The Building Test Centre

Fire Acoustics Structures

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Report Number BTC 21648FA

A FIRE RESISTANCE APPRAISAL COVERING A SERIES OF TESTS CARRIED OUT ON THE BRITISH GYPSUM GYPLYNER ENCASE STEEL PROTECTION SYSTEM CLAD WITH A SINGLE LAYER OF GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4:2013.

Appraisal Date: 8th February 2021

www.btconline.co.uk

Customer: **British Gypsum**
East Leake
Loughborough
Leicestershire
LE12 6HX

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FOREWORD

This appraisal report reviews and analyses the data from six separate fire resistance tests covering the GypLyner ENCASE steel protection system in accordance with the procedures given in BS EN 13381-4:2013.

The appraisal sponsor was British Gypsum.

This report provides the constructional details, the test conditions, the results obtained and the interpolated data obtained when the specified fire protection system described herein was tested following the procedures of BS EN 13381-4. Any deviation with respect to thickness and density of fire protection material and constructional details, loads, stresses, edge or end conditions other than those allowed under the field of application could invalidate the test result.

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.

REPORT AUTHORISATION

Report Author

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TEST REPORT AMENDMENTS

Page	Amendments	Date

Report Amendments Author	Amendments Authorised by

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INTRODUCTION TO BS EN 13381-4:2013

BS EN 13381-4:2013 specifies a test method for determining the contribution made by applied passive fire protection systems to the fire resistance of structural steel members, which can be used as beams or columns. It considers only sections without openings in the web. It is not directly applicable to structural tension members without further evaluation. Results from analysis of 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. BS EN 13381-4:2013 does not apply to solid bar or rod.

BS EN 13381-4:2013 covers fire protection systems that involve only passive materials and not to reactive fire protection materials as defined in BS EN 13381-4:2013.

The evaluation is designed to cover a range of thicknesses of the applied fire protection material, a range of steel sections, characterized by their section factors, a range of design temperatures and a range of valid fire protection classification periods.

BS EN 13381-4:2013 contains the fire test procedures, which specifies the tests which should be carried out to determine the ability of the fire protection system to remain coherent and attached to the steelwork, and to provide data on the thermal characteristics of the fire protection system, when exposed to the standard temperature/time curve specified in EN 1363-1.

The fire test methodology makes provision for the collection and presentation of data, which can be used as direct input to the calculation of fire resistance of steel structural members in accordance with the procedures given in EN 1993-1-2 and EN 1994-1-2.

BS EN 13381-4:2013 also contains the assessment, which prescribes how the analysis of the test data shall be made and gives guidance on the procedures by which interpolation should be undertaken.

The assessment procedure is used to establish:

a) On the basis of temperature data derived from testing loaded and unloaded sections, a correction factor and any practical constraints on the use of the fire protection system under fire test conditions, (the physical performance).

b) On the basis of the temperature data derived from testing short steel sections, the thermal properties of the fire protection system, (the thermal performance).

The limits of applicability of the results of the assessment arising from the fire test are defined, together with permitted direct application of the results, to different steel sections and grades and to the fire protection system.

The results of the test and assessment obtained according to BS EN 13381-4:2013 are directly applicable to steel sections of I and H cross sectional shape and hollow sections.

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TESTS USED IN THE APPRAISAL

This appraisal report reviews and analyses the data from six separate fire resistance tests conducted in accordance with the procedures given in BS EN 13381-4:2013. The test sponsor for all of the short column data and the loaded test data was British Gypsum. The following tests use Gyplyner Encase System.

The ten tests were as follows:

BTC 21622F
A FIRE RESISTANCE TEST ON A LOADED STEEL BEAM PROTECTED GYPLYNER ENCASE SYSTEM CLAD WITH 12.5 MM GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4: 2013

BTC 21449F
A FIRE RESISTANCE TEST ON A LOADED STEEL BEAM PROTECTED GYPLYNER ENCASE SYSTEM CLAD WITH 15 MM GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4: 2013

BTC 21604F
A FIRE RESISTANCE TEST ON 4 SHORT STRUCTURAL STEEL COLUMNS PROTECTED USING THE GYPLYNER ENCASE SYSTEM CLAD WITH EITRHER A SINGLE LAYER OF 12.5 MM GYPROC FIRELINE OR A TRIPLE LAYER OF 15 MM GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4: 2013.

BTC 21507F
A FIRE RESISTANCE TEST ON 4 SHORT STRUCTURAL STEEL COLUMNS PROTECTED USING THE GYPLYNER ENCASE SYSTEM CLAD WITH 12.5 mm OR 15 mm GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4: 2013.

BTC 21469F
A FIRE RESISTANCE TEST ON 4 SHORT STRUCTURAL STEEL COLUMNS PROTECTED USING THE GYPLYNER ENCASE SYSTEM CLAD WITH 15mm GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4: 2013.

BTC 21453F
A FIRE RESISTANCE TEST ON 4 SHORT STRUCTURAL STEEL COLUMNS PROTECTED USING THE GYPLYNER ENCASE SYSTEM CLAD WITH 12.5mm GYPROC FIRELINE, CONDUCTED IN ACCORDANCE WITH BS EN 13381-4: 2013

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Individual Test Specimens

Section ID	Test Report No.	Section Serial Size	Section factor (m^{-1})	Calculated Section Factor (m^{-1})	Gyproc FireLine cladding thickness (mm)
LBS07	BTC 21622F	406mm x 178mm x 67kg	115	119.77	12.5
RBS07	BTC 21622F	406mm x 178mm x 67kg	115	120.23	12.5
LBS01	BTC 21449F	406mm x 178mm x 67kg	115	123.22	15
RBS02	BTC 21449F	406mm x 178mm x 67kg	115	126.21	15
SCS01	BTC 21453F	305mm x 305mm x 198kg/m	50	52.6	12.5
SCS02	BTC 21453F	203mm x 203mm x 52kg/m	125	126.05	12.5
SCS03	BTC 21453F	203mm x 203mm x 46kg/m	140	150.7	12.5
SCS04	BTC 21453F	203mm x 102mm x 23kg/m	210	202.37	12.5
SCS06	BTC 21507F	305mm x 102mm x 25kg/m	255	257.88	12.5
SCS31	BTC 21604F	254mm x 254mm x 107kg/m	75	81.22	12.5
SCS07	BTC 21469F	305mm x 305mm x 198kg/m	50	53.14	15
SCS08	BTC 21469F	203mm x 203mm x 52kg/m	125	127.16	15
SCS10	BTC 21469F	203mm x 102mm x 23kg/m	210	203.39	15
SCS11	BTC 21469F	305mm x 102mm x 28kg/m	230	236.53	15
SCS09	BTC 21507F	203mm x 203mm x 46kg/m	140	145.69	15
SCS12	BTC 21507F	305mm x 102mm x 25kg/m	255	258.08	15

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TEST SPECIMEN CONSTRUCTION

Short Column Sections

Each short section was clad as follows:

Gypframe GL10 GypLyner Steel Framing Clips were fitted to each flange at 100 mm from the top and bottom ends of each steel section, e.g. at 800 mm centres. 1000 mm long lengths of Gypframe GL1 Lining Channels were engaged onto the clips.

The sections were clad with a single layer of 12.5 mm or 15 mm Gyproc FireLine that was fixed to all framing members at 300 mm centres using 25 mm British Gypsum Drywall Screws.

All board joints were left unfinished.

Cladding thickness	Screw lengths
12.5mm	25mm
12.5mm	25mm
15mm	25mm
15mm	25mm

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Short Column Steelwork Preparation – The Building Test Centre

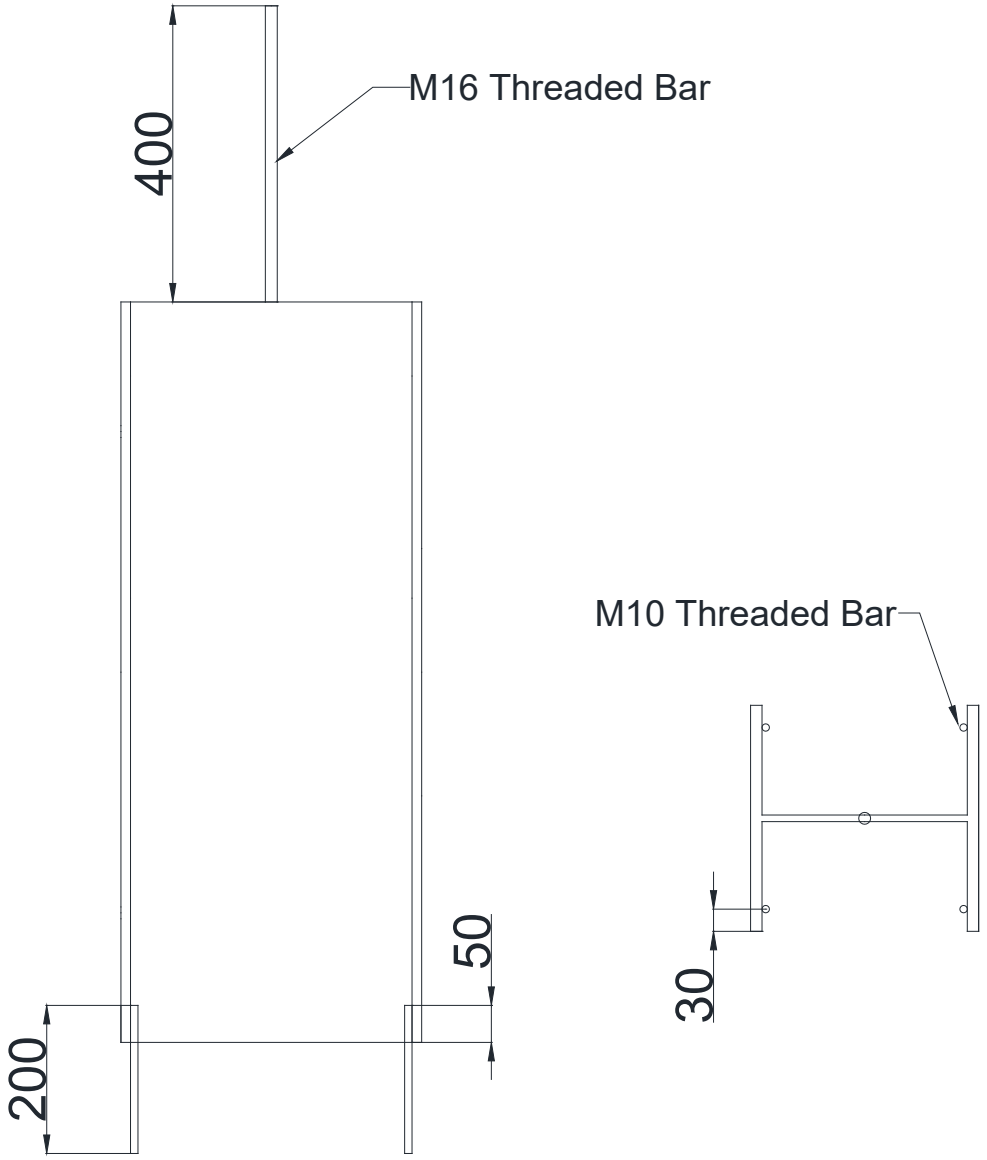

Figure 1. Steel column preparation

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Short Column Thermocouple Layout – The Building Test Centre

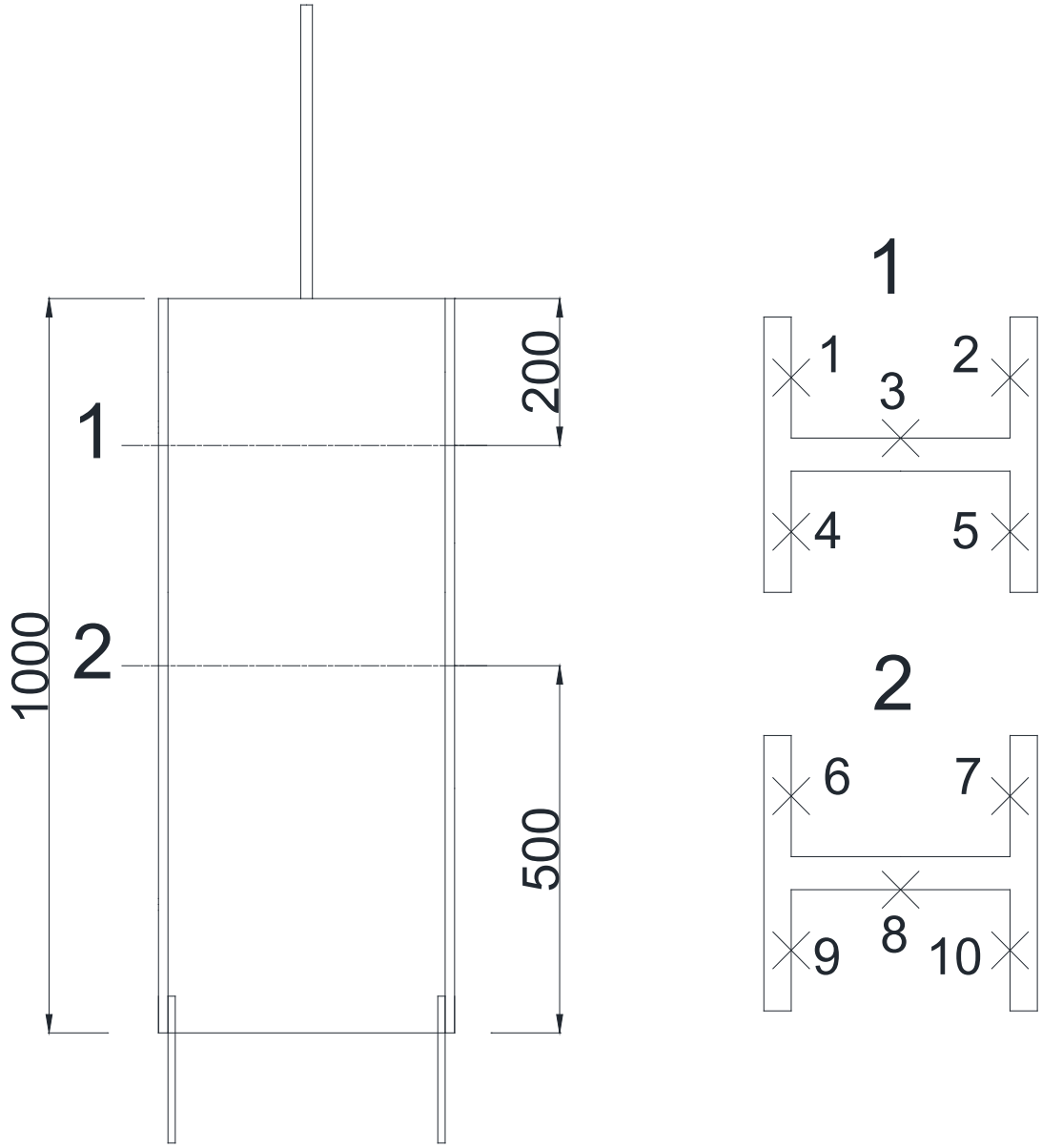

Figure 2. Steel column thermocouple layout.

