2	36.0	34.2	32.4
340			45.2	42.7	41.7	40.3	38.9	38.1	37.3	36.1	34.2	32.5
345			45.3	42.7	41.7	40.3	39.0	38.1	37.3	36.1	34.2	32.5
350			45.3	42.7	41.7	40.3	39.0	38.2	37.3	36.1	34.3	32.5
355			45.3	42.7	41.8	40.4	39.0	38.2	37.4	36.2	34.3	32.6
360			45.4	42.8	41.8	40.4	39.1	38.2	37.4	36.2	34.3	32.6

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 7: I-Section Beams and Columns: Fire Protection Period 210 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 210 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	34.9	32.2	29.5	26.6	25.4	23.6	21.7	20.5	19.2	17.2	13.8	10.3
35	37.9	35.3	32.7	30.0	28.9	27.2	25.5	24.4	23.2	21.5	18.6	15.6
40	40.3	37.7	35.1	32.5	31.5	29.9	28.3	27.2	26.2	24.6	21.9	19.2
45	42.2	39.7	37.1	34.5	33.5	32.0	30.5	29.4	28.4	26.9	24.4	21.9
50	43.9	41.3	38.7	36.2	35.1	33.7	32.2	31.2	30.2	28.8	26.4	24.0
55	45.2	42.6	40.0	37.5	36.5	35.0	33.6	32.6	31.6	30.2	27.9	25.6
60	46.4	43.7	41.1	38.6	37.6	36.2	34.7	33.8	32.8	31.4	29.2	27.0
65	47.4	44.7	42.1	39.6	38.6	37.1	35.7	34.7	33.8	32.4	30.2	28.1
70		45.6	42.9	40.4	39.4	37.9	36.5	35.6	34.7	33.3	31.1	29.0
75		46.3	43.6	41.1	40.1	38.6	37.2	36.3	35.4	34.0	31.9	29.8
80		47.0	44.3	41.7	40.7	39.3	37.8	36.9	36.0	34.7	32.5	30.5
85		47.5	44.8	42.3	41.3	39.8	38.4	37.5	36.6	35.2	33.1	31.1
90			45.3	42.8	41.8	40.3	38.9	38.0	37.1	35.7	33.6	31.6
95			45.8	43.2	42.2	40.7	39.3	38.4	37.5	36.2	34.1	32.0
100			46.2	43.6	42.6	41.1	39.7	38.8	37.9	36.6	34.5	32.5
105			46.6	44.0	43.0	41.5	40.1	39.1	38.2	36.9	34.8	32.8
110			46.9	44.3	43.3	41.8	40.4	39.5	38.6	37.2	35.2	33.2
115			47.2	44.6	43.6	42.1	40.7	39.8	38.9	37.5	35.5	33.5
120			47.5	44.9	43.8	42.4	40.9	40.0	39.1	37.8	35.7	33.7
125			47.8	45.1	44.1	42.6	41.2	40.3	39.4	38.1	36.0	34.0
130			48.0	45.3	44.3	42.8	41.4	40.5	39.6	38.3	36.2	34.2
135				45.6	44.5	43.1	41.6	40.7	39.8	38.5	36.4	34.4
140				45.8	44.7	43.3	41.8	40.9	40.0	38.7	36.6	34.6
145				46.0	44.9	43.4	42.0	41.1	40.2	38.9	36.8	34.8
150				46.1	45.1	43.6	42.2	41.2	40.3	39.0	37.0	35.0
155				46.3	45.3	43.8	42.3	41.4	40.5	39.2	37.1	35.2
160				46.5	45.4	43.9	42.5	41.5	40.6	39.3	37.3	35.3
165				46.6	45.6	44.1	42.6	41.7	40.8	39.5	37.4	35.4
170				46.7	45.7	44.2	42.7	41.8	40.9	39.6	37.5	35.6
175				46.9	45.8	44.3	42.9	41.9	41.0	39.7	37.6	35.7
180				47.0	45.9	44.4	43.0	42.1	41.1	39.8	37.8	35.8
185				47.1	46.1	44.5	43.1	42.2	41.3	39.9	37.9	35.9
190				47.2	46.2	44.6	43.2	42.3	41.4	40.0	38.0	36.0
195				47.3	46.3	44.7	43.3	42.4	41.5	40.1	38.1	36.1
200				47.4	46.4	44.8	43.4	42.5	41.5	40.2	38.2	36.2
205				47.5	46.5	44.9	43.5	42.5	41.6	40.3	38.2	36.3
210				47.6	46.5	45.0	43.6	42.6	41.7	40.4	38.3	36.4
215				47.7	46.6	45.1	43.6	42.7	41.8	40.5	38.4	36.5
220				47.8	46.7	45.2	43.7	42.8	41.9	40.6	38.5	36.6
225				47.8	46.8	45.3	43.8	42.9	41.9	40.6	38.6	36.6
230				47.9	46.9	45.3	43.9	42.9	42.0	40.7	38.6	36.7
235				48.0	46.9	45.4	43.9	43.0	42.1	40.8	38.7	36.8
240					47.0	45.5	44.0	43.1	42.1	40.8	38.8	36.8
245					47.1	45.5	44.1	43.1	42.2	40.9	38.8	36.9
250					47.1	45.6	44.1	43.2	42.3	40.9	38.9	36.9
255					47.2	45.6	44.2	43.2	42.3	41.0	38.9	37.0
260					47.2	45.7	44.2	43.3	42.4	41.1	39.0	37.1
265					47.3	45.7	44.3	43.3	42.4	41.1	39.0	37.1
270					47.3	45.8	44.3	43.4	42.5	41.2	39.1	37.2
275					47.4	45.9	44.4	43.4	42.5	41.2	39.1	37.2
280					47.4	45.9	44.4	43.5	42.6	41.3	39.2	37.2
285					47.5	45.9	44.5	43.5	42.6	41.3	39.2	37.3
290					47.5	46.0	44.5	43.6	42.7	41.3	39.3	37.3
295					47.6	46.0	44.6	43.6	42.7	41.4	39.3	37.4
300					47.6	46.1	44.6	43.7	42.7	41.4	39.3	37.4
305					47.7	46.1	44.6	43.7	42.8	41.5	39.4	37.5
310					47.7	46.2	44.7	43.7	42.8	41.5	39.4	37.5
315					47.7	46.2	44.7	43.8	42.9	41.5	39.5	37.5
320					47.8	46.2	44.8	43.8	42.9	41.6	39.5	37.6
325					47.8	46.3	44.8	43.8	42.9	41.6	39.5	37.6
330					47.9	46.3	44.8	43.9	43.0	41.6	39.6	37.6
335					47.9	46.3	44.9	43.9	43.0	41.7	39.6	37.7
340					47.9	46.4	44.9	43.9	43.0	41.7	39.6	37.7
345					48.0	46.4	44.9	44.0	43.1	41.7	39.7	37.7
350					48.0	46.4	44.9	44.0	43.1	41.8	39.7	37.8
355					48.0	46.5	45.0	44.0	43.1	41.8	39.7	37.8
360					48.0	46.5	45.0	44.1	43.1	41.8	39.7	37.8

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 8: I-Section Beams and Columns: Fire Protection Period 240 minutes