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Short Column Board Layout – The Building Test Centre

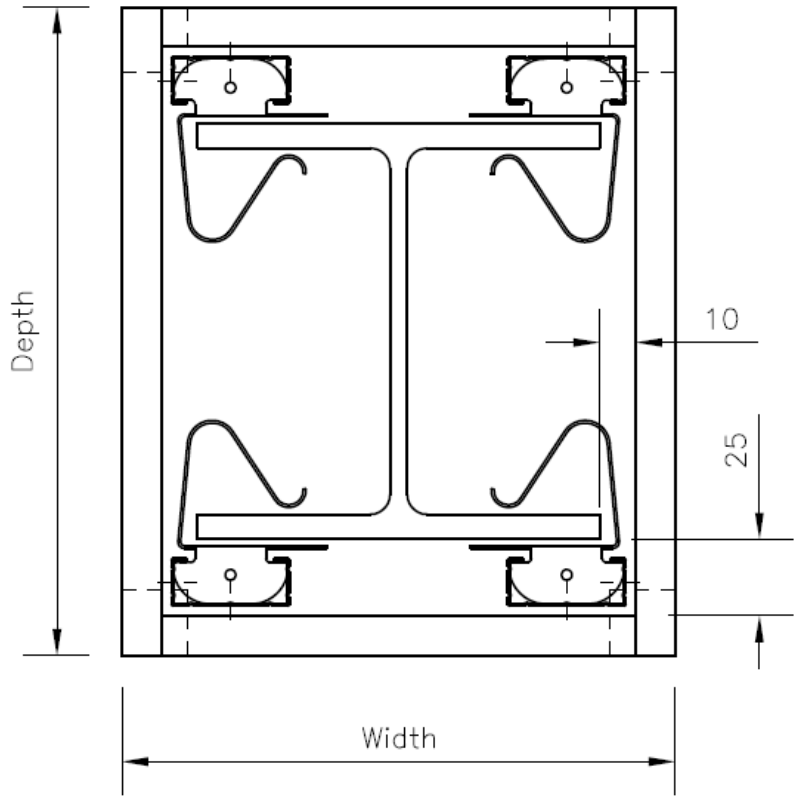

Figure 3. Short column board and staple layout.

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Short Column End Detail – The Building Test Centre

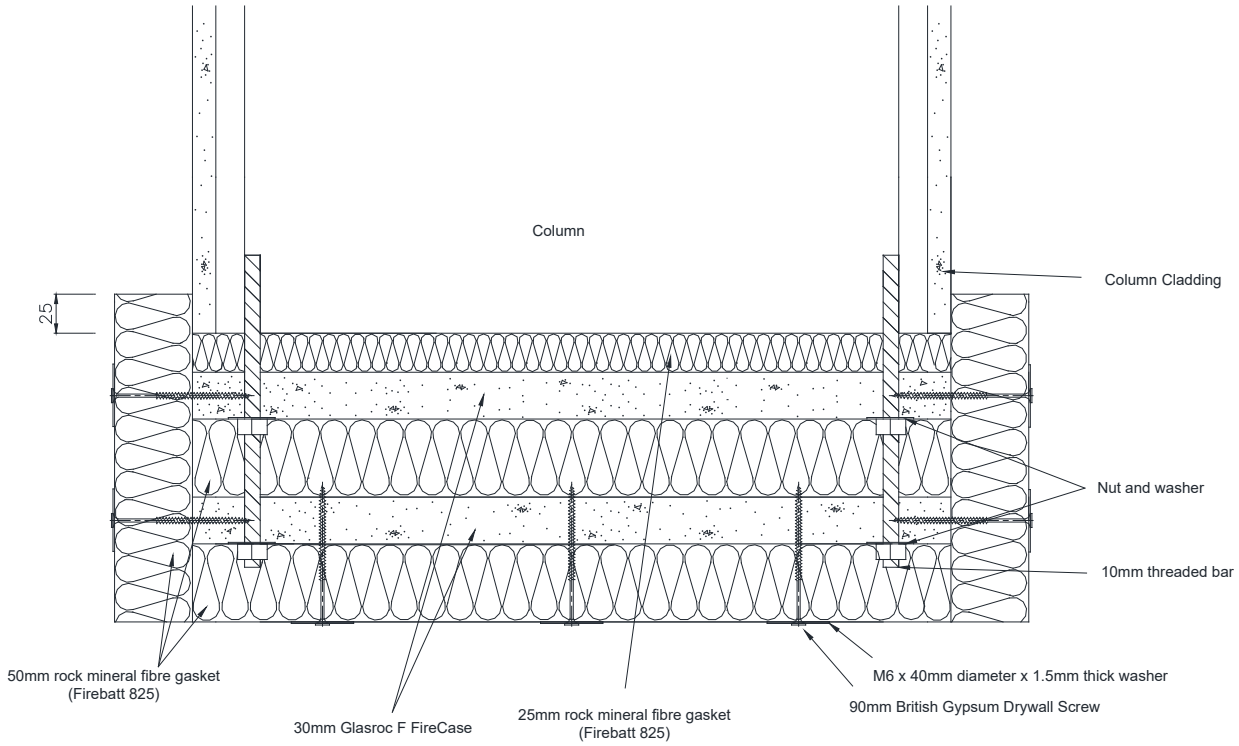

Figure 4. Short column end detail.

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Loaded Beam Steelwork Preparation

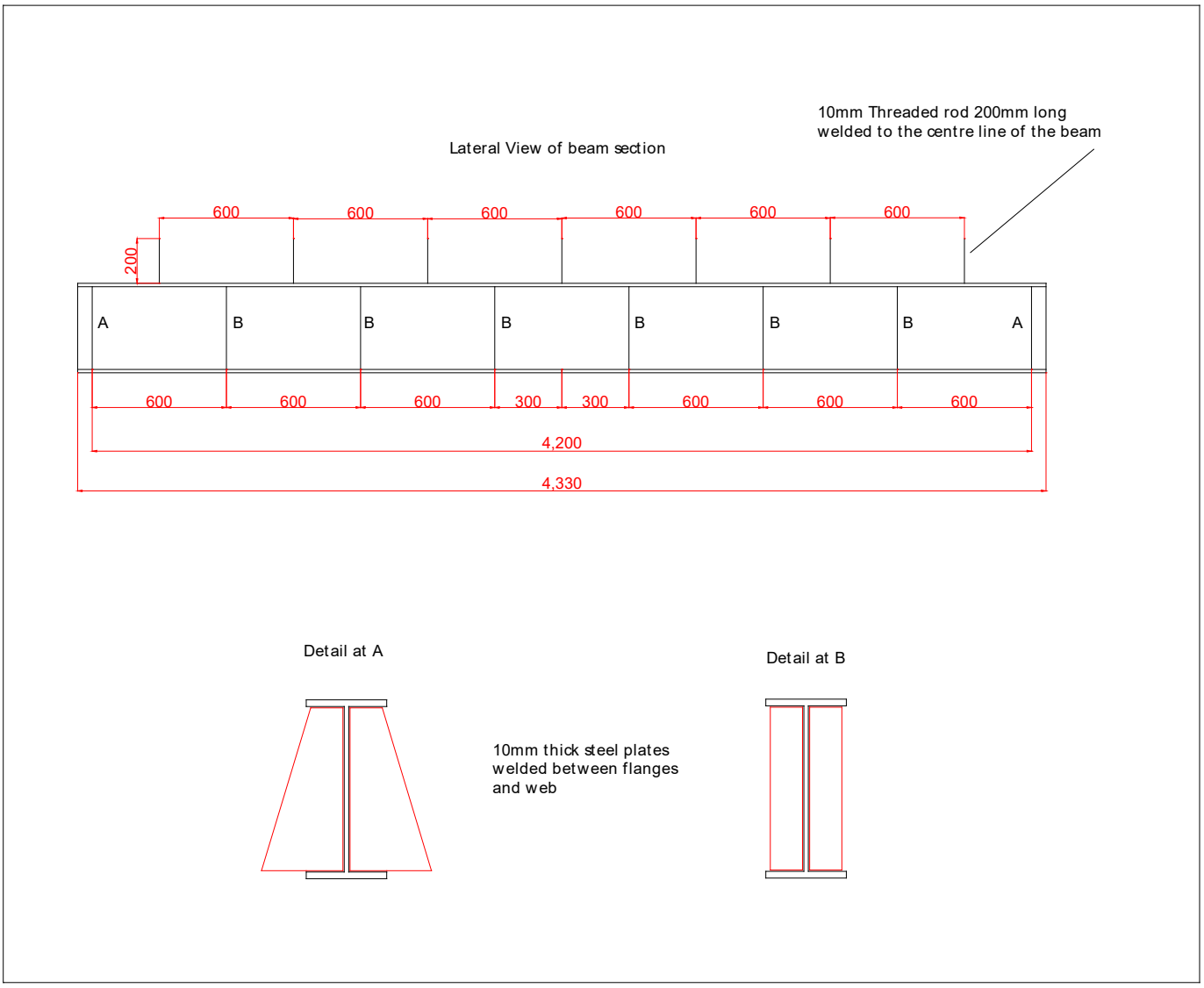

Figure 5. Loaded beam steelwork preparation.

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Loaded Beam Thermocouple Layout

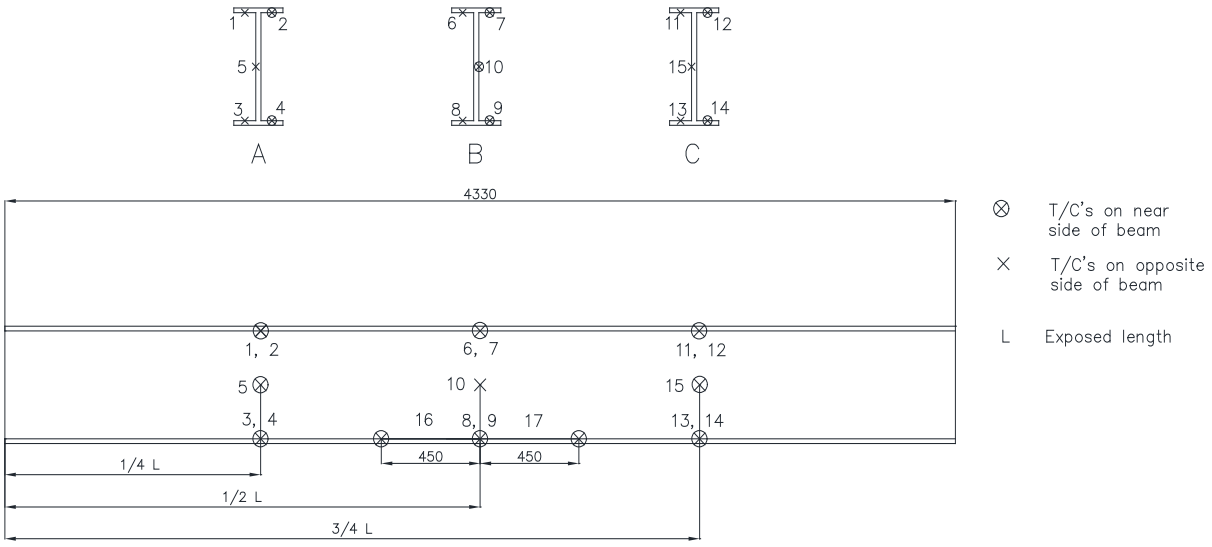

Figure 6. Loaded beam thermocouple layout.

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Loaded Beam Test Set-Up

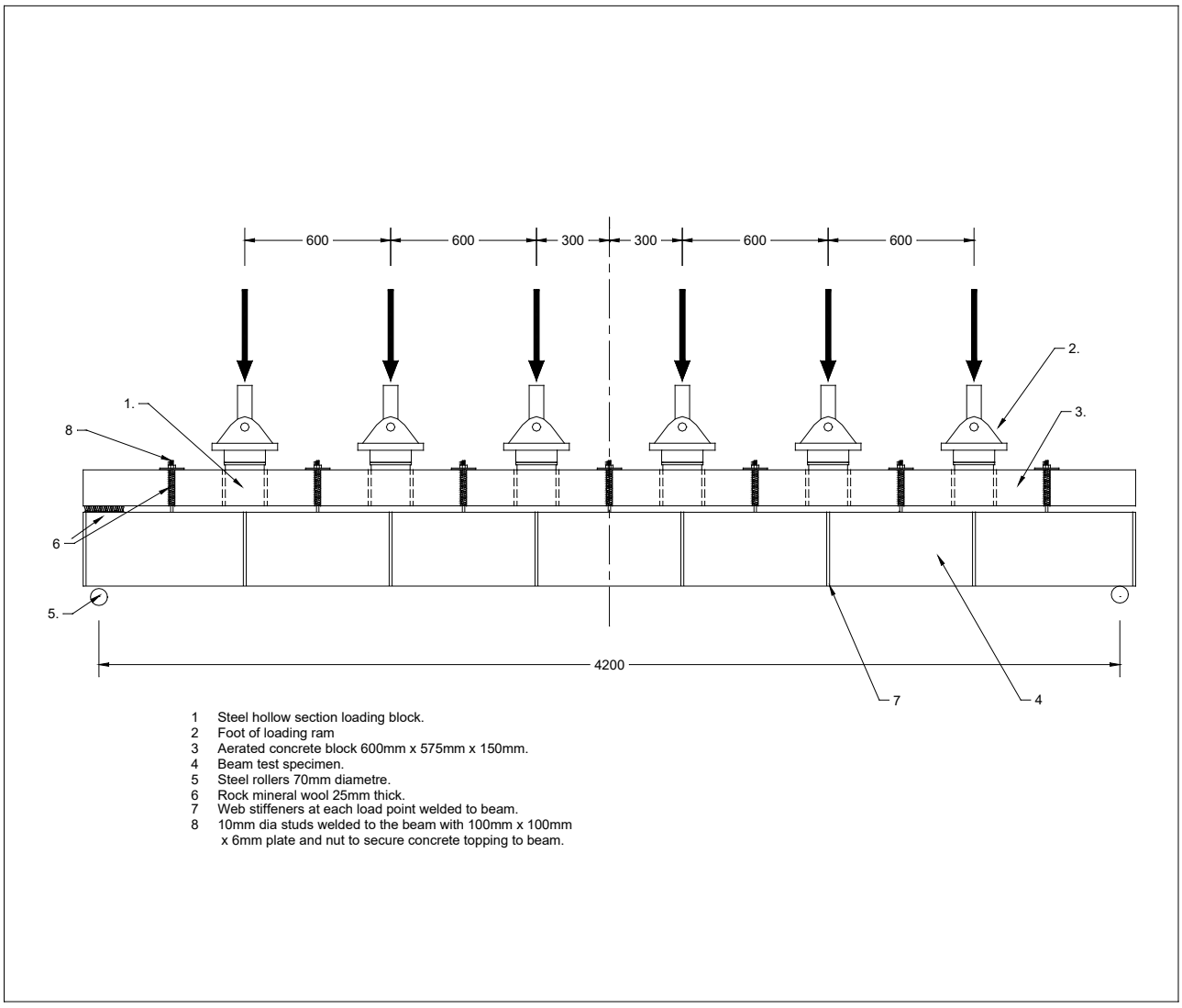

Figure 7. Loaded beam test set-up.