Section Factor m ⁻¹	Monokote Z146 : I-Section Beams & Columns: FRR (FRL) 240 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	40.6	38.1	35.4	32.6	31.5	29.7	28.0	26.7	25.5	23.6	20.4	17.0
35	43.8	41.3	38.7	36.0	35.0	33.3	31.7	30.6	29.5	27.8	24.9	22.0
40	46.4	43.8	41.2	38.6	37.6	36.0	34.5	33.4	32.4	30.8	28.1	25.4
45		45.8	43.3	40.7	39.7	38.1	36.6	35.6	34.6	33.0	30.5	28.0
50		47.5	44.9	42.3	41.3	39.8	38.3	37.3	36.3	34.8	32.4	30.0
55			46.3	43.7	42.7	41.1	39.6	38.7	37.7	36.2	33.8	31.5
60			47.4	44.8	43.8	42.3	40.8	39.8	38.8	37.4	35.1	32.8
65				45.8	44.7	43.2	41.7	40.8	39.8	38.4	36.1	33.8
70				46.6	45.6	44.0	42.6	41.6	40.6	39.2	36.9	34.7
75				47.3	46.3	44.8	43.3	42.3	41.3	39.9	37.6	35.4
80				48.0	46.9	45.4	43.9	42.9	41.9	40.5	38.3	36.1
85					47.5	45.9	44.4	43.4	42.5	41.1	38.8	36.6
90					48.0	46.4	44.9	43.9	43.0	41.6	39.3	37.1
95						46.8	45.3	44.3	43.4	42.0	39.7	37.6
100						47.2	45.7	44.7	43.8	42.4	40.1	38.0
105						47.6	46.1	45.1	44.1	42.7	40.5	38.3
110						47.9	46.4	45.4	44.4	43.0	40.8	38.6
115							46.7	45.7	44.7	43.3	41.1	38.9
120							46.9	45.9	45.0	43.6	41.3	39.2
125							47.2	46.2	45.2	43.8	41.5	39.4
130							47.4	46.4	45.4	44.0	41.8	39.6
135							47.6	46.6	45.6	44.2	42.0	39.8
140							47.8	46.8	45.8	44.4	42.2	40.0
145							48.0	47.0	46.0	44.6	42.3	40.2
150								47.1	46.2	44.7	42.5	40.4
155								47.3	46.3	44.9	42.6	40.5
160								47.4	46.5	45.0	42.8	40.7
165								47.6	46.6	45.2	42.9	40.8
170								47.7	46.7	45.3	43.0	40.9
175								47.8	46.8	45.4	43.2	41.0
180								47.9	46.9	45.5	43.3	41.1
185								48.0	47.1	45.6	43.4	41.2
190									47.2	45.7	43.5	41.3
195									47.2	45.8	43.6	41.4
200									47.3	45.9	43.6	41.5
205									47.4	46.0	43.7	41.6
210									47.5	46.1	43.8	41.7
215									47.6	46.1	43.9	41.8
220									47.7	46.2	44.0	41.8
225									47.7	46.3	44.0	41.9
230									47.8	46.4	44.1	42.0
235									47.9	46.4	44.2	42.0
240									47.9	46.5	44.2	42.1
245									48.0	46.5	44.3	42.2
250									48.0	46.6	44.3	42.2
255										46.6	44.4	42.3
260										46.7	44.4	42.3
265										46.8	44.5	42.4
270										46.8	44.5	42.4
275										46.8	44.6	42.5
280										46.9	44.6	42.5
285										46.9	44.7	42.5
290										47.0	44.7	42.6
295										47.0	44.7	42.6
300										47.1	44.8	42.7
305										47.1	44.8	42.7
310										47.1	44.8	42.7
315										47.2	44.9	42.8
320										47.2	44.9	42.8
325										47.2	44.9	42.8
330										47.3	45.0	42.9
335										47.3	45.0	42.9
340										47.3	45.0	42.9
345										47.4	45.1	42.9
350										47.4	45.1	43.0
355										47.4	45.1	43.0
360										47.4	45.1	43.0

Table applies to beams protected on three sides including a concrete slab.

Table applies to columns and beams protected on four sides. Thickness is protection only.



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Table 9: Hollow Columns: Fire Protection Period 30 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 30 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
40	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
45	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
50	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
55	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
60	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
65	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
70	9.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
75	9.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
80	10.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
85	10.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
90	11.2	8.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
95	11.6	8.9	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
100	11.9	9.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
105	12.2	9.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
110	12.5	9.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
115	12.8	10.0	8.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
120	13.1	10.2	8.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
125	13.4	10.4	8.9	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
130	13.6	10.6	9.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
135	13.9	10.8	9.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
140	14.1	10.9	9.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
145	14.3	11.1	9.6	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
150	14.5	11.2	9.7	8.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
155	14.7	11.3	9.9	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
160	14.9	11.5	10.0	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
165	15.1	11.6	10.1	8.8	8.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1
170	15.3	11.7	10.3	8.9	8.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1
175	15.5	11.8	10.4	9.1	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1
180	15.6	11.9	10.5	9.2	8.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1
185	15.8	12.0	10.6	9.3	8.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1
190	16.0	12.1	10.7	9.4	8.9	8.2	8.1	8.1	8.1	8.1	8.1	8.1
195	16.1	12.2	10.8	9.5	9.0	8.3	8.1	8.1	8.1	8.1	8.1	8.1
200	16.3	12.2	10.8	9.6	9.1	8.4	8.1	8.1	8.1	8.1	8.1	8.1
205	16.4	12.3	10.9	9.7	9.2	8.5	8.1	8.1	8.1	8.1	8.1	8.1
210	16.6	12.4	11.0	9.7	9.2	8.6	8.1	8.1	8.1	8.1	8.1	8.1
215	16.7	12.5	11.1	9.8	9.3	8.6	8.1	8.1	8.1	8.1	8.1	8.1
220	16.9	12.5	11.2	9.9	9.4	8.7	8.1	8.1	8.1	8.1	8.1	8.1
225	17.0	12.6	11.2	10.0	9.5	8.8	8.1	8.1	8.1	8.1	8.1	8.1
230	17.1	12.7	11.3	10.0	9.6	8.9	8.2	8.1	8.1	8.1	8.1	8.1
235	17.3	12.7	11.4	10.1	9.6	8.9	8.3	8.1	8.1	8.1	8.1	8.1
240	17.4	12.8	11.4	10.2	9.7	9.0	8.4	8.1	8.1	8.1	8.1	8.1
245	17.5	12.8	11.5	10.2	9.8	9.1	8.4	8.1	8.1	8.1	8.1	8.1
250	17.7	12.9	11.5	10.3	9.8	9.1	8.5	8.1	8.1	8.1	8.1	8.1
255	17.7	12.9	11.6	10.3	9.9	9.2	8.6	8.1	8.1	8.1	8.1	8.1
260	17.8	13.0	11.6	10.4	9.9	9.3	8.6	8.2	8.1	8.1	8.1	8.1
265	17.8	13.0	11.7	10.5	10.0	9.3	8.7	8.3	8.1	8.1	8.1	8.1
270	17.9	13.1	11.7	10.5	10.0	9.4	8.7	8.3	8.1	8.1	8.1	8.1
275	17.9	13.1	11.8	10.6	10.1	9.4	8.8	8.4	8.1	8.1	8.1	8.1
280	18.0	13.2	11.8	10.6	10.1	9.5	8.8	8.4	8.1	8.1	8.1	8.1
285	18.0	13.2	11.9	10.6	10.2	9.5	8.9	8.5	8.1	8.1	8.1	8.1
290	18.1	13.2	11.9	10.7	10.2	9.6	8.9	8.5	8.1	8.1	8.1	8.1
295	18.1	13.3	11.9	10.7	10.3	9.6	9.0	8.6	8.2	8.1	8.1	8.1
300	18.2	13.3	12.0	10.8	10.3	9.7	9.0	8.6	8.3	8.1	8.1	8.1
305	18.2	13.3	12.0	10.8	10.4	9.7	9.1	8.7	8.3	8.1	8.1	8.1
310	18.2	13.4	12.1	10.9	10.4	9.7	9.1	8.7	8.3	8.1	8.1	8.1
315	18.3	13.4	12.1	10.9	10.4	9.8	9.2	8.8	8.4	8.1	8.1	8.1
320	18.3	13.4	12.1	10.9	10.5	9.8	9.2	8.8	8.4	8.1	8.1	8.1
325	18.3	13.5	12.2	11.0	10.5	9.9	9.2	8.8	8.5	8.1	8.1	8.1
330	18.4	13.5	12.2	11.0	10.5	9.9	9.3	8.9	8.5	8.1	8.1	8.1
335	18.4	13.5	12.2	11.0	10.6	9.9	9.3	8.9	8.5	8.1	8.1	8.1
340	18.4	13.6	12.3	11.1	10.6	10.0	9.4	9.0	8.6	8.1	8.1	8.1
345	18.5	13.6	12.3	11.1	10.6	10.0	9.4	9.0	8.6	8.1	8.1	8.1
350	18.5	13.6	12.3	11.1	10.7	10.0	9.4	9.0	8.6	8.1	8.1	8.1
355	18.5	13.6	12.3	11.1	10.7	10.1	9.4	9.1	8.7	8.1	8.1	8.1
360	18.6	13.7	12.4	11.2	10.7	10.1	9.5	9.1	8.7	8.2	8.1	8.1

Table applies to columns protected on all sides. Thickness is protection only.