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Reference Beam Steelwork Preparation

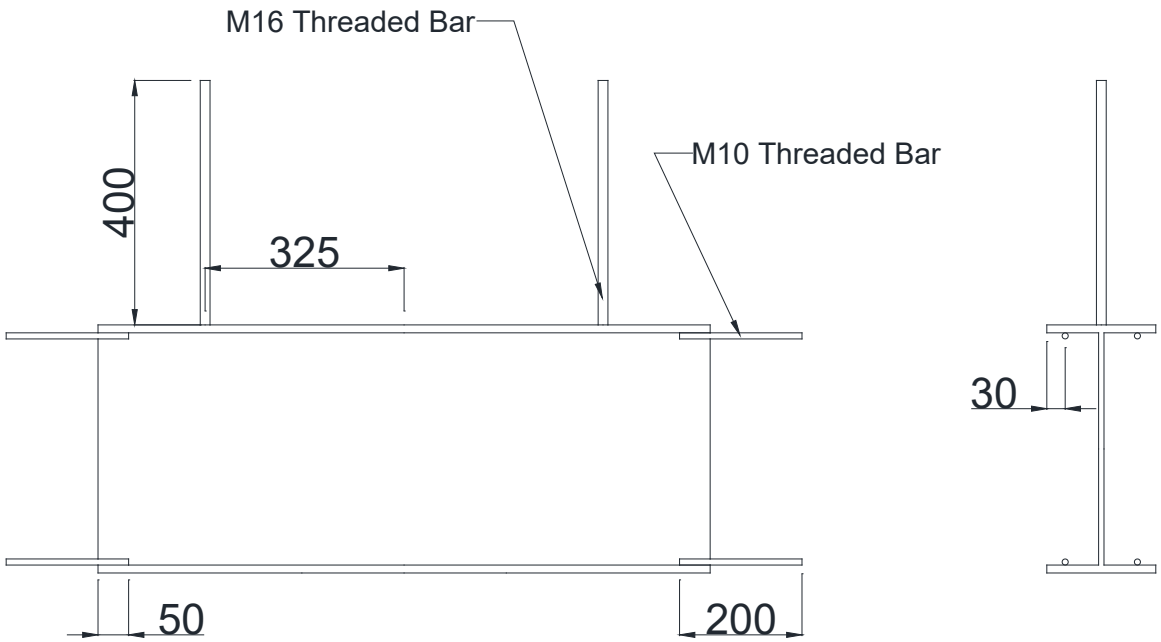

Figure 8. Reference beam steelwork preparation.

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Reference Beam Thermocouple Layout

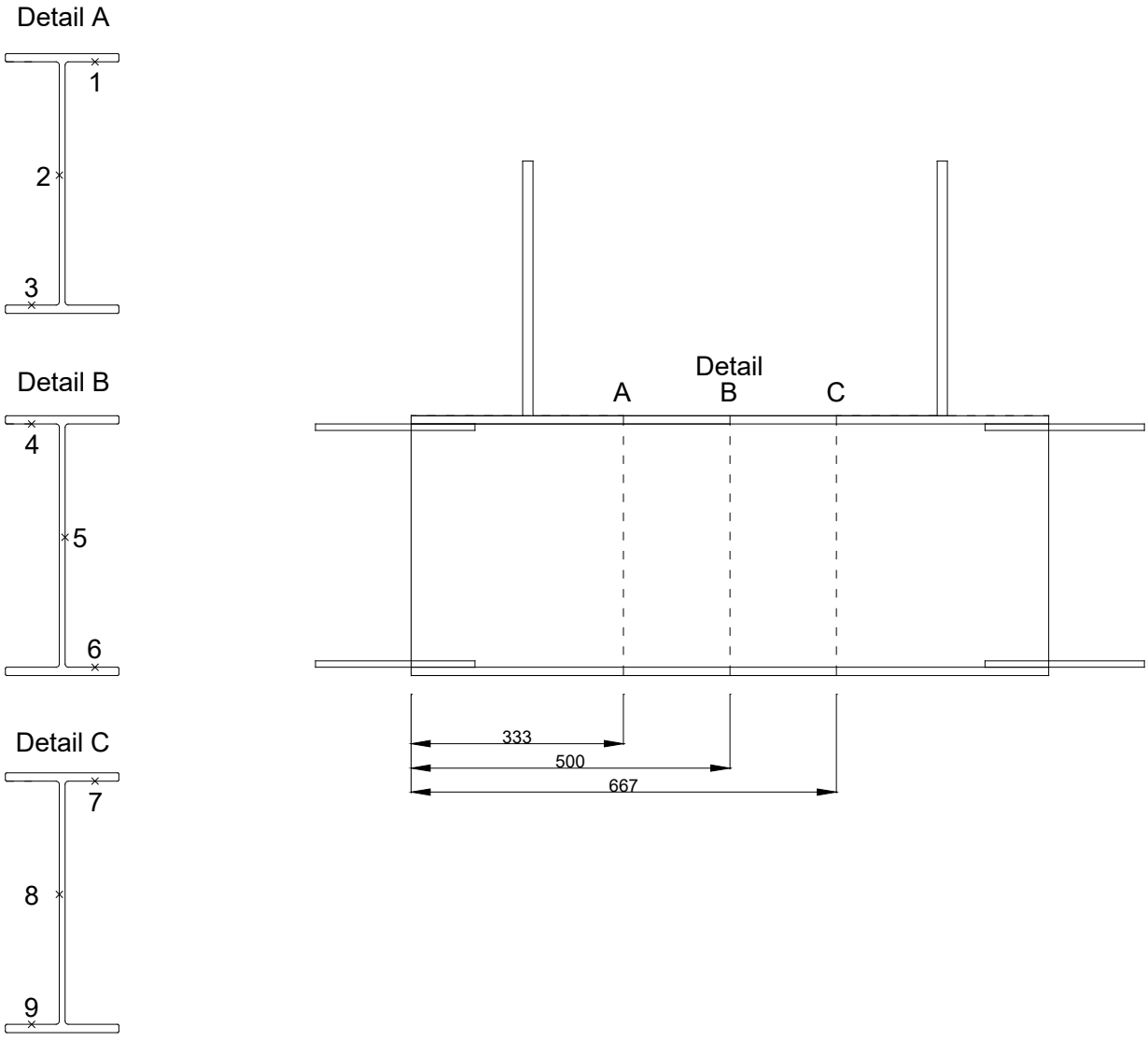

Figure 9. Reference beam thermocouple layout.

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Reference Beam End Detail

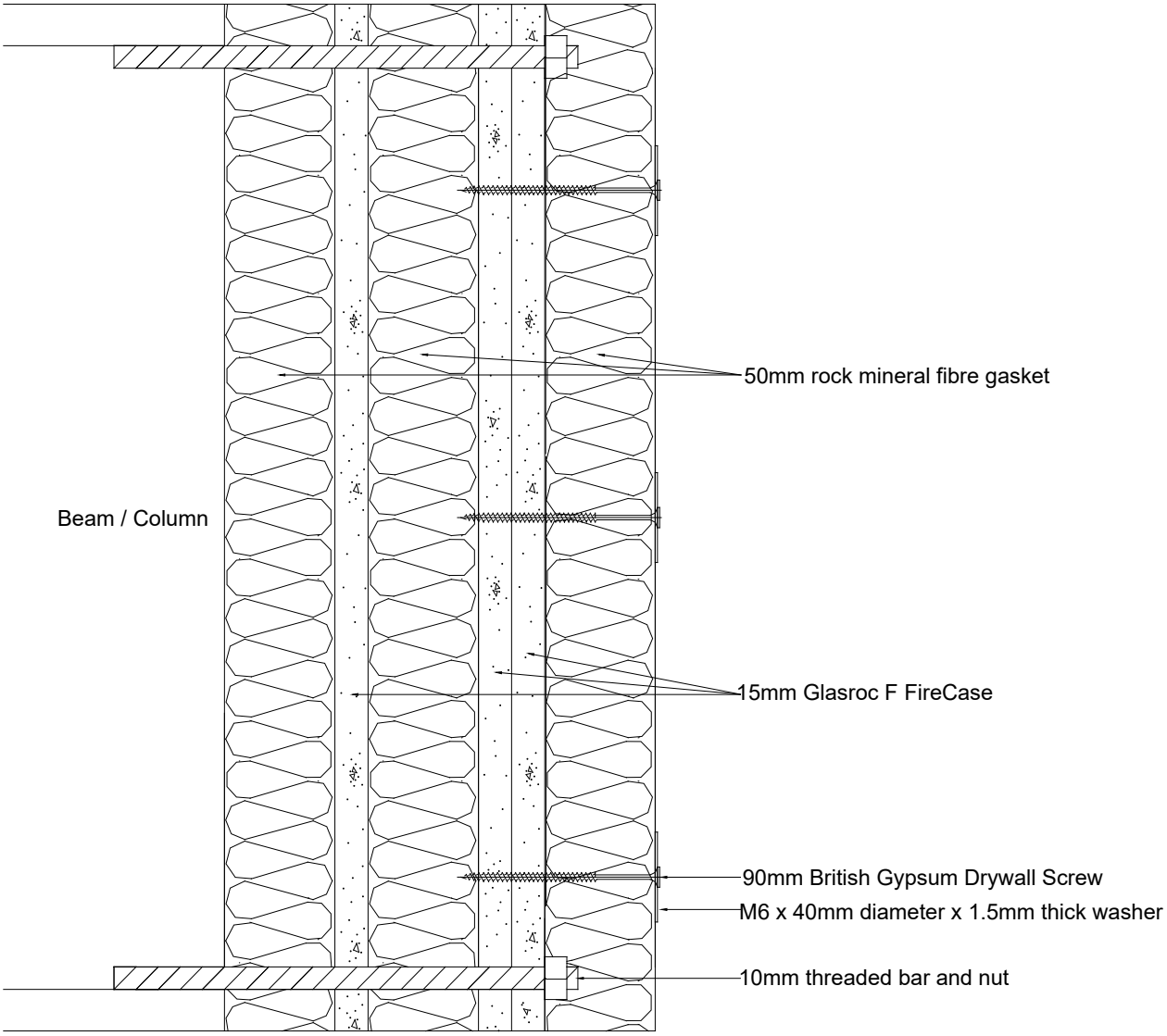

Figure 10. Reference beam end detail.

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TEST MATERIALS

See below for the range of materials that were used in the supporting tests of this appraisal report.

Boards

Board	Nominal Thickness	Test Report No.	Nominal Length	Nominal Width	Measured Mass Per Unit Area	Measured Thickness	Measured Moisture Content	Board Identification Numbers
Gyproc FireLine	12.5mm	BTC 21622F	2400mm	1200mm	10.7kg/m²	12.9mm	0.63%	24 329 20 11:42 24 329 20 11:42 24 329 20 11:42
Gyproc FireLine	15mm	BTC 21449F	2700mm	1200mm	12.9kg/m²	15.3mm	0.56%	24 070 20 15:42 24 070 20 15:42 24 070 20 15:42
Gyproc FireLine	12.5mm	BTC 21453F	2400mm	1200mm	10.9kg/m²	12.9mm	0.29%	24 070 20 22:06 24 070 20 22:07 24 070 20 22:07
Gyproc FireLine	12.5mm	BTC 21507F	2400mm	1200mm	10.9kg/m²	12.9mm	0.17%	24 070 20 22:06 24 070 20 22:07 24 070 20 22:07
Gyproc FireLine	12.5mm	BTC 21604F	2400mm	1200mm	10.9kg/m²	12.9mm	Less than 1%	24 070 20 22:06 24 070 20 22:07 24 070 20 22:07
Gyproc FireLine	15mm	BTC 21469F	2400mm	1200mm	12.9kg/m^2	15.3mm	0.54%	24 070 20 15:42 24 070 20 15:42 24 070 20 15:42
Gyproc FireLine	15mm	BTC 21507F	2400mm	1200mm	12.9kg/m^2	15.3mm	0.47%	24 070 20 15:42 24 070 20 15:42 24 070 20 15:42

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DATA ANALYSIS

Characteristic Steel Beam Temperatures (12.5mm Loaded Beam)

Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
0.0	15.9	16	16
0.5	15.9	16	16
1.0	16	18	17
1.5	16.2	22	19.1
2.0	16.9	26	21.5
2.5	18.1	30	24.1
3.0	20.1	34	27.1
3.5	22.4	37	29.7
4.0	25	41	33
4.5	27.5	44	35.8
5.0	30.2	47	38.6
5.5	32.7	50	41.4
6.0	35.2	53	44.1
6.5	37.5	56	46.8
7.0	39.6	58	48.8
7.5	41.9	60	51
8.0	44.1	62	53.1
8.5	46.4	64	55.2
9.0	48.5	66	57.3
9.5	50.6	68	59.3
10.0	52.7	70	61.4
10.5	54.8	71	62.9
11.0	56.8	73	64.9
11.5	58.8	75	66.9
12.0	60.9	76	68.5
12.5	63.3	78	70.7
13.0	65.1	79	72.1
13.5	67.2	81	74.1
14.0	69	82	75.5
14.5	71	84	77.5
15.0	72.8	85	78.9
15.5	74.6	86	80.3
16.0	76.5	87	81.8
16.5	78.3	88	83.2
17.0	80	89	84.5

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Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
17.5	81.8	90	85.9
18.0	83.6	91	87.3
18.5	85.4	92	88.7
19.0	87.5	94	90.8
19.5	89.3	98	93.7
20.0	91	102	96.5
20.5	92.8	107	99.9
21.0	94.7	112	103.4
21.5	96.7	117	106.9
22.0	98.5	122	110.3
22.5	100.8	128	114.4
23.0	103.3	133	118.2
23.5	105.9	139	122.5
24.0	108.9	144	126.5
24.5	112.2	149	130.6
25.0	115.7	155	135.4
25.5	119.1	160	139.6
26.0	122.2	165	143.6
26.5	125.6	170	147.8
27.0	129.3	176	152.7
27.5	132.8	181	156.9
28.0	136.7	186	161.4
28.5	141.2	192	166.6
29.0	146	197	171.5
29.5	150.5	202	176.3
30.0	155.2	207	181.1
30.5	159.7	212	185.9
31.0	164.4	217	190.7
31.5	168.8	222	195.4
32.0	173.5	227	200.3
32.5	177.9	232	205
33.0	182.5	237	209.8
33.5	186.9	242	214.5
34.0	191.3	246	218.7
34.5	195.9	251	223.5
35.0	200.5	256	228.3
35.5	204.8	260	232.4
36.0	209.3	265	237.2
36.5	213.9	270	242

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Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
37.0	218.4	274	246.2
37.5	222.9	279	251
38.0	227.4	283	255.2
38.5	232.2	288	260.1
39.0	236.6	292	264.3
39.5	241.3	297	269.2
40.0	246	301	273.5
40.5	250.3	305	277.7
41.0	255	310	282.5
41.5	259.7	314	286.9
42.0	264	318	291
42.5	268.6	323	295.8
43.0	273.1	327	300.1
43.5	277.7	331	304.4
44.0	281.9	335	308.5
44.5	286.3	339	312.7
45.0	290.7	343	316.9
45.5	295.2	347	321.1
46.0	299.5	351	325.3
46.5	303.7	355	329.4
47.0	308.1	359	333.6
47.5	312.5	363	337.8
48.0	316.6	367	341.8
48.5	321.1	371	346.1
49.0	325.4	375	350.2
49.5	329.7	379	354.4
50.0	333.9	383	358.5
50.5	338.1	387	362.6
51.0	342.1	391	366.6
51.5	346.5	395	370.8
52.0	350.8	399	374.9
52.5	354.7	402	378.4
53.0	358.8	406	382.4
53.5	363	410	386.5
54.0	367.2	414	390.6
54.5	371.2	417	394.1
55.0	375.3	421	398.2
55.5	379.2	425	402.1
56.0	383.4	428	405.7

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Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
56.5	387.2	432	409.6
57.0	391.3	436	413.7
57.5	395.6	440	417.8
58.0	399.3	443	421.2
58.5	403.3	447	425.2
59.0	407.3	451	429.2
59.5	411	456	433.5
60.0	415	461	438
60.5	419	465	442
61.0	422.9	470	446.5
61.5	426.7	475	450.9
62.0	430.7	480	455.4
62.5	434.6	485	459.8
63.0	438.2	489	463.6
63.5	441.9	494	468
64.0	445.9	499	472.5
64.5	449.7	503	476.4
65.0	453.5	508	480.8
65.5	457.2	512	484.6
66.0	461.2	517	489.1
66.5	464.9	521	493
67.0	468.7	526	497.4
67.5	472.4	531	501.7
68.0	476.1	536	506.1
68.5	479.8	540	509.9
69.0	483.5	545	514.3
69.5	487.4	550	518.7
70.0	491.1	555	523.1
70.5	494.8	560	527.4
71.0	498.8	565	531.9
71.5	502.6	571	536.8
72.0	506.7	577	541.9
72.5	511	584	547.5
73.0	515.4	592	553.7
73.5	520.1	601	560.6
74.0	528.8	616	572.4
74.5	543	648	595.5
75.0	556.8	678	617.4
75.5	569	703	636

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Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
76.0	580	724	652
76.5	589.9	736	663
77.0	598.3	747	672.7
77.5	605.4	764	684.7
78.0	612.3	780	696.2
78.5	620.1	794	707.1
79.0	627.8	807	717.4
79.5	634.9	819	727
80.0	642	830	736
80.5	648.9	841	745
81.0	655.6	853	754.3
81.5	662.5	864	763.3
82.0	669	875	772
82.5	675.1	884	779.6
83.0	681	892	786.5
83.5	686.6	899	792.8
84.0	692	906	799
84.5	697.3	913	805.2
85.0	702.8	920	811.4
85.5	707.8	926	816.9
86.0	713	931	822
86.5	717.9	936	827
87.0	722.6	940	831.3
87.5	727	944	835.5
88.0	731.2	948	839.6
88.5	735.5	951	843.3
89.0	740	955	847.5
89.5	744.3	959	851.7
90.0	748.6	963	855.8
90.5	752.9	966	859.5
91.0	757.2	969	863.1
91.5	762.1	973	867.6
92.0	769	976	872.5
92.5	777.4	982	879.7
93.0	786.3	990	888.2
93.5	795.8	998	896.9
94.0	804.6	1005	904.8
94.5	812.9	1010	911.5
95.0	821.1	1015	918.1

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Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
95.5	828.7	1019	923.9
96.0	835.9	1023	929.5
96.5	843.6	1027	935.3
97.0	851.4	1031	941.2
97.5	858.6	1033	945.8
98.0	866	1036	951
98.5	872.6	1039	955.8
99.0	879.1	1042	960.6
99.5	885.5	1044	964.8
100.0	891.4	1047	969.2
100.5	897.1	1048	972.6
101.0	903.6	1050	976.8
101.5	908.8	1049	978.9
102.0	913	1048	980.5
102.5	916.7	1047	981.9
103.0	920.3	1046	983.2
103.5	923.8	1045	984.4
104.0	927.4	1045	986.2
104.5	931.8	1045	988.4
105.0	936.9	1045	991
105.5	941.5	1045	993.3
106.0	946.8	1045	995.9
106.5	951.5	1045	998.3
107.0	956.3	1046	1001.2
107.5	960.8	1046	1003.4
108.0	965	1047	1006
108.5	969	1048	1008.5
109.0	973.1	1048	1010.6
109.5	976.6	1049	1012.8
110.0	980.3	1050	1015.2
110.5	983.3	1051	1017.2
111.0	986.7	1052	1019.4
111.5	989.8	1053	1021.4
112.0	993.5	1054	1023.8
112.5	996.6	1055	1025.8
113.0	1000.5	1055	1027.8
113.5	1003.7	1057	1030.4
114.0	1006.7	1057	1031.9
114.5	1009.8	1058	1033.9

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Time (minutes)	Loaded Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
115.0	1012.6	1059	1035.8
115.5	1013.4	1058	1035.7
116.0	1000.1	1041	1020.6

NB: The characteristic temperature is the average of the mean and maximum temperatures.

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Characteristic Steel Beam Temperatures (12.5mm Reference Beam)

Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
0.0	15.2	16	15.6
0.5	15.1	16	15.6
1.0	15	15	15
1.5	15	15	15
2.0	15.2	16	15.6
2.5	15.9	16	16
3.0	17.3	18	17.7
3.5	19.3	20	19.7
4.0	21.2	23	22.1
4.5	23.9	26	25
5.0	26.2	29	27.6
5.5	28.8	32	30.4
6.0	31.2	35	33.1
6.5	33.1	37	35.1
7.0	35.8	40	37.9
7.5	37.9	43	40.5
8.0	39.9	45	42.5
8.5	41.9	47	44.5
9.0	44.1	50	47.1
9.5	46.4	52	49.2
10.0	48.2	54	51.1
10.5	50.4	56	53.2
11.0	52.7	59	55.9
11.5	54.6	61	57.8
12.0	56.8	63	59.9
12.5	58.8	65	61.9
13.0	61	67	64
13.5	63.1	69	66.1
14.0	65.1	71	68.1
14.5	67.1	73	70.1
15.0	69	74	71.5
15.5	71.1	76	73.6
16.0	72.9	78	75.5
16.5	74.8	79	76.9
17.0	76.7	81	78.9
17.5	78.4	82	80.2
18.0	80.2	84	82.1

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Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
18.5	81.9	85	83.5
19.0	84	87	85.5
19.5	85.9	89	87.5
20.0	87.9	92	90
20.5	89.8	94	91.9
21.0	91.8	96	93.9
21.5	93.3	98	95.7
22.0	95.3	101	98.2
22.5	97.3	105	101.2
23.0	99.1	109	104.1
23.5	101	112	106.5
24.0	102.7	116	109.4
24.5	104.4	120	112.2
25.0	106.4	124	115.2
25.5	108.4	129	118.7
26.0	110.9	133	122
26.5	113.2	138	125.6
27.0	116	143	129.5
27.5	118.8	148	133.4
28.0	121.9	153	137.5
28.5	125.9	158	142
29.0	130.2	163	146.6
29.5	134.3	168	151.2
30.0	138.6	173	155.8
30.5	142.7	178	160.4
31.0	147.2	183	165.1
31.5	151.6	188	169.8
32.0	156	193	174.5
32.5	160.3	197	178.7
33.0	164.7	202	183.4
33.5	169.3	207	188.2
34.0	173.6	212	192.8
34.5	177.9	216	197
35.0	182.3	221	201.7
35.5	186.6	225	205.8
36.0	191.2	230	210.6
36.5	195.6	234	214.8
37.0	200	239	219.5
37.5	204.3	243	223.7

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Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
38.0	208.9	248	228.5
38.5	213.1	252	232.6
39.0	217.3	256	236.7
39.5	222	261	241.5
40.0	226	265	245.5
40.5	230.3	269	249.7
41.0	234.8	273	253.9
41.5	238.9	277	258
42.0	243.3	282	262.7
42.5	247.4	286	266.7
43.0	251.6	290	270.8
43.5	255.8	294	274.9
44.0	260	298	279
44.5	264.1	302	283.1
45.0	268.3	306	287.2
45.5	272.6	310	291.3
46.0	276.7	314	295.4
46.5	280.8	318	299.4
47.0	284.9	322	303.5
47.5	289	326	307.5
48.0	292.9	330	311.5
48.5	297	334	315.5
49.0	301.2	338	319.6
49.5	305.2	342	323.6
50.0	309.3	346	327.7
50.5	313.3	349	331.2
51.0	317.3	353	335.2
51.5	321.6	357	339.3
52.0	325.3	361	343.2
52.5	329.3	365	347.2
53.0	333.2	369	351.1
53.5	337.3	373	355.2
54.0	341.2	377	359.1
54.5	345.1	381	363.1
55.0	349.1	385	367.1
55.5	353.2	389	371.1
56.0	357.2	393	375.1
56.5	361.2	397	379.1
57.0	365.2	401	383.1

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Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
57.5	369.2	405	387.1
58.0	373.4	410	391.7
58.5	377.7	414	395.9
59.0	381.4	418	399.7
59.5	385.6	422	403.8
60.0	389.7	426	407.9
60.5	393.4	430	411.7
61.0	397.4	434	415.7
61.5	401.4	438	419.7
62.0	405.7	442	423.9
62.5	409.6	447	428.3
63.0	413.6	451	432.3
63.5	417.6	455	436.3
64.0	421.8	459	440.4
64.5	425.8	463	444.4
65.0	429.8	467	448.4
65.5	434	471	452.5
66.0	438	475	456.5
66.5	442.1	480	461.1
67.0	446.2	484	465.1
67.5	450.1	488	469.1
68.0	454.3	492	473.2
68.5	458.4	496	477.2
69.0	462.8	500	481.4
69.5	466.8	504	485.4
70.0	470.8	508	489.4
70.5	475	512	493.5
71.0	479	516	497.5
71.5	483.2	521	502.1
72.0	487.4	525	506.2
72.5	491.6	529	510.3
73.0	495.8	533	514.4
73.5	499.8	537	518.4
74.0	503.9	541	522.5
74.5	508.2	545	526.6
75.0	512.3	549	530.7
75.5	516.6	553	534.8
76.0	520.8	557	538.9
76.5	525	561	543

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Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
77.0	529.1	565	547.1
77.5	533.1	569	551.1
78.0	537.2	573	555.1
78.5	541.3	577	559.2
79.0	545.6	581	563.3
79.5	549.8	585	567.4
80.0	553.8	589	571.4
80.5	558	592	575
81.0	562.2	596	579.1
81.5	566.6	600	583.3
82.0	570.9	604	587.5
82.5	576	609	592.5
83.0	581.1	620	600.6
83.5	586	630	608
84.0	591	641	616
84.5	596.2	651	623.6
85.0	601.6	661	631.3
85.5	607.4	671	639.2
86.0	616.6	688	652.3
86.5	626.8	706	666.4
87.0	636.6	722	679.3
87.5	645.4	733	689.2
88.0	653.3	740	696.7
88.5	659.8	751	705.4
89.0	666.9	764	715.5
89.5	674.4	776	725.2
90.0	682.2	787	734.6
90.5	690.1	798	744.1
91.0	697.6	809	753.3
91.5	704.8	818	761.4
92.0	711.3	827	769.2
92.5	717.7	835	776.4
93.0	723.6	843	783.3
93.5	729.8	851	790.4
94.0	741.3	859	800.2
94.5	757.3	873	815.2
95.0	777.1	894	835.6
95.5	795.9	911	853.5
96.0	812.7	925	868.9

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Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
96.5	830.2	938	884.1
97.0	845.7	949	897.4
97.5	863.6	960	911.8
98.0	878.2	970	924.1
98.5	891.6	979	935.3
99.0	901.8	986	943.9
99.5	910.8	993	951.9
100.0	919.2	999	959.1
100.5	927.1	1004	965.6
101.0	934.4	1009	971.7
101.5	940.4	1011	975.7
102.0	945.2	1013	979.1
102.5	948.9	1012	980.5
103.0	953.6	1013	983.3
103.5	957.8	1014	985.9
104.0	962.6	1015	988.8
104.5	966.6	1016	991.3
105.0	969.7	1016	992.9
105.5	972.6	1017	994.8
106.0	975.7	1017	996.4
106.5	978.4	1018	998.2
107.0	980.4	1018	999.2
107.5	983.2	1019	1001.1
108.0	985.4	1020	1002.7
108.5	987.8	1020	1003.9
109.0	989.6	1021	1005.3
109.5	991.7	1022	1006.9
110.0	993.2	1023	1008.1
110.5	995	1024	1009.5
111.0	997.1	1025	1011.1
111.5	998.4	1026	1012.2
112.0	999.8	1027	1013.4
112.5	1001.2	1027	1014.1
113.0	1003.3	1029	1016.2
113.5	1004.2	1030	1017.1
114.0	1006.7	1032	1019.4
114.5	1008.2	1033	1020.6
115.0	1009.3	1033	1021.2
115.5	1009.2	1034	1021.6

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Time (minutes)	Reference Beam 12.5mm		
	Mean	Maximum	Characteristic Mean
116.0	997.6	1021	1009.3

NB: The characteristic temperature is the average of the mean and maximum temperatures.

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Characteristic Steel Beam Temperatures (15mm Loaded Beam)

Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
0.0	25	25	25
0.5	25	25	25
1.0	25	25	25
1.5	25	25	25
2.0	25.3	26	25.7
2.5	25.9	27	26.5
3.0	26.8	29	27.9
3.5	28.3	32	30.2
4.0	30.1	34	32.1
4.5	32.2	37	34.6
5.0	34.6	40	37.3
5.5	36.9	42	39.5
6.0	39.3	45	42.2
6.5	41.7	47	44.4
7.0	44.3	50	47.2
7.5	46.3	52	49.2
8.0	48.7	55	51.9
8.5	50.8	57	53.9
9.0	52.6	59	55.8
9.5	54.7	61	57.9
10.0	56.6	63	59.8
10.5	58.3	64	61.2
11.0	60	66	63
11.5	61.8	68	64.9
12.0	63.6	70	66.8
12.5	65.4	71	68.2
13.0	67.1	73	70.1
13.5	68.7	74	71.4
14.0	70.4	76	73.2
14.5	72.3	78	75.2
15.0	73.8	79	76.4
15.5	75.7	81	78.4
16.0	77.1	82	79.6
16.5	78.6	83	80.8
17.0	80	84	82
17.5	81.6	86	83.8
18.0	83	87	85

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Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
18.5	84.4	88	86.2
19.0	85.5	89	87.3
19.5	86.9	90	88.5
20.0	87.9	90	89
20.5	88.9	91	90
21.0	90	92	91
21.5	91.2	93	92.1
22.0	92.1	93	92.6
22.5	93	95	94
23.0	93.8	96	94.9
23.5	95	99	97
24.0	95.9	101	98.5
24.5	97.5	107	102.3
25.0	99.4	112	105.7
25.5	101.3	118	109.7
26.0	103.3	123	113.2
26.5	105.9	128	117
27.0	108.6	134	121.3
27.5	111.2	139	125.1
28.0	114.1	144	129.1
28.5	116.7	149	132.9
29.0	119.8	154	136.9
29.5	123.1	159	141.1
30.0	126.5	164	145.3
30.5	130.1	169	149.6
31.0	133.9	173	153.5
31.5	137.1	178	157.6
32.0	140.6	182	161.3
32.5	144.1	187	165.6
33.0	147.6	191	169.3
33.5	151.5	195	173.3
34.0	155.6	200	177.8
34.5	159.4	204	181.7
35.0	163.4	208	185.7
35.5	167.3	212	189.7
36.0	171.2	216	193.6
36.5	175	220	197.5
37.0	178.9	224	201.5
37.5	183	228	205.5