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Table 10: Hollow Columns: Fire Protection Period 60 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 60 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	8.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
40	10.3	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
45	11.7	8.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
50	12.9	10.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
55	13.9	11.1	8.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
60	14.8	12.0	9.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
65	15.6	12.7	10.6	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
70	16.3	13.4	11.3	9.3	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1
75	17.0	13.9	11.9	10.0	9.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1
80	17.5	14.5	12.5	10.6	9.9	8.8	8.1	8.1	8.1	8.1	8.1	8.1
85	18.1	14.9	13.0	11.1	10.4	9.4	8.4	8.1	8.1	8.1	8.1	8.1
90	18.6	15.3	13.4	11.6	10.9	9.9	8.9	8.2	8.1	8.1	8.1	8.1
95	19.0	15.7	13.8	12.0	11.3	10.3	9.4	8.7	8.1	8.1	8.1	8.1
100	19.4	16.0	14.2	12.4	11.7	10.7	9.8	9.2	8.6	8.1	8.1	8.1
105	19.8	16.3	14.5	12.7	12.1	11.1	10.2	9.6	9.0	8.1	8.1	8.1
110	20.2	16.6	14.8	13.1	12.4	11.4	10.5	9.9	9.3	8.5	8.1	8.1
115	20.6	16.9	15.0	13.3	12.7	11.7	10.8	10.2	9.7	8.8	8.1	8.1
120	20.9	17.1	15.3	13.6	13.0	12.0	11.1	10.5	10.0	9.2	8.1	8.1
125	21.2	17.3	15.5	13.9	13.2	12.3	11.4	10.8	10.3	9.4	8.1	8.1
130	21.5	17.5	15.7	14.1	13.4	12.5	11.6	11.1	10.5	9.7	8.4	8.1
135	21.8	17.7	15.9	14.3	13.6	12.7	11.9	11.3	10.8	10.0	8.7	8.1
140	22.1	17.9	16.1	14.5	13.8	12.9	12.1	11.5	11.0	10.2	8.9	8.1
145	22.4	18.0	16.3	14.7	14.0	13.1	12.3	11.7	11.2	10.4	9.2	8.1
150	22.6	18.2	16.5	14.8	14.2	13.3	12.5	11.9	11.4	10.6	9.4	8.2
155	22.9	18.3	16.6	15.0	14.4	13.5	12.6	12.1	11.6	10.8	9.6	8.4
160	23.1	18.5	16.7	15.1	14.5	13.6	12.8	12.3	11.7	11.0	9.8	8.6
165	23.4	18.6	16.9	15.3	14.7	13.8	12.9	12.4	11.9	11.1	9.9	8.8
170	23.6	18.7	17.0	15.4	14.8	13.9	13.1	12.6	12.0	11.3	10.1	9.0
175	23.8	18.8	17.1	15.5	14.9	14.1	13.2	12.7	12.2	11.4	10.2	9.1
180	24.0	18.9	17.2	15.6	15.0	14.2	13.4	12.8	12.3	11.6	10.4	9.3
185	24.2	19.0	17.3	15.8	15.2	14.3	13.5	12.9	12.4	11.7	10.5	9.4
190	24.4	19.1	17.4	15.9	15.3	14.4	13.6	13.1	12.5	11.8	10.6	9.6
195	24.7	19.2	17.5	16.0	15.4	14.5	13.7	13.2	12.7	11.9	10.8	9.7
200	24.9	19.3	17.6	16.1	15.5	14.6	13.8	13.3	12.8	12.0	10.9	9.8
205	25.0	19.4	17.7	16.2	15.5	14.7	13.9	13.4	12.9	12.1	11.0	9.9
210	25.2	19.5	17.8	16.2	15.6	14.8	14.0	13.5	13.0	12.2	11.1	10.0
215	25.4	19.6	17.9	16.3	15.7	14.9	14.1	13.6	13.1	12.3	11.2	10.1
220	25.6	19.6	17.9	16.4	15.8	15.0	14.2	13.6	13.1	12.4	11.3	10.2
225	25.8	19.7	18.0	16.5	15.9	15.0	14.2	13.7	13.2	12.5	11.4	10.3
230	26.0	19.8	18.1	16.5	15.9	15.1	14.3	13.8	13.3	12.6	11.5	10.4
235	26.2	19.8	18.2	16.6	16.0	15.2	14.4	13.9	13.4	12.7	11.6	10.5
240	26.3	19.9	18.2	16.7	16.1	15.3	14.5	13.9	13.5	12.7	11.6	10.6
245	26.5	20.0	18.3	16.7	16.2	15.3	14.5	14.0	13.5	12.8	11.7	10.7
250	26.7	20.0	18.3	16.8	16.2	15.4	14.6	14.1	13.6	12.9	11.8	10.7
255	26.8	20.1	18.4	16.9	16.3	15.4	14.7	14.1	13.7	13.0	11.8	10.8
260	26.8	20.1	18.4	16.9	16.3	15.5	14.7	14.2	13.7	13.0	11.9	10.9
265	26.9	20.2	18.5	17.0	16.4	15.6	14.8	14.3	13.8	13.1	12.0	10.9
270	26.9	20.2	18.5	17.0	16.4	15.6	14.8	14.3	13.8	13.1	12.0	11.0
275	27.0	20.3	18.6	17.1	16.5	15.7	14.9	14.4	13.9	13.2	12.1	11.1
280	27.0	20.3	18.6	17.1	16.5	15.7	14.9	14.4	13.9	13.3	12.2	11.1
285	27.1	20.4	18.7	17.2	16.6	15.8	15.0	14.5	14.0	13.3	12.2	11.2
290	27.1	20.4	18.7	17.2	16.6	15.8	15.0	14.5	14.0	13.4	12.3	11.2
295	27.2	20.4	18.8	17.3	16.7	15.9	15.1	14.6	14.1	13.4	12.3	11.3
300	27.2	20.5	18.8	17.3	16.7	15.9	15.1	14.6	14.1	13.5	12.4	11.4
305	27.3	20.5	18.9	17.3	16.8	15.9	15.2	14.7	14.2	13.5	12.4	11.4
310	27.3	20.5	18.9	17.4	16.8	16.0	15.2	14.7	14.2	13.5	12.5	11.5
315	27.4	20.6	18.9	17.4	16.8	16.0	15.3	14.8	14.3	13.6	12.5	11.5
320	27.4	20.6	19.0	17.5	16.9	16.1	15.3	14.8	14.3	13.6	12.6	11.5
325	27.4	20.7	19.0	17.5	16.9	16.1	15.3	14.8	14.4	13.7	12.6	11.6
330	27.5	20.7	19.0	17.5	16.9	16.1	15.4	14.9	14.4	13.7	12.6	11.6
335	27.5	20.7	19.1	17.6	17.0	16.2	15.4	14.9	14.4	13.7	12.7	11.7
340	27.6	20.7	19.1	17.6	17.0	16.2	15.4	14.9	14.5	13.8	12.7	11.7
345	27.6	20.8	19.1	17.6	17.0	16.2	15.5	15.0	14.5	13.8	12.7	11.8
350	27.6	20.8	19.2	17.7	17.1	16.3	15.5	15.0	14.5	13.9	12.8	11.8
355	27.7	20.8	19.2	17.7	17.1	16.3	15.5	15.0	14.6	13.9	12.8	11.8
360	27.7	20.9	19.2	17.7	17.1	16.3	15.6	15.1	14.6	13.9	12.9	11.9

Table applies to columns protected on all sides. Thickness is protection only.