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Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
38.0	186.8	232	209.4
38.5	190.7	236	213.4
39.0	194.5	240	217.3
39.5	198.5	244	221.3
40.0	202.3	248	225.2
40.5	206.2	252	229.1
41.0	209.9	255	232.5
41.5	213.8	259	236.4
42.0	217.9	263	240.5
42.5	221.6	267	244.3
43.0	225.6	271	248.3
43.5	229.5	275	252.3
44.0	233.6	279	256.3
44.5	237.6	283	260.3
45.0	241.5	287	264.3
45.5	245.3	290	267.7
46.0	249.3	294	271.7
46.5	253.3	298	275.7
47.0	257	302	279.5
47.5	261.2	306	283.6
48.0	264.8	309	286.9
48.5	268.7	313	290.9
49.0	272.6	317	294.8
49.5	276.4	321	298.7
50.0	280.1	324	302.1
50.5	283.8	328	305.9
51.0	287.8	332	309.9
51.5	291.3	335	313.2
52.0	295.1	339	317.1
52.5	298.9	343	321
53.0	302.5	346	324.3
53.5	306.2	350	328.1
54.0	309.8	354	331.9
54.5	313.4	357	335.2
55.0	317	361	339
55.5	320.7	364	342.4
56.0	324.3	368	346.2
56.5	327.9	372	350
57.0	331.5	375	353.3

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Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
57.5	335	379	357
58.0	338.5	383	360.8
58.5	341.9	386	364
59.0	345.6	390	367.8
59.5	349.1	393	371.1
60.0	352.5	397	374.8
60.5	356.2	401	378.6
61.0	359.7	404	381.9
61.5	363.1	408	385.6
62.0	366.4	411	388.7
62.5	370	415	392.5
63.0	373.5	418	395.8
63.5	376.9	422	399.5
64.0	380.3	425	402.7
64.5	383.8	429	406.4
65.0	387.3	433	410.2
65.5	390.7	436	413.4
66.0	394	439	416.5
66.5	397.5	443	420.3
67.0	400.9	446	423.5
67.5	404.1	450	427.1
68.0	407.6	453	430.3
68.5	411	457	434
69.0	414.2	460	437.1
69.5	417.5	464	440.8
70.0	421	468	444.5
70.5	424.2	472	448.1
71.0	427.5	476	451.8
71.5	430.8	480	455.4
72.0	434.1	484	459.1
72.5	437.4	488	462.7
73.0	440.5	492	466.3
73.5	443.7	497	470.4
74.0	447.1	501	474.1
74.5	450.4	505	477.7
75.0	453.6	509	481.3
75.5	456.8	513	484.9
76.0	460.1	517	488.6
76.5	463.4	521	492.2

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Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
77.0	466.6	525	495.8
77.5	469.6	529	499.3
78.0	472.9	534	503.5
78.5	476.3	538	507.2
79.0	479.3	542	510.7
79.5	482.5	546	514.3
80.0	485.9	551	518.5
80.5	489	555	522
81.0	492.4	560	526.2
81.5	495.7	565	530.4
82.0	498.8	570	534.4
82.5	502.3	576	539.2
83.0	505.4	582	543.7
83.5	508.9	588	548.5
84.0	512.5	598	555.3
84.5	516.3	609	562.7
85.0	521.2	639	580.1
85.5	526.3	670	598.2
86.0	533.3	695	614.2
86.5	541.8	716	628.9
87.0	549.9	731	640.5
87.5	557.3	745	651.2
88.0	564.5	762	663.3
88.5	571.2	778	674.6
89.0	577.8	794	685.9
89.5	584.4	807	695.7
90.0	590.7	819	704.9
90.5	597.1	829	713.1
91.0	603.2	840	721.6
91.5	609.3	849	729.2
92.0	615.2	859	737.1
92.5	621.1	871	746.1
93.0	627.3	881	754.2
93.5	632.8	890	761.4
94.0	638.7	898	768.4
94.5	644	905	774.5
95.0	649.5	912	780.8
95.5	654.4	919	786.7
96.0	659.4	925	792.2

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Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
96.5	664.1	931	797.6
97.0	668.9	937	803
97.5	673.8	941	807.4
98.0	678.1	946	812.1
98.5	682.6	949	815.8
99.0	686.8	953	819.9
99.5	691.3	957	824.2
100.0	695.9	960	828
100.5	700.6	964	832.3
101.0	705.2	967	836.1
101.5	709.7	970	839.9
102.0	714.2	973	843.6
102.5	718.9	976	847.5
103.0	723.6	979	851.3
103.5	729.6	982	855.8
104.0	737.6	985	861.3
104.5	745.4	989	867.2
105.0	755.6	996	875.8
105.5	766.5	1003	884.8
106.0	776.1	1010	893.1
106.5	785	1016	900.5
107.0	794.6	1022	908.3
107.5	803.9	1028	916
108.0	812.6	1035	923.8
108.5	821.4	1040	930.7
109.0	830.1	1045	937.6
109.5	838.5	1049	943.8
110.0	846.7	1052	949.4
110.5	854.5	1055	954.8
111.0	861.3	1058	959.7
111.5	867.8	1061	964.4
112.0	873.8	1063	968.4
112.5	879.2	1065	972.1
113.0	892.6	1067	979.8
113.5	897.5	1070	983.8
114.0	901.7	1071	986.4
114.5	908	1072	990
115.0	912.7	1074	993.4
115.5	916.8	1075	995.9

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Time (minutes)	Loaded 15mm Beam		
	Mean	Maximum	Characteristic Mean
116.0	921.2	1077	999.1
116.5	924.9	1078	1001.5
117.0	928.2	1079	1003.6
117.5	931.2	1080	1005.6
118.0	934.8	1082	1008.4
118.5	937.4	1082	1009.7
119.0	941.2	1084	1012.6
119.5	943.9	1085	1014.5
120.0	947.3	1086	1016.7
120.5	951.1	1087	1019.1
121.0	954.3	1088	1021.2
121.5	958.1	1090	1024.1
122.0	961.8	1091	1026.4
122.5	965.4	1092	1028.7
123.0	970	1094	1032
123.5	973.7	1095	1034.4
124.0	977.8	1096	1036.9
124.5	981.3	1097	1039.2
125.0	984.8	1098	1041.4
125.5	988.2	1099	1043.6
126.0	991.2	1100	1045.6
126.5	994.3	1101	1047.7
127.0	997.4	1102	1049.7
127.5	1000.5	1103	1051.8
128.0	1006.5	1104	1055.3
128.5	1012.5	1105	1058.8
129.0	1018.4	1105	1061.7
129.5	1025.6	1106	1065.8
130.0	1031.5	1107	1069.3
130.5	1035.5	1107	1071.3

NB: The characteristic temperature is the average of the mean and maximum temperatures.

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Characteristic Steel Beam Temperatures (15mm Reference Beam)

Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
0.0	25	25	25
0.5	25	25	25
1.0	25	25	25
1.5	25	25	25
2.0	25	25	25
2.5	25.3	26	25.7
3.0	25.9	26	26
3.5	27.2	28	27.6
4.0	28.2	30	29.1
4.5	30.4	32	31.2
5.0	32.3	35	33.7
5.5	34.6	37	35.8
6.0	37.2	41	39.1
6.5	39.5	44	41.8
7.0	42	47	44.5
7.5	44.4	50	47.2
8.0	46.5	52	49.3
8.5	48.7	55	51.9
9.0	50.9	57	54
9.5	52.9	60	56.5
10.0	54.9	62	58.5
10.5	56.9	64	60.5
11.0	58.8	65	61.9
11.5	60.7	67	63.9
12.0	62.6	69	65.8
12.5	64.3	70	67.2
13.0	66.3	72	69.2
13.5	68.1	74	71.1
14.0	69.7	75	72.4
14.5	71.6	77	74.3
15.0	73.1	78	75.6
15.5	74.9	80	77.5
16.0	76.6	81	78.8
16.5	77.9	82	80
17.0	79.6	84	81.8
17.5	81	85	83
18.0	82.5	86	84.3

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Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
18.5	83.9	87	85.5
19.0	85.2	88	86.6
19.5	86.5	89	87.8
20.0	87.3	89	88.2
20.5	88.7	90	89.4
21.0	89.7	91	90.4
21.5	90.4	92	91.2
22.0	91.1	92	91.6
22.5	92.1	94	93.1
23.0	93	95	94
23.5	94.1	97	95.6
24.0	94.7	98	96.4
24.5	95.7	99	97.4
25.0	96.8	102	99.4
25.5	98	105	101.5
26.0	99.5	109	104.3
26.5	101.2	113	107.1
27.0	102.7	116	109.4
27.5	104.7	120	112.4
28.0	106.6	124	115.3
28.5	108.5	128	118.3
29.0	110.7	133	121.9
29.5	113	137	125
30.0	116.1	142	129.1
30.5	119.2	146	132.6
31.0	122.8	151	136.9
31.5	126.4	156	141.2
32.0	129.9	160	145
32.5	133.5	165	149.3
33.0	137.4	170	153.7
33.5	140.9	174	157.5
34.0	144.7	179	161.9
34.5	148.5	184	166.3
35.0	152.1	188	170.1
35.5	156.1	193	174.6
36.0	159.7	197	178.4
36.5	163.4	201	182.2
37.0	167.2	206	186.6
37.5	171	210	190.5

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Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
38.0	174.9	214	194.5
38.5	178.6	219	198.8
39.0	182.3	223	202.7
39.5	186.1	227	206.6
40.0	189.8	231	210.4
40.5	193.5	235	214.3
41.0	197.2	239	218.1
41.5	201	243	222
42.0	204.8	247	225.9
42.5	208.6	251	229.8
43.0	212.2	255	233.6
43.5	216.1	259	237.6
44.0	219.9	262	241
44.5	223.6	266	244.8
45.0	227.3	270	248.7
45.5	230.9	273	252
46.0	234.9	277	256
46.5	238.9	281	260
47.0	242.6	285	263.8
47.5	246.1	288	267.1
48.0	250	292	271
48.5	253.8	295	274.4
49.0	257.7	299	278.4
49.5	261.3	302	281.7
50.0	265	306	285.5
50.5	268.7	310	289.4
51.0	272.3	313	292.7
51.5	276	316	296
52.0	279.8	320	299.9
52.5	283.5	323	303.3
53.0	287.3	327	307.2
53.5	290.7	330	310.4
54.0	294.3	334	314.2
54.5	297.9	337	317.5
55.0	301.3	340	320.7
55.5	305.2	344	324.6
56.0	308.7	347	327.9
56.5	312.2	351	331.6
57.0	315.9	354	335

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Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
57.5	319.4	357	338.2
58.0	322.9	361	342
58.5	326.4	364	345.2
59.0	329.9	367	348.5
59.5	333.3	370	351.7
60.0	337	374	355.5
60.5	340.4	377	358.7
61.0	343.8	380	361.9
61.5	347.4	384	365.7
62.0	350.8	387	368.9
62.5	354.2	390	372.1
63.0	357.8	393	375.4
63.5	361.1	397	379.1
64.0	364.5	400	382.3
64.5	367.9	403	385.5
65.0	371.1	406	388.6
65.5	374.6	409	391.8
66.0	378	413	395.5
66.5	381.1	416	398.6
67.0	384.5	419	401.8
67.5	388.1	422	405.1
68.0	391.3	426	408.7
68.5	394.6	429	411.8
69.0	397.9	432	415
69.5	401.1	435	418.1
70.0	404.3	438	421.2
70.5	407.6	441	424.3
71.0	411	445	428
71.5	414.1	448	431.1
72.0	417.3	451	434.2
72.5	420.5	454	437.3
73.0	424	458	441
73.5	427.2	461	444.1
74.0	430.5	464	447.3
74.5	433.6	467	450.3
75.0	436.6	470	453.3
75.5	440.3	474	457.2
76.0	443.4	477	460.2
76.5	446.7	480	463.4

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Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
77.0	449.8	483	466.4
77.5	453	486	469.5
78.0	456.3	490	473.2
78.5	459.6	493	476.3
79.0	462.8	496	479.4
79.5	465.8	499	482.4
80.0	469.2	503	486.1
80.5	472.4	506	489.2
81.0	475.6	509	492.3
81.5	478.6	512	495.3
82.0	482	516	499
82.5	485.3	519	502.2
83.0	488.4	522	505.2
83.5	491.5	525	508.3
84.0	494.9	528	511.5
84.5	498	532	515
85.0	501.1	535	518.1
85.5	504.5	538	521.3
86.0	507.6	541	524.3
86.5	510.8	545	527.9
87.0	514	548	531
87.5	517.1	551	534.1
88.0	520.3	554	537.2
88.5	523.6	557	540.3
89.0	526.8	560	543.4
89.5	530	564	547
90.0	533.2	567	550.1
90.5	536.3	570	553.2
91.0	539.4	573	556.2
91.5	542.6	576	559.3
92.0	545.8	579	562.4
92.5	549.1	583	566.1
93.0	552.1	586	569.1
93.5	555.2	589	572.1
94.0	558.3	592	575.2
94.5	561.4	595	578.2
95.0	564.6	598	581.3
95.5	568	602	585
96.0	571.1	605	588.1

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Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
96.5	574.2	608	591.1
97.0	577.4	611	594.2
97.5	580.4	614	597.2
98.0	583.6	617	600.3
98.5	587.1	621	604.1
99.0	590.4	624	607.2
99.5	593.6	628	610.8
100.0	596.8	631	613.9
100.5	600.4	635	617.7
101.0	603.8	639	621.4
101.5	607.4	643	625.2
102.0	610.9	647	629
102.5	614.5	651	632.8
103.0	618.2	655	636.6
103.5	622.1	660	641.1
104.0	626	664	645
104.5	630	669	649.5
105.0	634	673	653.5
105.5	638.9	678	658.5
106.0	643.4	683	663.2
106.5	649	697	673
107.0	655	712	683.5
107.5	661.9	726	694
108.0	668.2	737	702.6
108.5	674.9	748	711.5
109.0	682.4	761	721.7
109.5	690	774	732
110.0	697.3	787	742.2
110.5	704	799	751.5
111.0	710.8	809	759.9
111.5	717.5	819	768.3
112.0	724	828	776
112.5	730.7	837	783.9
113.0	737.1	845	791.1
113.5	744.5	854	799.3
114.0	756.5	864	810.3
114.5	767.4	875	821.2
115.0	778.8	887	832.9
115.5	790.2	898	844.1

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Time (minutes)	Reference Beam 15mm		
	Mean	Maximum	Characteristic Mean
116.0	801.8	910	855.9

NB: The characteristic temperature is the average of the mean and maximum temperatures.