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Table 11: Hollow Columns: Fire Protection Period 90 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 90 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	12.4	9.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	14.8	11.6	8.6	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
40	16.6	13.6	10.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
45	18.2	15.2	12.6	10.0	9.0	8.1	8.1	8.1	8.1	8.1	8.1	8.1
50	19.6	16.5	14.0	11.6	10.6	9.2	8.1	8.1	8.1	8.1	8.1	8.1
55	20.7	17.6	15.2	12.9	12.0	10.6	9.3	8.4	8.1	8.1	8.1	8.1
60	21.7	18.6	16.2	14.0	13.1	11.8	10.5	9.7	8.9	8.1	8.1	8.1
65	22.6	19.4	17.1	14.9	14.1	12.8	11.6	10.8	10.0	8.8	8.1	8.1
70	23.4	20.1	17.9	15.7	14.9	13.7	12.5	11.7	10.9	9.8	8.1	8.1
75	24.1	20.7	18.5	16.4	15.6	14.4	13.3	12.5	11.8	10.7	8.9	8.1
80	24.8	21.3	19.1	17.0	16.2	15.1	13.9	13.2	12.5	11.4	9.7	8.1
85	25.4	21.7	19.6	17.6	16.8	15.6	14.5	13.8	13.1	12.1	10.4	8.8
90	26.0	22.2	20.1	18.1	17.3	16.1	15.1	14.3	13.6	12.6	11.0	9.5
95	26.5	22.6	20.5	18.5	17.7	16.6	15.5	14.8	14.1	13.1	11.6	10.0
100	27.0	22.9	20.8	18.9	18.1	17.0	15.9	15.3	14.6	13.6	12.0	10.6
105	27.4	23.3	21.2	19.2	18.5	17.4	16.3	15.6	15.0	14.0	12.5	11.0
110	27.9	23.6	21.5	19.6	18.8	17.7	16.7	16.0	15.3	14.4	12.9	11.4
115	28.3	23.8	21.8	19.9	19.1	18.0	17.0	16.3	15.7	14.7	13.2	11.8
120	28.7	24.1	22.0	20.1	19.4	18.3	17.3	16.6	16.0	15.0	13.6	12.2
125	29.0	24.3	22.3	20.4	19.6	18.6	17.6	16.9	16.3	15.3	13.9	12.5
130	29.4	24.6	22.5	20.6	19.9	18.8	17.8	17.1	16.5	15.6	14.1	12.8
135	29.8	24.8	22.7	20.8	20.1	19.0	18.0	17.4	16.7	15.8	14.4	13.0
140	30.1	24.9	22.9	21.0	20.3	19.2	18.2	17.6	17.0	16.1	14.6	13.3
145	30.4	25.1	23.1	21.2	20.5	19.4	18.4	17.8	17.2	16.3	14.9	13.5
150	30.7	25.3	23.3	21.4	20.6	19.6	18.6	18.0	17.4	16.5	15.1	13.7
155	31.0	25.4	23.4	21.5	20.8	19.8	18.8	18.2	17.5	16.7	15.2	13.9
160	31.3	25.6	23.6	21.7	21.0	19.9	19.0	18.3	17.7	16.8	15.4	14.1
165	31.6	25.7	23.7	21.8	21.1	20.1	19.1	18.5	17.9	17.0	15.6	14.3
170	31.9	25.9	23.8	22.0	21.2	20.2	19.3	18.6	18.0	17.1	15.7	14.4
175	32.2	26.0	24.0	22.1	21.4	20.4	19.4	18.8	18.2	17.3	15.9	14.6
180	32.4	26.1	24.1	22.2	21.5	20.5	19.5	18.9	18.3	17.4	16.0	14.7
185	32.7	26.2	24.2	22.3	21.6	20.6	19.6	19.0	18.4	17.5	16.2	14.9
190	32.9	26.3	24.3	22.4	21.7	20.7	19.7	19.1	18.5	17.7	16.3	15.0
195	33.2	26.4	24.4	22.5	21.8	20.8	19.9	19.2	18.6	17.8	16.4	15.1
200	33.4	26.5	24.5	22.6	21.9	20.9	20.0	19.3	18.7	17.9	16.5	15.3
205	33.7	26.6	24.6	22.7	22.0	21.0	20.1	19.4	18.8	18.0	16.6	15.4
210	33.9	26.7	24.7	22.8	22.1	21.1	20.1	19.5	18.9	18.1	16.7	15.5
215	34.1	26.8	24.8	22.9	22.2	21.2	20.2	19.6	19.0	18.2	16.8	15.6
220	34.4	26.8	24.8	23.0	22.3	21.3	20.3	19.7	19.1	18.3	16.9	15.7
225	34.6	26.9	24.9	23.1	22.3	21.4	20.4	19.8	19.2	18.3	17.0	15.8
230	34.8	27.0	25.0	23.1	22.4	21.4	20.5	19.9	19.3	18.4	17.1	15.8
235	35.1	27.1	25.0	23.2	22.5	21.5	20.6	19.9	19.3	18.5	17.2	15.9
240	35.3	27.1	25.1	23.3	22.6	21.6	20.6	20.0	19.4	18.6	17.2	16.0
245	35.5	27.2	25.2	23.3	22.6	21.6	20.7	20.1	19.5	18.6	17.3	16.1
250	35.7	27.2	25.2	23.4	22.7	21.7	20.8	20.1	19.6	18.7	17.4	16.2
255	35.8	27.3	25.3	23.5	22.7	21.8	20.8	20.2	19.6	18.8	17.5	16.2
260	35.8	27.4	25.4	23.5	22.8	21.8	20.9	20.3	19.7	18.8	17.5	16.3
265	35.9	27.4	25.4	23.6	22.9	21.9	20.9	20.3	19.7	18.9	17.6	16.4
270	36.0	27.5	25.5	23.6	22.9	21.9	21.0	20.4	19.8	19.0	17.6	16.4
275	36.0	27.5	25.5	23.7	23.0	22.0	21.0	20.4	19.9	19.0	17.7	16.5
280	36.1	27.6	25.6	23.7	23.0	22.0	21.1	20.5	19.9	19.1	17.8	16.5
285	36.1	27.6	25.6	23.8	23.1	22.1	21.1	20.5	20.0	19.1	17.8	16.6
290	36.2	27.7	25.7	23.8	23.1	22.1	21.2	20.6	20.0	19.2	17.9	16.6
295	36.2	27.7	25.7	23.9	23.2	22.2	21.2	20.6	20.1	19.2	17.9	16.7
300	36.3	27.7	25.7	23.9	23.2	22.2	21.3	20.7	20.1	19.3	18.0	16.7
305	36.3	27.8	25.8	24.0	23.2	22.3	21.3	20.7	20.1	19.3	18.0	16.8
310	36.4	27.8	25.8	24.0	23.3	22.3	21.4	20.8	20.2	19.4	18.1	16.8
315	36.4	27.9	25.9	24.0	23.3	22.4	21.4	20.8	20.2	19.4	18.1	16.9
320	36.5	27.9	25.9	24.1	23.4	22.4	21.5	20.9	20.3	19.4	18.1	16.9
325	36.5	27.9	25.9	24.1	23.4	22.4	21.5	20.9	20.3	19.5	18.2	17.0
330	36.6	28.0	26.0	24.1	23.4	22.5	21.5	20.9	20.3	19.5	18.2	17.0
335	36.6	28.0	26.0	24.2	23.5	22.5	21.6	21.0	20.4	19.6	18.3	17.1
340	36.7	28.0	26.0	24.2	23.5	22.5	21.6	21.0	20.4	19.6	18.3	17.1
345	36.7	28.1	26.1	24.2	23.5	22.6	21.6	21.0	20.5	19.6	18.3	17.1
350	36.7	28.1	26.1	24.3	23.6	22.6	21.7	21.1	20.5	19.7	18.4	17.2
355	36.8	28.1	26.1	24.3	23.6	22.6	21.7	21.1	20.5	19.7	18.4	17.2
360	36.8	28.2	26.2	24.3	23.6	22.7	21.7	21.1	20.6	19.7	18.4	17.2

Table applies to columns protected on all sides. Thickness is protection only.