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Stickability Correction Factor

θ	Stickability Correction Factors	
	12.5	15
350°C	0.92028	0.93494
400°C	0.92864	0.93227
450°C	0.93487	0.93013
500°C	0.94005	0.92273
550°C	0.93342	0.90974
600°C	0.93342	0.90974
620°C	0.93342	0.90974
650°C	0.93342	0.90974
700°C	0.93342	0.90974
750°C	0.93342	0.90974

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Modified Steel Column Times

SCS01 Modified Steel Column Time

SCS01		
Design Temp	Time (mins)	Modified Time (mins)
350°C	70	64.4
400°C	79.5	73.8
450°C	89	83.2
500°C	98	92.1
550°C	107	99.9
600°C	115.5	107.8
620°C	118.5	110.6
650°C	123	114.8
700°C	131	122.3
750°C	134.5	125.5

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SCS31 Modified Steel Column Time

SCS31		
Design Temp	Time (mins)	Modified Time (mins)
350°C	54	49.7
400°C	61	56.6
450°C	69	64.5
500°C	77	72.4
550°C	85	79.3
600°C	93	86.8
620°C	96	89.6
650°C	100	93.3
700°C	108	100.8
750°C	115	107.3

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SCS02 Modified Steel Column Time

SCS02		
Design Temp	Time (mins)	Modified Time (mins)
350°C	44.5	41.0
400°C	50	46.4
450°C	56	52.4
500°C	62.5	58.8
550°C	69.5	64.9
600°C	77.5	72.3
620°C	81	75.6
650°C	86	80.3
700°C	95.5	89.1
750°C	109.5	102.2

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SCS03 Modified Steel Column Time

SCS03		
Design Temp	Time (mins)	Modified Time (mins)
350°C	40	36.8
400°C	45	41.8
450°C	50.5	47.2
500°C	56	52.6
550°C	62.5	58.3
600°C	69.5	64.9
620°C	72.5	67.7
650°C	77	71.9
700°C	86	80.3
750°C	96.5	90.1

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SCS04 Modified Steel Column Time

SCS04		
Design Temp	Time (mins)	Modified Time (mins)
350°C	34	31.3
400°C	37.5	34.8
450°C	41.5	38.8
500°C	46	43.2
550°C	50.5	47.1
600°C	55.5	51.8
620°C	58	54.1
650°C	61.5	57.4
700°C	68	63.5
750°C	76.5	71.4

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SCS06 Modified Steel Column Time

SCS06		
Design Temp	Time (mins)	Modified Time (mins)
350°C	31.5	29.0
400°C	34.5	32.0
450°C	38	35.5
500°C	41.5	39.0
550°C	45.5	42.5
600°C	50	46.7
620°C	52	48.5
650°C	55.5	51.8
700°C	61	56.9
750°C	66.5	62.1

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SCS07 Modified Steel Column Time

SCS07		
Design Temp	Time (mins)	Modified Time (mins)
350°C	81.5	76.2
400°C	91.5	85.3
450°C	101.5	94.4
500°C	111	102.4
550°C	120	109.2
600°C	124	112.8
620°C	125	113.7
650°C	126.5	115.1
700°C	129.5	117.8
750°C	132.5	120.5

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SCS08 Modified Steel Column Time

SCS08		
Design Temp	Time (mins)	Modified Time (mins)
350°C	48.5	45.3
400°C	54.5	50.8
450°C	60.5	56.3
500°C	66.5	61.4
550°C	73.5	66.9
600°C	80.0	72.8
620°C	83.0	75.5
650°C	87.0	79.1
700°C	94.0	85.5
750°C	101.0	91.9

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SCS10 Modified Steel Column Time

SCS10		
Design Temp	Time (mins)	Modified Time (mins)
350°C	43.5	40.7
400°C	47.5	44.3
450°C	52.5	48.8
500°C	57.5	53.1
550°C	63.5	57.8
600°C	70.0	63.7
620°C	72.5	66.0
650°C	77.0	70.1
700°C	85.5	77.8
750°C	96.5	87.8

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SCS11 Modified Steel Column Time

SCS11		
Design Temp	Time (mins)	Modified Time (mins)
350°C	38.5	36.0
400°C	42.0	39.2
450°C	46.0	42.8
500°C	50.5	46.6
550°C	55.5	50.5
600°C	60.5	55.0
620°C	63.0	57.3
650°C	66.5	60.5
700°C	72.0	65.5
750°C	78.0	71.0

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SCS09 Modified Steel Column Time

SCS09		
Design Temp	Time (mins)	Modified Time (mins)
350°C	47.5	44.4
400°C	53.5	49.9
450°C	59.5	55.3
500°C	65.5	60.4
550°C	72.5	66.0
600°C	80.0	72.8
620°C	83.0	75.5
650°C	87.5	79.6
700°C	95.0	86.4
750°C	103.5	94.2

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SCS12 Modified Steel Column Time

SCS12		
Design Temp	Time (mins)	Modified Time (mins)
350°C	37.5	35.1
400°C	41.0	38.2
450°C	45.0	41.9
500°C	49.5	45.7
550°C	54.0	49.1
600°C	59.0	53.7
620°C	61.5	55.9
650°C	65.0	59.1
700°C	70.5	64.1
750°C	77.0	70.1

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CORRECTED AND PREDICTED TIMES

350°C Corrected Vs. Predicted Times

350 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	29.0	29.0	0.0
	202.37	0.004941444	31.3	31.3	0.0
	150.7	0.0066357	36.8	36.8	0.0
	126.05	0.00793336	41.0	41.0	0.0
	81.22	0.012312238	49.7	49.7	0.0
	52.6	0.019011407	64.4	64.4	0.0
15	258.08	0.003874768	35.1	35.1	0.0
	236.53	0.004227794	36.0	36.0	0.0
	203.39	0.004916663	40.7	40.7	0.0
	145.69	0.006863889	44.4	44.4	0.0
	127.16	0.007864108	45.3	45.3	0.0
	53.14	0.018818216	76.2	76.2	0.0

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400°C Corrected Vs. Predicted Times

400 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	32.0	32.0	0.0
	202.37	0.004941444	34.8	34.8	0.0
	150.7	0.0066357	41.8	41.8	0.0
	126.05	0.00793336	46.4	46.4	0.0
	81.22	0.012312238	56.6	56.6	0.0
	52.6	0.019011407	73.8	73.8	0.0
15	258.08	0.003874768	38.2	38.2	0.0
	236.53	0.004227794	39.2	39.2	0.0
	203.39	0.004916663	44.3	44.3	0.0
	145.69	0.006863889	49.9	49.9	0.0
	127.16	0.007864108	50.8	50.8	0.0
	53.14	0.018818216	85.3	85.3	0.0

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450°C Corrected Vs. Predicted Times

450 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	35.5	35.5	0.0
	202.37	0.004941444	38.8	38.8	0.0
	150.7	0.0066357	47.2	47.2	0.0
	126.05	0.00793336	52.4	52.4	0.0
	81.22	0.012312238	64.5	64.5	0.0
	52.6	0.019011407	83.2	83.2	0.0
15	258.08	0.003874768	41.9	41.9	0.0
	236.53	0.004227794	42.8	42.8	0.0
	203.39	0.004916663	48.8	48.8	0.0
	145.69	0.006863889	55.3	55.3	0.0
	127.16	0.007864108	56.3	56.3	0.0
	53.14	0.018818216	94.4	94.4	0.0

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500°C Corrected Vs. Predicted Times

500 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	39.0	39.0	0.0
	202.37	0.004941444	43.2	43.2	0.0
	150.7	0.0066357	52.6	52.6	0.0
	126.05	0.00793336	58.8	58.8	0.0
	81.22	0.012312238	72.4	72.4	0.0
	52.6	0.019011407	92.1	92.1	0.0
15	258.08	0.003874768	45.7	45.7	0.0
	236.53	0.004227794	46.6	46.6	0.0
	203.39	0.004916663	53.1	53.1	0.0
	145.69	0.006863889	60.4	60.4	0.0
	127.16	0.007864108	61.4	61.4	0.0
	53.14	0.018818216	102.4	102.4	0.0

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550°C Corrected Vs. Predicted Times

550 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	42.5	42.5	0.0
	202.37	0.004941444	47.1	47.1	0.0
	150.7	0.0066357	58.3	58.3	0.0
	126.05	0.00793336	64.9	64.9	0.0
	81.22	0.012312238	79.3	79.3	0.0
	52.6	0.019011407	99.9	99.9	0.0
15	258.08	0.003874768	49.1	49.1	0.0
	236.53	0.004227794	50.5	50.5	0.0
	203.39	0.004916663	57.8	57.8	0.0
	145.69	0.006863889	66.0	66.0	0.0
	127.16	0.007864108	66.9	66.9	0.0
	53.14	0.018818216	109.2	109.2	0.0

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600°C Corrected Vs. Predicted Times

600 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	46.7	46.7	0.0
	202.37	0.004941444	51.8	51.8	0.0
	150.7	0.0066357	64.9	64.9	0.0
	126.05	0.00793336	72.3	72.3	0.0
	81.22	0.012312238	86.8	86.8	0.0
	52.6	0.019011407	107.8	107.8	0.0
15	258.08	0.003874768	53.7	53.7	0.0
	236.53	0.004227794	55.0	55.0	0.0
	203.39	0.004916663	63.7	63.7	0.0
	127.16	0.007864108	72.8	72.8	0.0
	53.14	0.018818216	112.8	112.8	0.0

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620°C Corrected Vs. Predicted Times

620 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	48.5	48.5	0.0
	202.37	0.004941444	54.1	54.1	0.0
	150.7	0.0066357	67.7	67.7	0.0
	126.05	0.00793336	75.6	75.6	0.0
	81.22	0.012312238	89.6	89.6	0.0
	52.6	0.019011407	110.6	110.6	0.0
15	258.08	0.003874768	55.9	55.9	0.0
	236.53	0.004227794	57.3	57.3	0.0
	203.39	0.004916663	66.0	66.0	0.0
	127.16	0.007864108	75.5	75.5	0.0
	53.14	0.018818216	113.7	113.7	0.0

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650°C Corrected Vs. Predicted Times

650 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	51.8	51.8	0.0
	202.37	0.004941444	57.4	57.4	0.0
	150.7	0.0066357	71.9	71.9	0.0
	126.05	0.00793336	80.3	79.4	0.0
	81.22	0.012312238	93.3	93.3	0.0
	52.6	0.019011407	114.8	114.8	0.0
15	258.08	0.003874768	59.1	59.1	0.0
	236.53	0.004227794	60.5	60.5	0.0
	203.39	0.004916663	70.1	70.1	0.0
	127.16	0.007864108	79.1	79.1	0.0
	53.14	0.018818216	115.1	115.1	0.0

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700°C Corrected Vs. Predicted Times

700 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	56.9	56.9	0.0
	202.37	0.004941444	63.5	63.5	0.0
	150.7	0.0066357	80.3	80.3	0.0
	126.05	0.00793336	85.7	85.7	0.0
	81.22	0.012312238	98.6	98.6	0.0
	52.6	0.019011407	118.4	118.4	0.0
15	258.08	0.003874768	64.1	64.1	0.0
	236.53	0.004227794	65.5	65.5	0.0
	203.39	0.004916663	77.8	77.8	0.0
	127.16	0.007864108	85.5	85.5	0.0
	53.14	0.018818216	117.8	117.8	0.0

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750°C Corrected Vs. Predicted Times

750 °C					
Thickness (mm)	Section Factor (A/V)	Inverse Section Factor (V/A)	Corrected Time (minutes)	Predicted Time (minutes)	Difference (%)
12.5	257.88	0.003877773	62.1	62.1	0.0
	202.37	0.004941444	71.4	71.4	0.0
	150.7	0.0066357	90.1	90.1	0.0
	126.05	0.00793336	102.2	92.0	0.0
	81.22	0.012312238	107.3	103.5	0.0
	52.6	0.019011407	125.5	121.0	0.0
15	258.08	0.003874768	70.1	70.1	0.0
	236.53	0.004227794	71.0	71.0	0.0
	203.39	0.004916663	87.8	87.8	0.0
	127.16	0.007864108	91.9	91.9	0.0
	53.14	0.018818216	120.5	120.5	0.0

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SELECTION OF APPRAISAL METHOD

The appraisal method used was the graphical approach, details given in Annex E E.2. This method showed compliance with the requirements in 13.5.

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GRAPHICAL METHOD

Line Graphs

350˚C GRAPHICAL METHOD

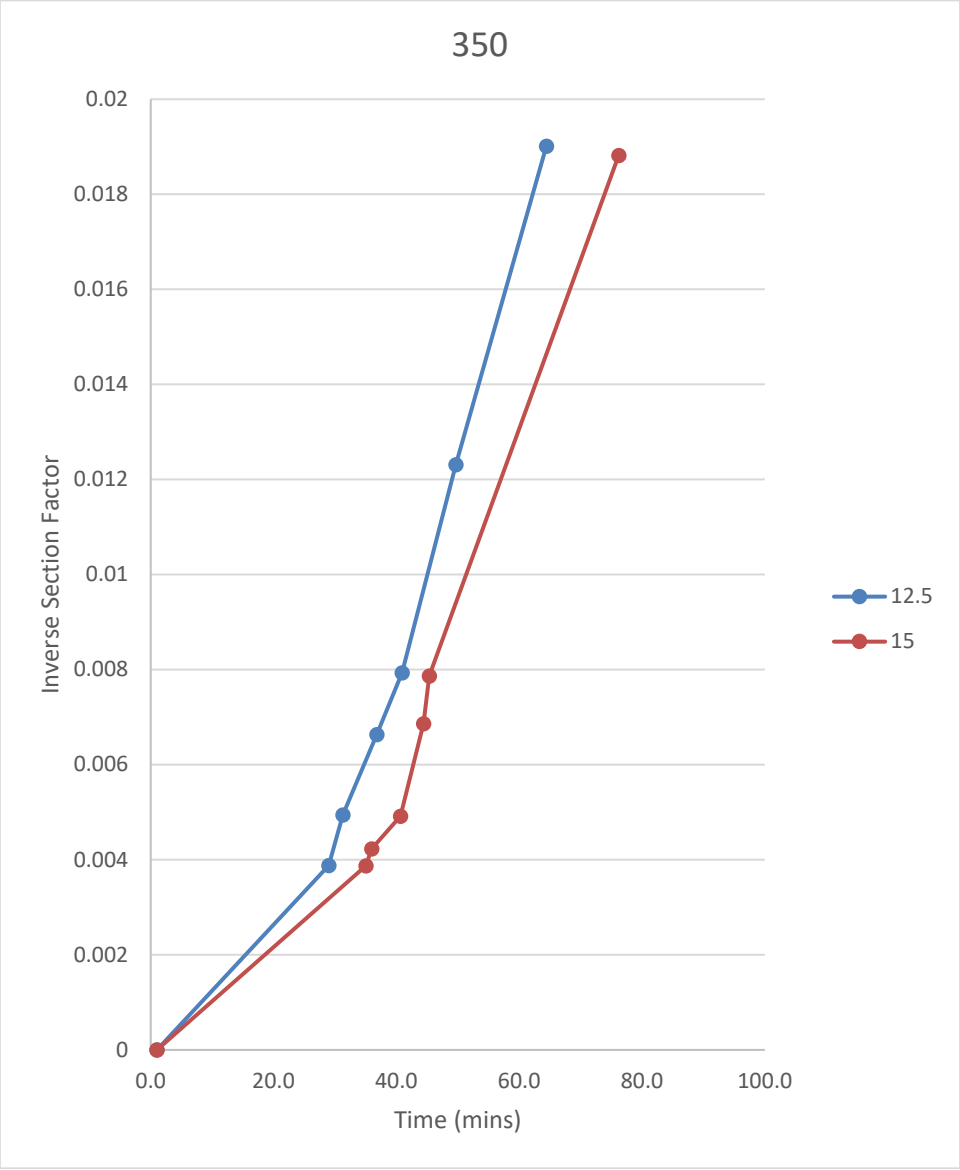

Figure 11. 350˚C graphical chart.