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Table 12: Hollow Columns: Fire Protection Period 120 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 120 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	18.3	15.0	11.8	8.5	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
35	20.9	17.7	14.8	11.8	10.6	8.8	8.1	8.1	8.1	8.1	8.1	8.1
40	23.0	19.9	17.1	14.4	13.2	11.6	9.9	8.8	8.1	8.1	8.1	8.1
45	24.7	21.6	19.0	16.4	15.3	13.8	12.2	11.2	10.2	8.7	8.1	8.1
50	26.2	23.0	20.5	18.0	17.0	15.5	14.1	13.1	12.2	10.8	8.4	8.1
55	27.5	24.2	21.7	19.3	18.3	16.9	15.6	14.6	13.7	12.4	10.2	8.1
60	28.6	25.2	22.8	20.4	19.5	18.1	16.8	15.9	15.0	13.8	11.7	9.7
65	29.6	26.1	23.7	21.4	20.4	19.1	17.8	17.0	16.1	14.9	12.9	11.0
70	30.5	26.9	24.5	22.2	21.3	20.0	18.7	17.9	17.1	15.9	14.0	12.1
75	31.3	27.5	25.2	22.9	22.0	20.7	19.5	18.7	17.9	16.7	14.8	13.0
80	32.0	28.1	25.8	23.5	22.7	21.4	20.2	19.4	18.6	17.4	15.6	13.8
85	32.7	28.7	26.3	24.1	23.2	22.0	20.8	20.0	19.2	18.1	16.3	14.5
90	33.4	29.1	26.8	24.6	23.7	22.5	21.3	20.5	19.7	18.6	16.9	15.2
95	33.9	29.6	27.2	25.0	24.2	22.9	21.8	21.0	20.2	19.1	17.4	15.7
100	34.5	29.9	27.6	25.4	24.6	23.4	22.2	21.4	20.7	19.6	17.9	16.2
105	35.0	30.3	28.0	25.8	24.9	23.7	22.6	21.8	21.1	20.0	18.3	16.7
110	35.5	30.6	28.3	26.1	25.3	24.1	22.9	22.2	21.4	20.4	18.7	17.1
115	36.0	30.9	28.6	26.4	25.6	24.4	23.2	22.5	21.8	20.7	19.0	17.4
120	36.5	31.2	28.9	26.7	25.9	24.7	23.5	22.8	22.1	21.0	19.3	17.8
125	36.9	31.4	29.1	27.0	26.1	24.9	23.8	23.0	22.3	21.3	19.6	18.1
130	37.3	31.7	29.4	27.2	26.4	25.2	24.0	23.3	22.6	21.5	19.9	18.3
135	37.7	31.9	29.6	27.4	26.6	25.4	24.3	23.5	22.8	21.8	20.2	18.6
140	38.1	32.1	29.8	27.6	26.8	25.6	24.5	23.7	23.0	22.0	20.4	18.8
145	38.5	32.3	30.0	27.8	27.0	25.8	24.7	23.9	23.2	22.2	20.6	19.1
150	38.8	32.5	30.2	28.0	27.2	26.0	24.9	24.1	23.4	22.4	20.8	19.3
155	39.2	32.6	30.3	28.2	27.3	26.2	25.0	24.3	23.6	22.6	21.0	19.5
160	39.5	32.8	30.5	28.3	27.5	26.3	25.2	24.5	23.8	22.8	21.2	19.6
165	39.9	32.9	30.6	28.5	27.6	26.5	25.3	24.6	23.9	22.9	21.3	19.8
170	40.2	33.1	30.8	28.6	27.8	26.6	25.5	24.8	24.1	23.1	21.5	20.0
175	40.5	33.2	30.9	28.7	27.9	26.7	25.6	24.9	24.2	23.2	21.6	20.1
180	40.8	33.3	31.0	28.9	28.0	26.9	25.8	25.0	24.3	23.3	21.8	20.3
185	41.1	33.5	31.1	29.0	28.1	27.0	25.9	25.1	24.5	23.5	21.9	20.4
190	41.4	33.6	31.2	29.1	28.3	27.1	26.0	25.3	24.6	23.6	22.0	20.5
195	41.7	33.7	31.3	29.2	28.4	27.2	26.1	25.4	24.7	23.7	22.1	20.6
200	42.0	33.8	31.4	29.3	28.5	27.3	26.2	25.5	24.8	23.8	22.2	20.8
205	42.3	33.9	31.5	29.4	28.6	27.4	26.3	25.6	24.9	23.9	22.3	20.9
210	42.6	34.0	31.6	29.5	28.6	27.5	26.4	25.7	25.0	24.0	22.4	21.0
215	42.9	34.1	31.7	29.6	28.7	27.6	26.5	25.8	25.1	24.1	22.5	21.1
220	43.1	34.1	31.8	29.7	28.8	27.7	26.6	25.8	25.1	24.2	22.6	21.1
225	43.4	34.2	31.9	29.7	28.9	27.7	26.6	25.9	25.2	24.2	22.7	21.2
230	43.7	34.3	32.0	29.8	29.0	27.8	26.7	26.0	25.3	24.3	22.8	21.3
235	43.9	34.4	32.0	29.9	29.0	27.9	26.8	26.1	25.4	24.4	22.9	21.4
240	44.2	34.4	32.1	30.0	29.1	28.0	26.9	26.1	25.5	24.5	22.9	21.5
245	44.5	34.5	32.2	30.0	29.2	28.0	26.9	26.2	25.5	24.5	23.0	21.6
250	44.7	34.6	32.2	30.1	29.2	28.1	27.0	26.3	25.6	24.6	23.1	21.6
255	44.8	34.6	32.3	30.1	29.3	28.2	27.1	26.3	25.7	24.7	23.1	21.7
260	44.9	34.7	32.4	30.2	29.4	28.2	27.1	26.4	25.7	24.7	23.2	21.8
265	44.9	34.8	32.4	30.3	29.4	28.3	27.2	26.5	25.8	24.8	23.3	21.8
270	45.0	34.8	32.5	30.3	29.5	28.3	27.2	26.5	25.8	24.9	23.3	21.9
275	45.1	34.9	32.5	30.4	29.5	28.4	27.3	26.6	25.9	24.9	23.4	21.9
280	45.1	34.9	32.6	30.4	29.6	28.4	27.3	26.6	25.9	25.0	23.4	22.0
285	45.2	35.0	32.6	30.5	29.6	28.5	27.4	26.7	26.0	25.0	23.5	22.0
290	45.3	35.0	32.7	30.5	29.7	28.5	27.4	26.7	26.0	25.1	23.5	22.1
295	45.3	35.1	32.7	30.6	29.7	28.6	27.5	26.8	26.1	25.1	23.6	22.1
300	45.4	35.1	32.8	30.6	29.8	28.6	27.5	26.8	26.1	25.2	23.6	22.2
305	45.4	35.2	32.8	30.7	29.8	28.7	27.6	26.9	26.2	25.2	23.7	22.2
310	45.5	35.2	32.8	30.7	29.9	28.7	27.6	26.9	26.2	25.2	23.7	22.3
315	45.5	35.2	32.9	30.7	29.9	28.7	27.6	26.9	26.3	25.3	23.8	22.3
320	45.6	35.3	32.9	30.8	29.9	28.8	27.7	27.0	26.3	25.3	23.8	22.4
325	45.6	35.3	33.0	30.8	30.0	28.8	27.7	27.0	26.3	25.4	23.8	22.4
330	45.7	35.4	33.0	30.8	30.0	28.9	27.8	27.1	26.4	25.4	23.9	22.5
335	45.7	35.4	33.0	30.9	30.0	28.9	27.8	27.1	26.4	25.4	23.9	22.5
340	45.8	35.4	33.1	30.9	30.1	28.9	27.8	27.1	26.4	25.5	24.0	22.5
345	45.8	35.5	33.1	31.0	30.1	29.0	27.9	27.2	26.5	25.5	24.0	22.6
350	45.8	35.5	33.1	31.0	30.1	29.0	27.9	27.2	26.5	25.5	24.0	22.6
355	45.9	35.5	33.2	31.0	30.2	29.0	27.9	27.2	26.5	25.6	24.1	22.6
360	45.9	35.6	33.2	31.0	30.2	29.1	28.0	27.3	26.6	25.6	24.1	22.7

Table applies to columns protected on all sides. Thickness is protection only.



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Table 13: Hollow Columns: Fire Protection Period 150 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 150 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	24.2	21.1	18.0	14.7	13.4	11.4	9.3	8.1	8.1	8.1	8.1	8.1
35	27.0	24.0	21.1	18.1	16.9	15.1	13.3	12.1	10.9	9.0	8.1	8.1
40	29.3	26.3	23.5	20.7	19.6	17.9	16.3	15.2	14.1	12.4	9.6	8.1
45	31.2	28.1	25.4	22.8	21.7	20.1	18.6	17.5	16.5	15.0	12.4	9.9
50	32.8	29.6	27.0	24.4	23.4	21.9	20.4	19.4	18.4	17.0	14.6	12.3
55	34.2	30.9	28.3	25.8	24.8	23.3	21.9	20.9	20.0	18.6	16.3	14.1
60	35.4	32.0	29.4	26.9	25.9	24.5	23.1	22.2	21.3	19.9	17.8	15.6
65	36.5	32.9	30.4	27.9	26.9	25.5	24.1	23.2	22.3	21.1	18.9	16.9
70	37.5	33.7	31.2	28.8	27.8	26.4	25.0	24.1	23.3	22.0	19.9	18.0
75	38.4	34.5	31.9	29.5	28.5	27.1	25.8	24.9	24.1	22.8	20.8	18.9
80	39.3	35.1	32.6	30.1	29.2	27.8	26.5	25.6	24.8	23.5	21.6	19.6
85	40.0	35.7	33.1	30.7	29.7	28.4	27.1	26.2	25.4	24.2	22.2	20.3
90	40.7	36.2	33.6	31.2	30.2	28.9	27.6	26.7	25.9	24.7	22.8	20.9
95	41.4	36.6	34.1	31.7	30.7	29.4	28.1	27.2	26.4	25.2	23.3	21.5
100	42.0	37.0	34.5	32.1	31.1	29.8	28.5	27.6	26.8	25.6	23.8	21.9
105	42.6	37.4	34.9	32.5	31.5	30.2	28.9	28.0	27.2	26.0	24.2	22.4
110	43.2	37.8	35.2	32.8	31.8	30.5	29.2	28.4	27.6	26.4	24.5	22.8
115	43.7	38.1	35.5	33.1	32.1	30.8	29.5	28.7	27.9	26.7	24.9	23.1
120	44.2	38.4	35.8	33.4	32.4	31.1	29.8	29.0	28.2	27.0	25.2	23.4
125	44.7	38.7	36.1	33.7	32.7	31.4	30.1	29.3	28.5	27.3	25.5	23.7
130	45.2	38.9	36.3	33.9	32.9	31.6	30.4	29.5	28.7	27.6	25.7	24.0
135	45.6	39.1	36.5	34.1	33.2	31.9	30.6	29.7	28.9	27.8	26.0	24.2
140	46.1	39.4	36.8	34.3	33.4	32.1	30.8	30.0	29.2	28.0	26.2	24.5
145	46.5	39.6	37.0	34.5	33.6	32.3	31.0	30.2	29.4	28.2	26.4	24.7
150	46.9	39.8	37.1	34.7	33.8	32.4	31.2	30.3	29.5	28.4	26.6	24.9
155	47.3	39.9	37.3	34.9	33.9	32.6	31.3	30.5	29.7	28.6	26.8	25.1
160	47.7	40.1	37.5	35.0	34.1	32.8	31.5	30.7	29.9	28.7	26.9	25.2
165		40.3	37.6	35.2	34.2	32.9	31.7	30.8	30.0	28.9	27.1	25.4
170		40.4	37.8	35.3	34.4	33.1	31.8	31.0	30.2	29.0	27.3	25.6
175		40.5	37.9	35.5	34.5	33.2	31.9	31.1	30.3	29.2	27.4	25.7
180		40.7	38.0	35.6	34.6	33.3	32.1	31.2	30.4	29.3	27.5	25.8
185		40.8	38.2	35.7	34.8	33.4	32.2	31.4	30.6	29.4	27.7	26.0
190		40.9	38.3	35.8	34.9	33.6	32.3	31.5	30.7	29.5	27.8	26.1
195		41.0	38.4	35.9	35.0	33.7	32.4	31.6	30.8	29.7	27.9	26.2
200		41.2	38.5	36.0	35.1	33.8	32.5	31.7	30.9	29.8	28.0	26.3
205		41.3	38.6	36.1	35.2	33.9	32.6	31.8	31.0	29.9	28.1	26.4
210		41.4	38.7	36.2	35.3	34.0	32.7	31.9	31.1	30.0	28.2	26.5
215		41.4	38.8	36.3	35.4	34.0	32.8	32.0	31.2	30.0	28.3	26.6
220		41.5	38.9	36.4	35.4	34.1	32.9	32.0	31.3	30.1	28.4	26.7
225		41.6	38.9	36.5	35.5	34.2	32.9	32.1	31.3	30.2	28.4	26.8
230		41.7	39.0	36.6	35.6	34.3	33.0	32.2	31.4	30.3	28.5	26.9
235		41.8	39.1	36.6	35.7	34.4	33.1	32.3	31.5	30.4	28.6	26.9
240		41.9	39.2	36.7	35.7	34.4	33.2	32.3	31.6	30.4	28.7	27.0
245		41.9	39.2	36.8	35.8	34.5	33.2	32.4	31.6	30.5	28.7	27.1
250		42.0	39.3	36.9	35.9	34.6	33.3	32.5	31.7	30.6	28.8	27.2
255		42.1	39.4	36.9	35.9	34.6	33.4	32.5	31.8	30.6	28.9	27.2
260		42.1	39.4	37.0	36.0	34.7	33.4	32.6	31.8	30.7	28.9	27.3
265		42.2	39.5	37.0	36.1	34.7	33.5	32.7	31.9	30.7	29.0	27.3
270		42.3	39.6	37.1	36.1	34.8	33.5	32.7	31.9	30.8	29.0	27.4
275		42.3	39.6	37.1	36.2	34.9	33.6	32.8	32.0	30.9	29.1	27.5
280		42.4	39.7	37.2	36.2	34.9	33.6	32.8	32.0	30.9	29.2	27.5
285		42.4	39.7	37.2	36.3	35.0	33.7	32.9	32.1	31.0	29.2	27.6
290		42.5	39.8	37.3	36.3	35.0	33.7	32.9	32.1	31.0	29.3	27.6
295		42.5	39.8	37.3	36.4	35.1	33.8	33.0	32.2	31.1	29.3	27.7
300		42.6	39.9	37.4	36.4	35.1	33.8	33.0	32.2	31.1	29.3	27.7
305		42.6	39.9	37.4	36.5	35.1	33.9	33.0	32.3	31.1	29.4	27.7
310		42.7	40.0	37.5	36.5	35.2	33.9	33.1	32.3	31.2	29.4	27.8
315		42.7	40.0	37.5	36.5	35.2	34.0	33.1	32.3	31.2	29.5	27.8
320		42.8	40.0	37.6	36.6	35.3	34.0	33.2	32.4	31.3	29.5	27.9
325		42.8	40.1	37.6	36.6	35.3	34.0	33.2	32.4	31.3	29.6	27.9
330		42.9	40.1	37.6	36.7	35.3	34.1	33.2	32.5	31.3	29.6	28.0
335		42.9	40.2	37.7	36.7	35.4	34.1	33.3	32.5	31.4	29.6	28.0
340		42.9	40.2	37.7	36.7	35.4	34.1	33.3	32.5	31.4	29.7	28.0
345		43.0	40.2	37.7	36.8	35.4	34.2	33.4	32.6	31.4	29.7	28.1
350		43.0	40.3	37.8	36.8	35.5	34.2	33.4	32.6	31.5	29.7	28.1
355		43.0	40.3	37.8	36.8	35.5	34.2	33.4	32.6	31.5	29.8	28.1
360		43.1	40.3	37.8	36.9	35.5	34.3	33.4	32.7	31.5	29.8	28.2

Table applies to columns protected on all sides. Thickness is protection only.