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400˚C GRAPHICAL METHOD

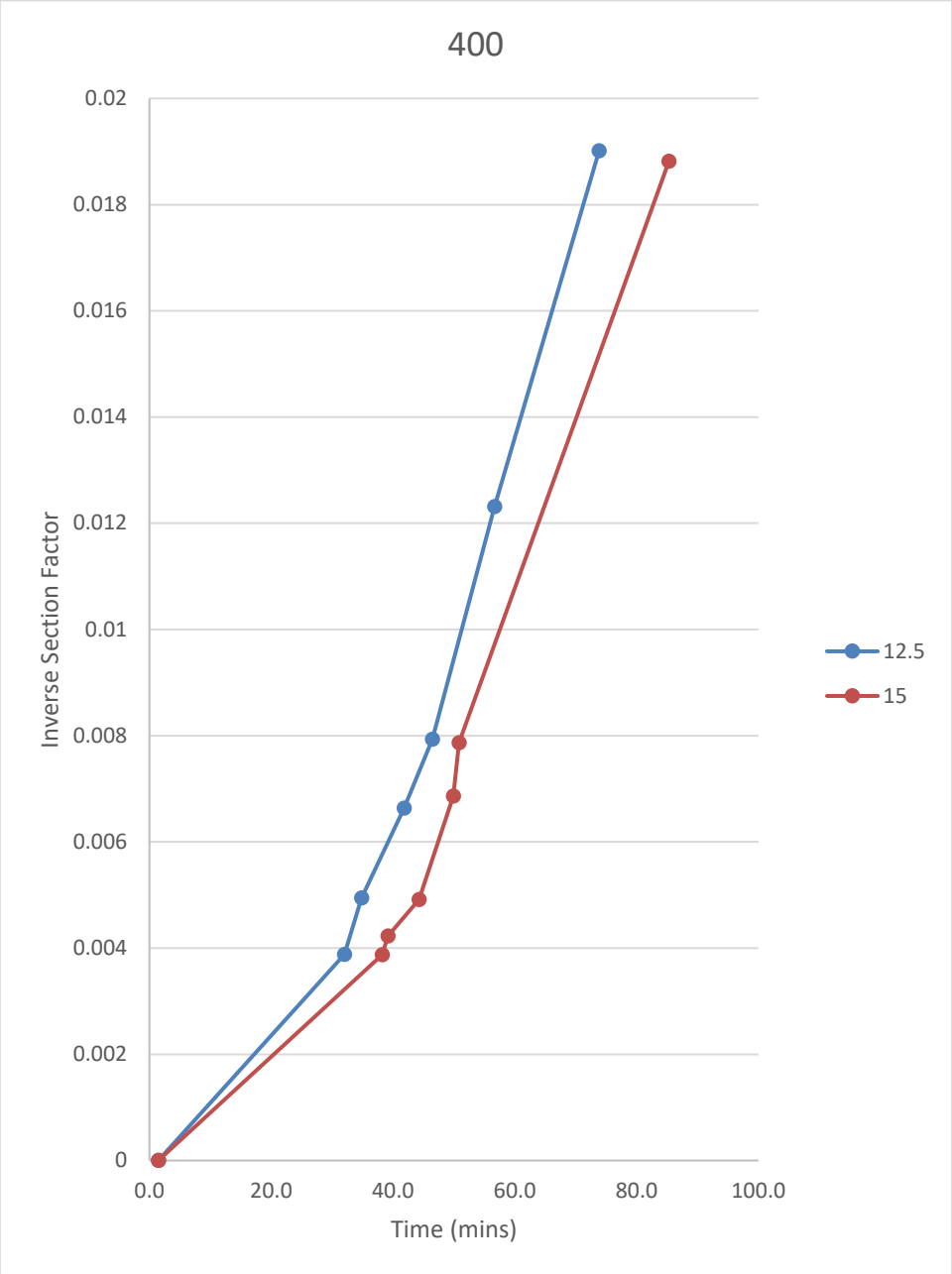

Figure 12. 400˚C graphical chart.

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450˚C GRAPHICAL METHOD

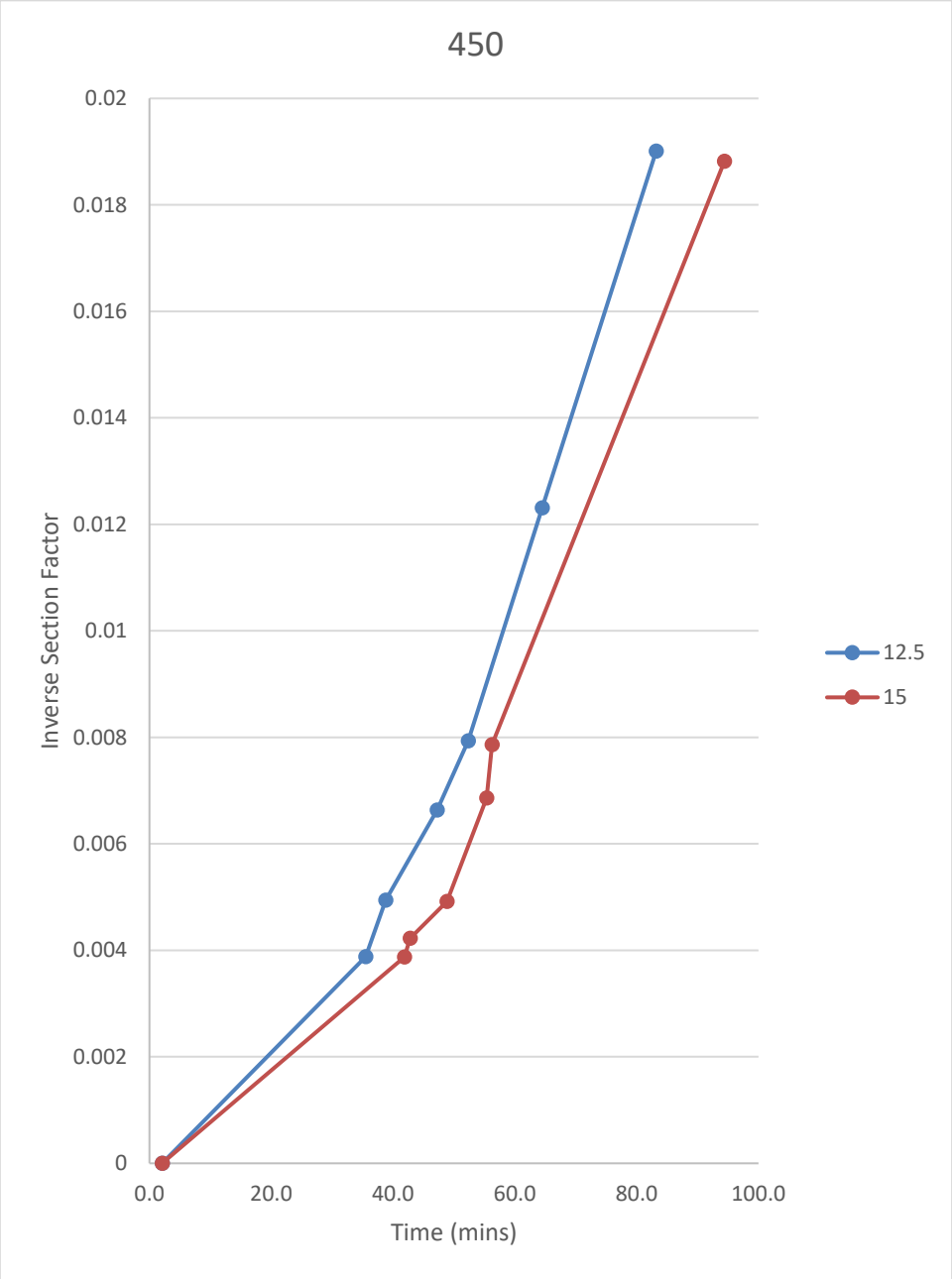

Figure 13. 450˚C graphical chart.

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500˚C GRAPHICAL METHOD

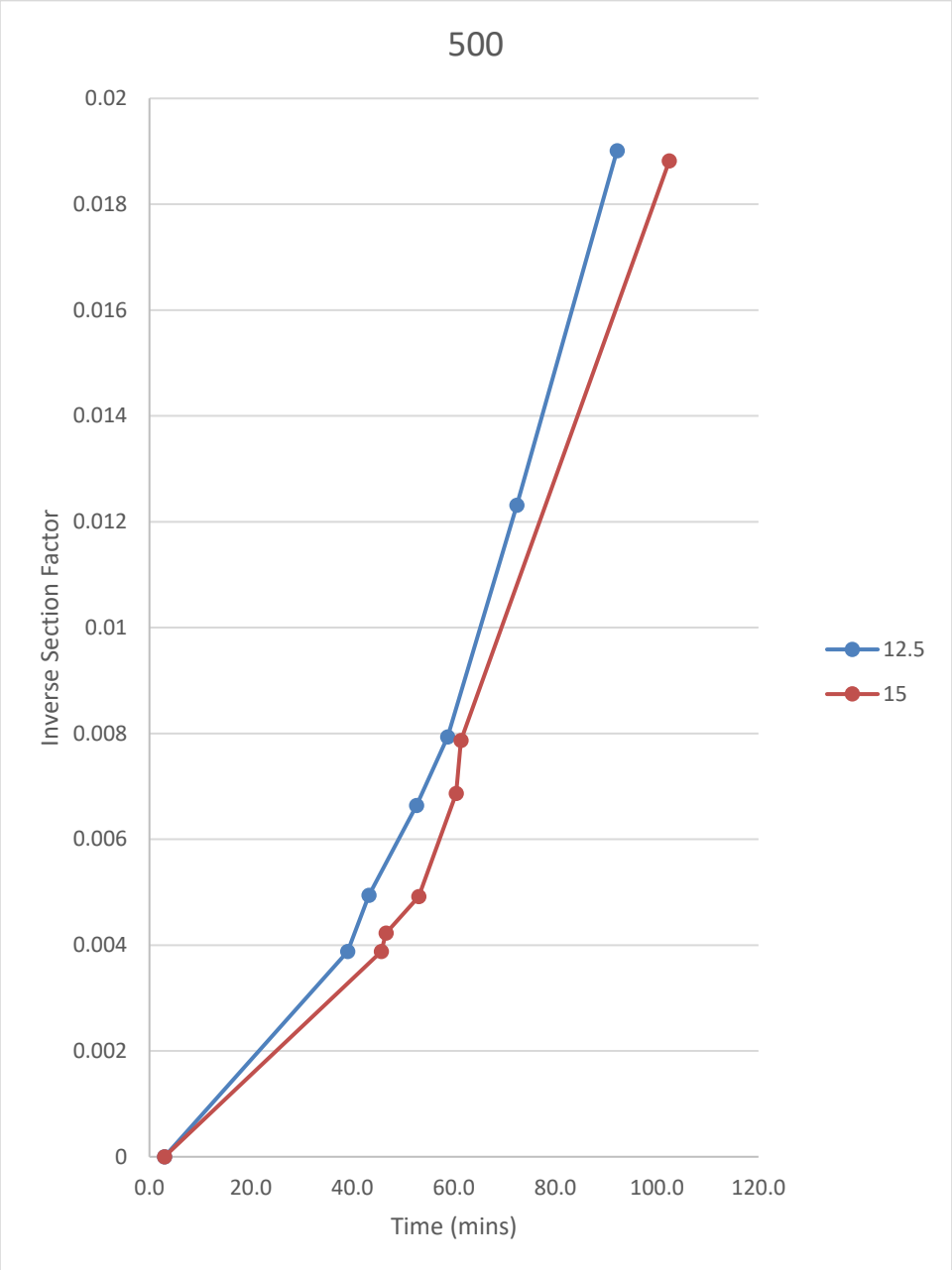

Figure 14. 500˚C graphical chart.

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550˚C GRAPHICAL METHOD

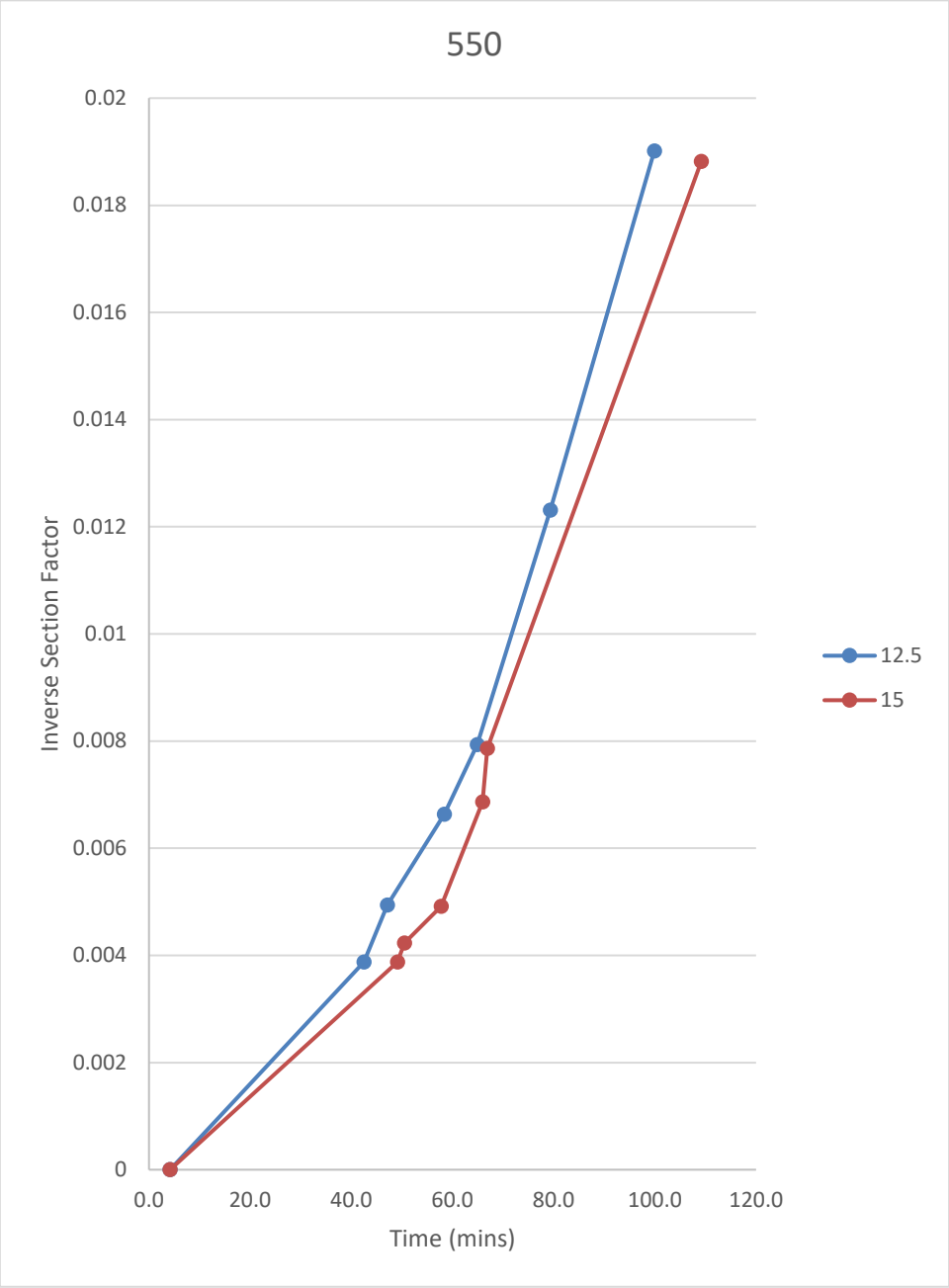

Figure 15. 550˚C graphical chart.