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Table 14: Hollow Columns: Fire Protection Period 180 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 180 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	30.1	27.2	24.2	21.0	19.7	17.7	15.7	14.4	13.0	10.9	8.1	8.1
35	33.1	30.3	27.4	24.5	23.3	21.5	19.7	18.5	17.3	15.5	12.4	9.3
40	35.6	32.7	29.9	27.2	26.0	24.3	22.7	21.6	20.4	18.8	16.0	13.2
45	37.7	34.7	32.0	29.3	28.1	26.6	25.0	23.9	22.8	21.3	18.7	16.1
50	39.4	36.3	33.6	30.9	29.9	28.3	26.8	25.8	24.7	23.3	20.8	18.4
55	41.0	37.7	35.0	32.4	31.3	29.8	28.3	27.3	26.3	24.9	22.5	20.2
60	42.3	38.8	36.1	33.5	32.5	31.0	29.5	28.5	27.6	26.2	23.9	21.7
65	43.5	39.8	37.1	34.5	33.5	32.0	30.5	29.6	28.6	27.3	25.0	22.9
70	44.6	40.7	38.0	35.4	34.3	32.9	31.4	30.5	29.5	28.2	26.0	23.9
75	45.6	41.5	38.7	36.1	35.1	33.6	32.2	31.3	30.3	29.0	26.9	24.8
80	46.5	42.2	39.4	36.8	35.8	34.3	32.9	31.9	31.0	29.7	27.6	25.5
85	47.4	42.8	40.0	37.4	36.3	34.9	33.5	32.5	31.6	30.3	28.2	26.2
90		43.3	40.5	37.9	36.9	35.4	34.0	33.1	32.2	30.9	28.8	26.8
95		43.8	41.0	38.4	37.3	35.9	34.5	33.5	32.6	31.3	29.3	27.3
100		44.2	41.4	38.8	37.7	36.3	34.9	34.0	33.1	31.8	29.7	27.7
105		44.6	41.8	39.2	38.1	36.7	35.3	34.3	33.4	32.2	30.1	28.1
110		45.0	42.2	39.5	38.5	37.0	35.6	34.7	33.8	32.5	30.5	28.5
115		45.4	42.5	39.9	38.8	37.3	35.9	35.0	34.1	32.8	30.8	28.9
120		45.7	42.8	40.2	39.1	37.6	36.2	35.3	34.4	33.1	31.1	29.2
125		46.0	43.1	40.4	39.4	37.9	36.5	35.6	34.7	33.4	31.4	29.4
130		46.2	43.3	40.7	39.6	38.1	36.7	35.8	34.9	33.6	31.6	29.7
135		46.5	43.6	40.9	39.8	38.4	37.0	36.0	35.1	33.9	31.9	29.9
140		46.7	43.8	41.1	40.0	38.6	37.2	36.2	35.4	34.1	32.1	30.2
145		46.9	44.0	41.3	40.2	38.8	37.4	36.4	35.6	34.3	32.3	30.4
150		47.1	44.2	41.5	40.4	39.0	37.6	36.6	35.7	34.5	32.5	30.6
155		47.3	44.4	41.7	40.6	39.1	37.7	36.8	35.9	34.6	32.6	30.7
160		47.5	44.6	41.9	40.8	39.3	37.9	37.0	36.1	34.8	32.8	30.9
165		47.7	44.7	42.0	40.9	39.5	38.0	37.1	36.2	35.0	33.0	31.1
170		47.8	44.9	42.2	41.1	39.6	38.2	37.3	36.4	35.1	33.1	31.2
175		48.0	45.0	42.3	41.2	39.7	38.3	37.4	36.5	35.2	33.2	31.3
180			45.2	42.4	41.3	39.9	38.4	37.5	36.6	35.4	33.4	31.5
185			45.3	42.5	41.5	40.0	38.6	37.6	36.7	35.5	33.5	31.6
190			45.4	42.7	41.6	40.1	38.7	37.7	36.9	35.6	33.6	31.7
195			45.5	42.8	41.7	40.2	38.8	37.9	37.0	35.7	33.7	31.8
200			45.6	42.9	41.8	40.3	38.9	38.0	37.1	35.8	33.8	31.9
205			45.7	43.0	41.9	40.4	39.0	38.0	37.2	35.9	33.9	32.0
210			45.8	43.1	42.0	40.5	39.1	38.1	37.3	36.0	34.0	32.1
215			45.9	43.2	42.1	40.6	39.2	38.2	37.3	36.1	34.1	32.2
220			46.0	43.3	42.1	40.7	39.2	38.3	37.4	36.2	34.2	32.3
225			46.1	43.3	42.2	40.8	39.3	38.4	37.5	36.2	34.3	32.4
230			46.2	43.4	42.3	40.8	39.4	38.5	37.6	36.3	34.3	32.5
235			46.3	43.5	42.4	40.9	39.5	38.5	37.7	36.4	34.4	32.5
240			46.3	43.6	42.5	41.0	39.5	38.6	37.7	36.5	34.5	32.6
245			46.4	43.6	42.5	41.0	39.6	38.7	37.8	36.5	34.5	32.7
250			46.5	43.7	42.6	41.1	39.7	38.7	37.9	36.6	34.6	32.7
255			46.6	43.8	42.7	41.2	39.7	38.8	37.9	36.7	34.7	32.8
260			46.6	43.8	42.7	41.2	39.8	38.9	38.0	36.7	34.7	32.9
265			46.7	43.9	42.8	41.3	39.9	38.9	38.0	36.8	34.8	32.9
270			46.7	43.9	42.8	41.3	39.9	39.0	38.1	36.8	34.8	33.0
275			46.8	44.0	42.9	41.4	40.0	39.0	38.1	36.9	34.9	33.0
280			46.9	44.1	42.9	41.5	40.0	39.1	38.2	36.9	34.9	33.1
285			46.9	44.1	43.0	41.5	40.1	39.1	38.2	37.0	35.0	33.1
290			47.0	44.2	43.0	41.6	40.1	39.2	38.3	37.0	35.0	33.2
295			47.0	44.2	43.1	41.6	40.2	39.2	38.3	37.1	35.1	33.2
300			47.1	44.3	43.1	41.6	40.2	39.3	38.4	37.1	35.1	33.3
305			47.1	44.3	43.2	41.7	40.3	39.3	38.4	37.2	35.2	33.3
310			47.2	44.3	43.2	41.7	40.3	39.4	38.5	37.2	35.2	33.4
315			47.2	44.4	43.3	41.8	40.3	39.4	38.5	37.2	35.3	33.4
320			47.3	44.4	43.3	41.8	40.4	39.4	38.5	37.3	35.3	33.4
325			47.3	44.5	43.3	41.9	40.4	39.5	38.6	37.3	35.3	33.5
330			47.3	44.5	43.4	41.9	40.4	39.5	38.6	37.4	35.4	33.5
335			47.4	44.5	43.4	41.9	40.5	39.5	38.7	37.4	35.4	33.5
340			47.4	44.6	43.5	42.0	40.5	39.6	38.7	37.4	35.4	33.6
345			47.4	44.6	43.5	42.0	40.6	39.6	38.7	37.5	35.5	33.6
350			47.5	44.7	43.5	42.0	40.6	39.6	38.8	37.5	35.5	33.6
355			47.5	44.7	43.6	42.1	40.6	39.7	38.8	37.5	35.5	33.7
360			47.6	44.7	43.6	42.1	40.6	39.7	38.8	37.5	35.6	33.7

Table applies to columns protected on all sides. Thickness is protection only.

Table 15: Hollow Columns: Fire Protection Period 210 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 210 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	36.0	33.4	30.4	27.4	26.1	24.2	22.2	20.9	19.6	17.5	14.1	10.4
35	39.2	36.6	33.8	30.9	29.7	28.0	26.2	25.0	23.8	22.0	19.0	15.8
40	41.9	39.2	36.4	33.7	32.5	30.8	29.2	28.0	26.9	25.2	22.5	19.7
45	44.1	41.3	38.6	35.8	34.7	33.1	31.4	30.3	29.3	27.7	25.1	22.5
50	46.1	43.1	40.3	37.5	36.4	34.8	33.3	32.2	31.2	29.6	27.1	24.6
55	47.7	44.5	41.7	39.0	37.9	36.3	34.7	33.7	32.7	31.2	28.8	26.4
60		45.8	42.9	40.2	39.1	37.5	36.0	34.9	33.9	32.5	30.1	27.8
65		46.8	44.0	41.2	40.1	38.5	37.0	36.0	35.0	33.5	31.2	28.9
70		47.8	44.9	42.1	41.0	39.4	37.9	36.9	35.9	34.5	32.2	29.9
75			45.7	42.9	41.7	40.2	38.7	37.6	36.7	35.2	33.0	30.7
80			46.4	43.6	42.4	40.9	39.3	38.3	37.3	35.9	33.7	31.5
85			47.0	44.2	43.0	41.5	39.9	38.9	37.9	36.5	34.3	32.1
90			47.5	44.7	43.5	42.0	40.5	39.4	38.5	37.1	34.8	32.6
95			48.0	45.2	44.0	42.5	40.9	39.9	38.9	37.5	35.3	33.1
100				45.6	44.5	42.9	41.3	40.3	39.4	38.0	35.7	33.6
105				46.0	44.8	43.3	41.7	40.7	39.7	38.3	36.1	34.0
110				46.4	45.2	43.6	42.1	41.1	40.1	38.7	36.5	34.3
115				46.7	45.5	43.9	42.4	41.4	40.4	39.0	36.8	34.7
120				47.0	45.8	44.2	42.7	41.7	40.7	39.3	37.1	35.0
125				47.3	46.1	44.5	42.9	41.9	41.0	39.6	37.3	35.2
130				47.5	46.3	44.7	43.2	42.2	41.2	39.8	37.6	35.5
135				47.8	46.6	45.0	43.4	42.4	41.4	40.0	37.8	35.7
140				48.0	46.8	45.2	43.6	42.6	41.6	40.2	38.0	35.9
145					47.0	45.4	43.8	42.8	41.8	40.4	38.2	36.1
150					47.2	45.6	44.0	43.0	42.0	40.6	38.4	36.3
155					47.4	45.7	44.2	43.2	42.2	40.8	38.6	36.5
160					47.5	45.9	44.3	43.3	42.3	40.9	38.7	36.6
165					47.7	46.1	44.5	43.5	42.5	41.1	38.9	36.8
170					47.8	46.2	44.6	43.6	42.6	41.2	39.0	36.9
175					48.0	46.3	44.8	43.7	42.8	41.4	39.1	37.0
180						46.5	44.9	43.9	42.9	41.5	39.3	37.2
185						46.6	45.0	44.0	43.0	41.6	39.4	37.3
190						46.7	45.1	44.1	43.1	41.7	39.5	37.4
195						46.8	45.2	44.2	43.2	41.8	39.6	37.5
200						46.9	45.3	44.3	43.3	41.9	39.7	37.6
205						47.0	45.4	44.4	43.4	42.0	39.8	37.7
210						47.1	45.5	44.5	43.5	42.1	39.9	37.8
215						47.2	45.6	44.6	43.6	42.2	40.0	37.9
220						47.3	45.7	44.7	43.7	42.3	40.0	38.0
225						47.4	45.8	44.7	43.7	42.3	40.1	38.0
230						47.4	45.9	44.8	43.8	42.4	40.2	38.1
235						47.5	45.9	44.9	43.9	42.5	40.3	38.2
240						47.6	46.0	45.0	44.0	42.6	40.3	38.3
245						47.7	46.1	45.0	44.0	42.6	40.4	38.3
250						47.7	46.1	45.1	44.1	42.7	40.5	38.4
255						47.8	46.2	45.1	44.2	42.7	40.5	38.4
260						47.9	46.3	45.2	44.2	42.8	40.6	38.5
265						47.9	46.3	45.3	44.3	42.9	40.6	38.6
270						48.0	46.4	45.3	44.3	42.9	40.7	38.6
275						48.0	46.4	45.4	44.4	43.0	40.7	38.7
280							46.5	45.4	44.4	43.0	40.8	38.7
285							46.5	45.5	44.5	43.1	40.8	38.8
290							46.6	45.5	44.5	43.1	40.9	38.8
295							46.6	45.6	44.6	43.1	40.9	38.8
300							46.7	45.6	44.6	43.2	41.0	38.9
305							46.7	45.6	44.7	43.2	41.0	38.9
310							46.7	45.7	44.7	43.3	41.1	39.0
315							46.8	45.7	44.7	43.3	41.1	39.0
320							46.8	45.8	44.8	43.4	41.1	39.0
325							46.9	45.8	44.8	43.4	41.2	39.1
330							46.9	45.8	44.8	43.4	41.2	39.1
335							46.9	45.9	44.9	43.5	41.2	39.2
340							47.0	45.9	44.9	43.5	41.3	39.2
345							47.0	45.9	44.9	43.5	41.3	39.2
350							47.0	46.0	45.0	43.6	41.3	39.2
355							47.1	46.0	45.0	43.6	41.4	39.3
360							47.1	46.0	45.0	43.6	41.4	39.3

Table applies to columns protected on all sides. Thickness is protection only.

Table 16: Hollow Columns: Fire Protection Period 240 minutes

Section Factor m ⁻¹	Monokote Z146 : Hollow Columns: FRR (FRL) 240 Minutes											
	Thickness (mm) Required for a Design Temperature of											
	350	400	450	500	520	550	580	600	620	650	700	750
30	41.9	39.6	36.7	33.8	32.5	30.7	28.8	27.5	26.2	24.2	20.9	17.3
35	45.4	43.1	40.3	37.4	36.2	34.5	32.8	31.6	30.4	28.6	25.6	22.5
40		45.8	43.0	40.2	39.1	37.4	35.7	34.6	33.4	31.8	29.0	26.2
45			45.2	42.4	41.3	39.6	38.0	36.9	35.8	34.2	31.5	28.9
50			47.0	44.2	43.1	41.4	39.8	38.7	37.6	36.1	33.5	30.9
55				45.7	44.5	42.9	41.3	40.2	39.1	37.6	35.1	32.6
60				46.9	45.8	44.1	42.5	41.4	40.4	38.9	36.4	33.9
65				48.0	46.8	45.2	43.5	42.5	41.4	39.9	37.4	35.0
70					47.7	46.1	44.4	43.4	42.3	40.8	38.4	36.0
75						46.8	45.2	44.1	43.1	41.6	39.1	36.8
80						47.5	45.9	44.8	43.7	42.2	39.8	37.5
85							46.5	45.4	44.3	42.8	40.4	38.1
90							47.0	45.9	44.8	43.3	40.9	38.6
95							47.5	46.4	45.3	43.8	41.4	39.1
100							47.9	46.8	45.7	44.2	41.8	39.5
105								47.2	46.1	44.6	42.2	39.9
110								47.5	46.4	44.9	42.5	40.2
115								47.8	46.8	45.2	42.8	40.5
120									47.0	45.5	43.1	40.8
125									47.3	45.8	43.4	41.1
130									47.5	46.0	43.6	41.3
135									47.8	46.2	43.8	41.5
140									48.0	46.4	44.0	41.7
145										46.6	44.2	41.9
150										46.8	44.4	42.1
155										47.0	44.6	42.2
160										47.1	44.7	42.4
165										47.3	44.8	42.5
170										47.4	45.0	42.7
175										47.5	45.1	42.8
180										47.7	45.2	42.9
185										47.8	45.3	43.0
190										47.9	45.4	43.1
195										48.0	45.6	43.2
200											45.6	43.3
205											45.7	43.4
210											45.8	43.5
215											45.9	43.6
220											46.0	43.7
225											46.1	43.8
230											46.1	43.8
235											46.2	43.9
240											46.3	44.0
245											46.3	44.0
250											46.4	44.1
255											46.4	44.1
260											46.5	44.2
265											46.6	44.2
270											46.6	44.3
275											46.7	44.3
280											46.7	44.4
285											46.8	44.4
290											46.8	44.5
295											46.8	44.5
300											46.9	44.6
305											46.9	44.6
310											47.0	44.6
315											47.0	44.7
320											47.0	44.7
325											47.1	44.8
330											47.1	44.8
335											47.1	44.8
340											47.2	44.9
345											47.2	44.9
350											47.2	44.9
355											47.3	44.9
360											47.3	45.0

Table applies to columns protected on all sides. Thickness is protection only.



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