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600˚C GRAPHICAL METHOD

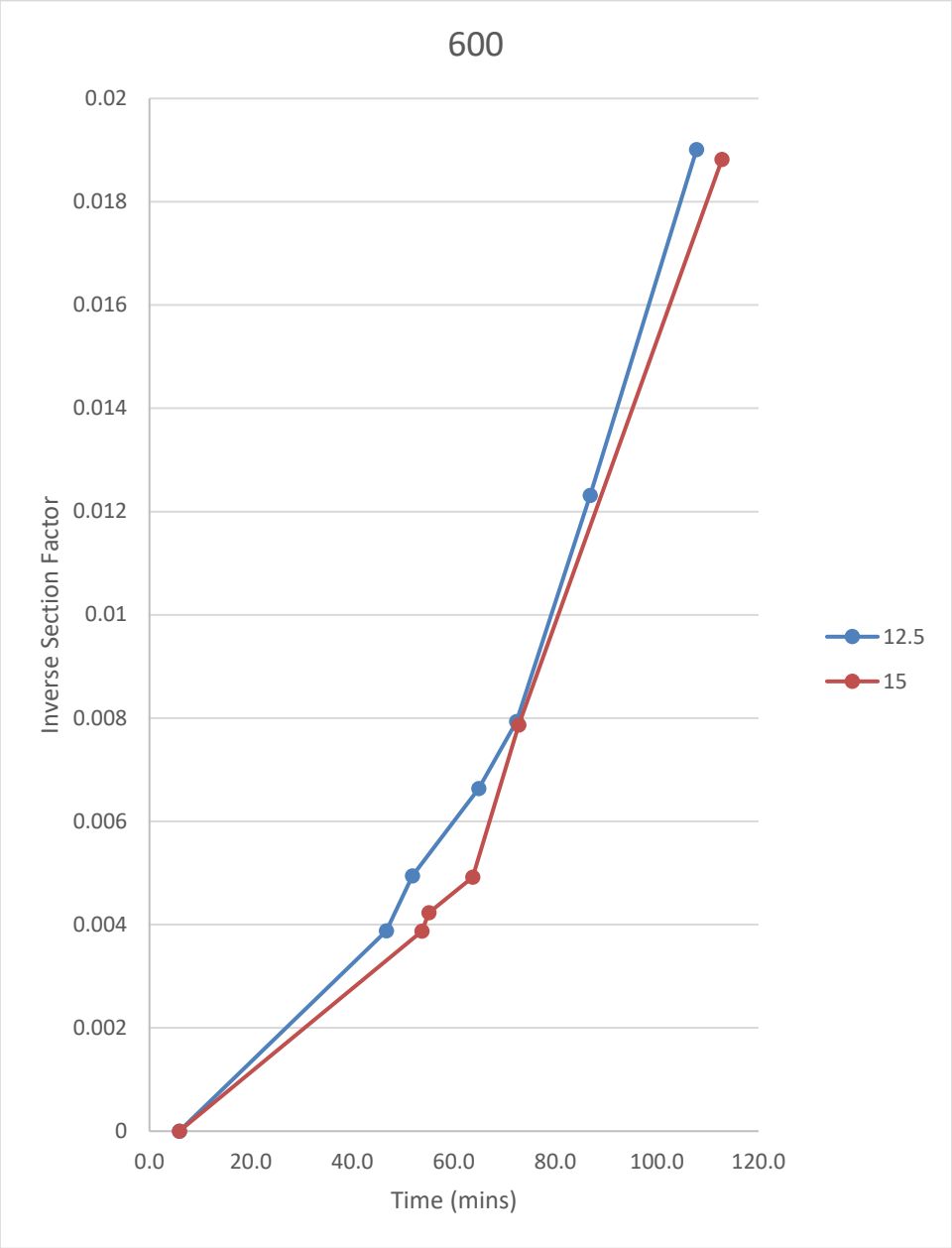

Figure 16. 600˚C graphical chart.

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620˚C GRAPHICAL METHOD

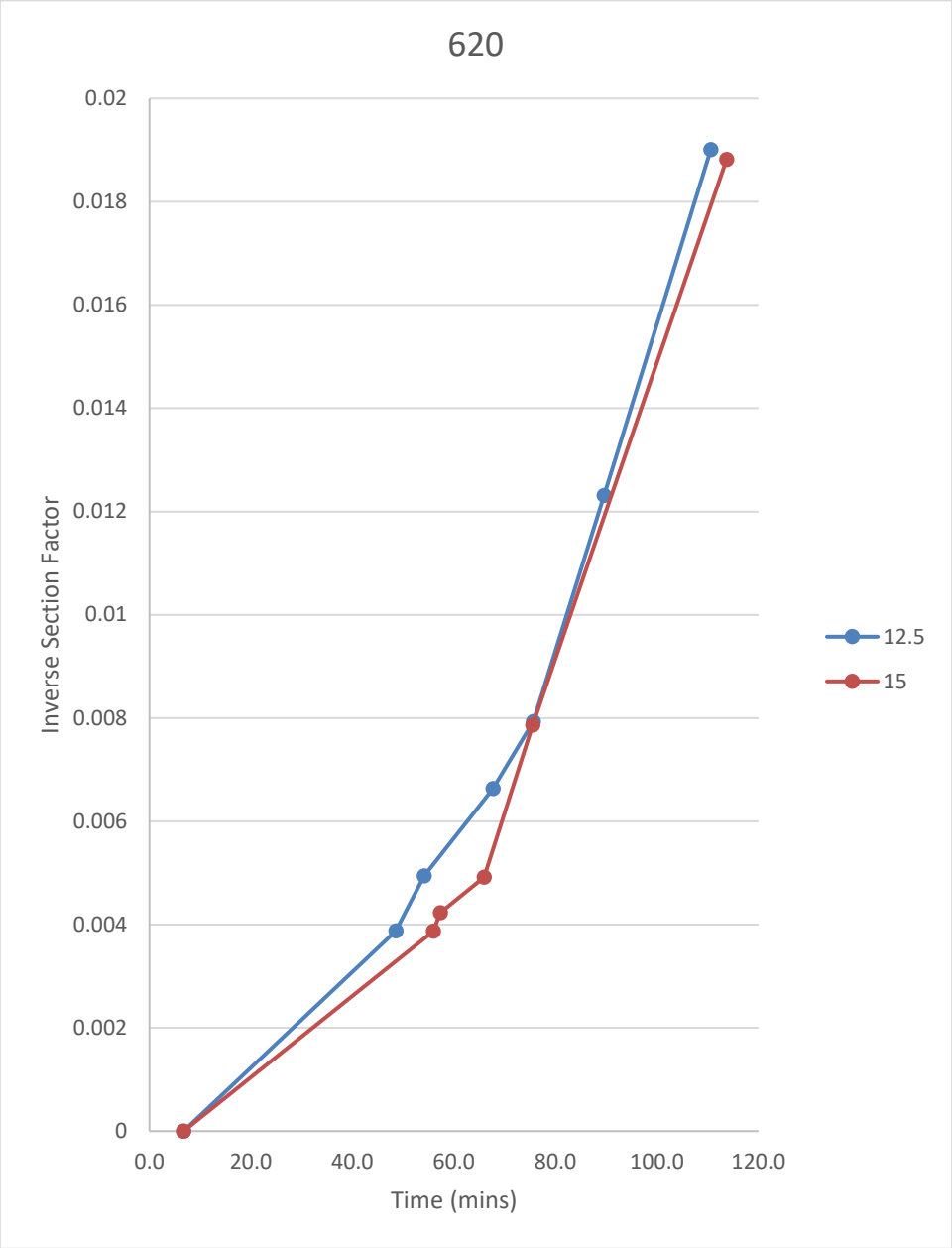

Figure 17. 620˚C graphical chart.

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650˚C GRAPHICAL METHOD

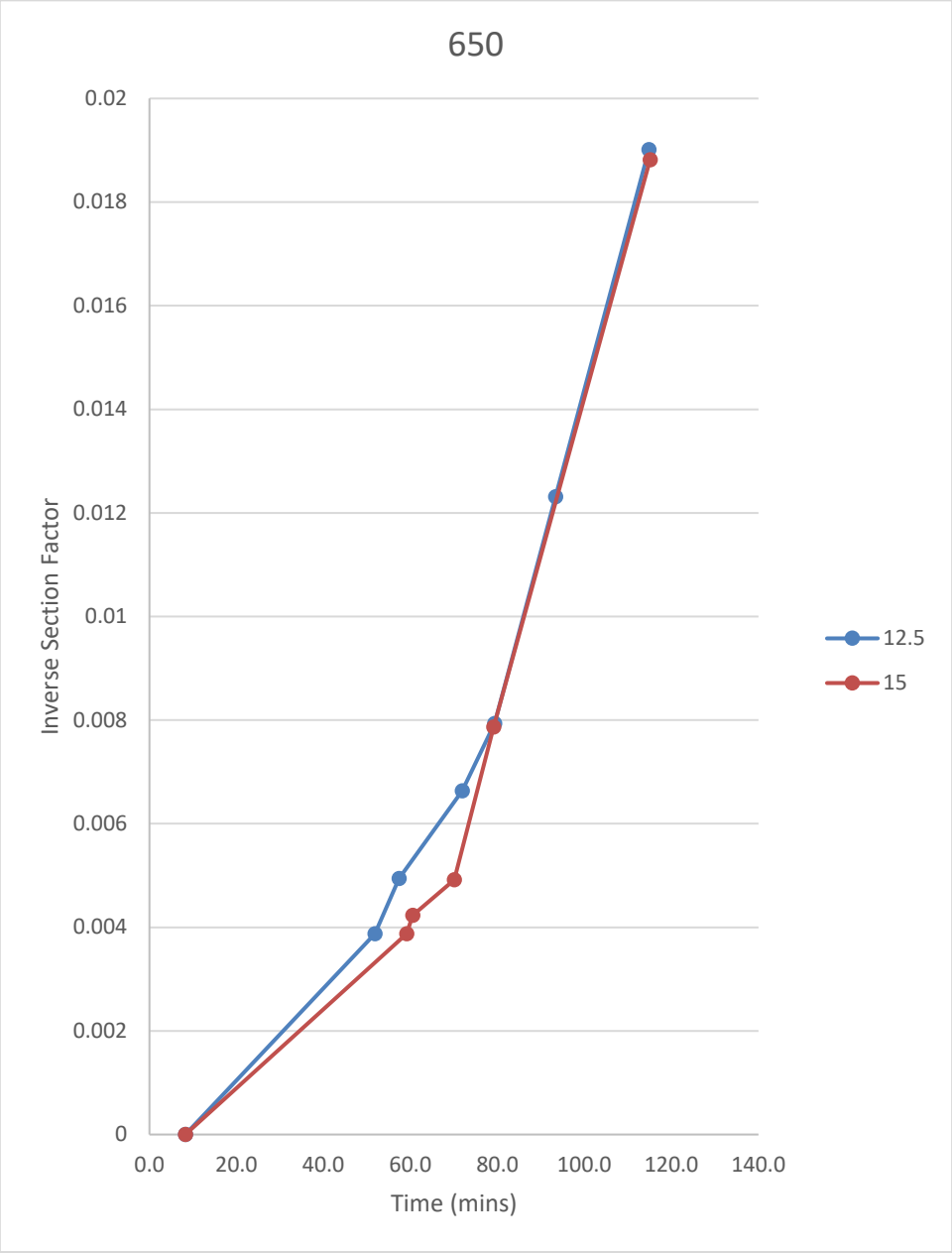

Figure 18. 650˚C graphical chart.

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700˚C GRAPHICAL METHOD

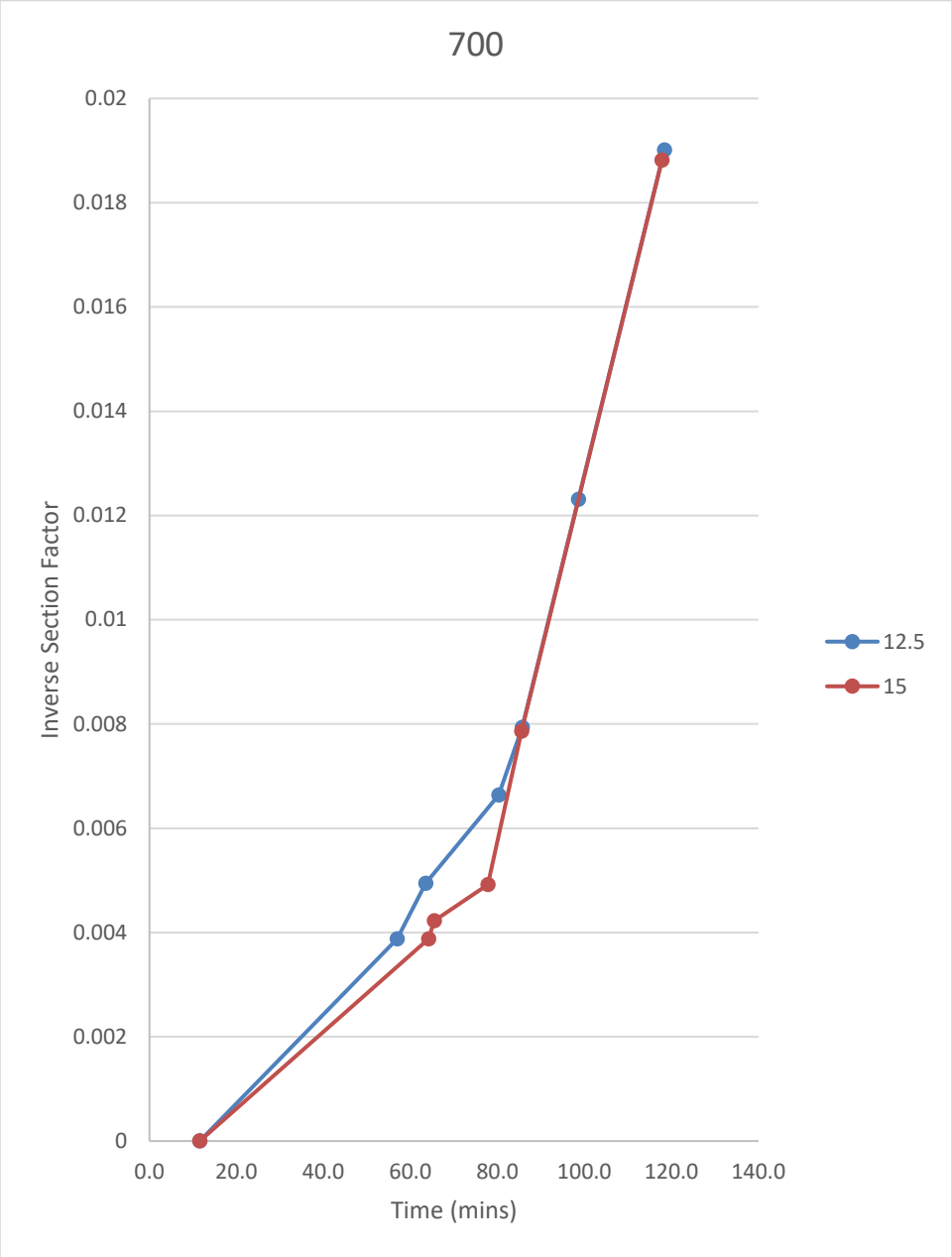

Figure 19. 700˚C graphical chart.

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750˚C GRAPHICAL METHOD

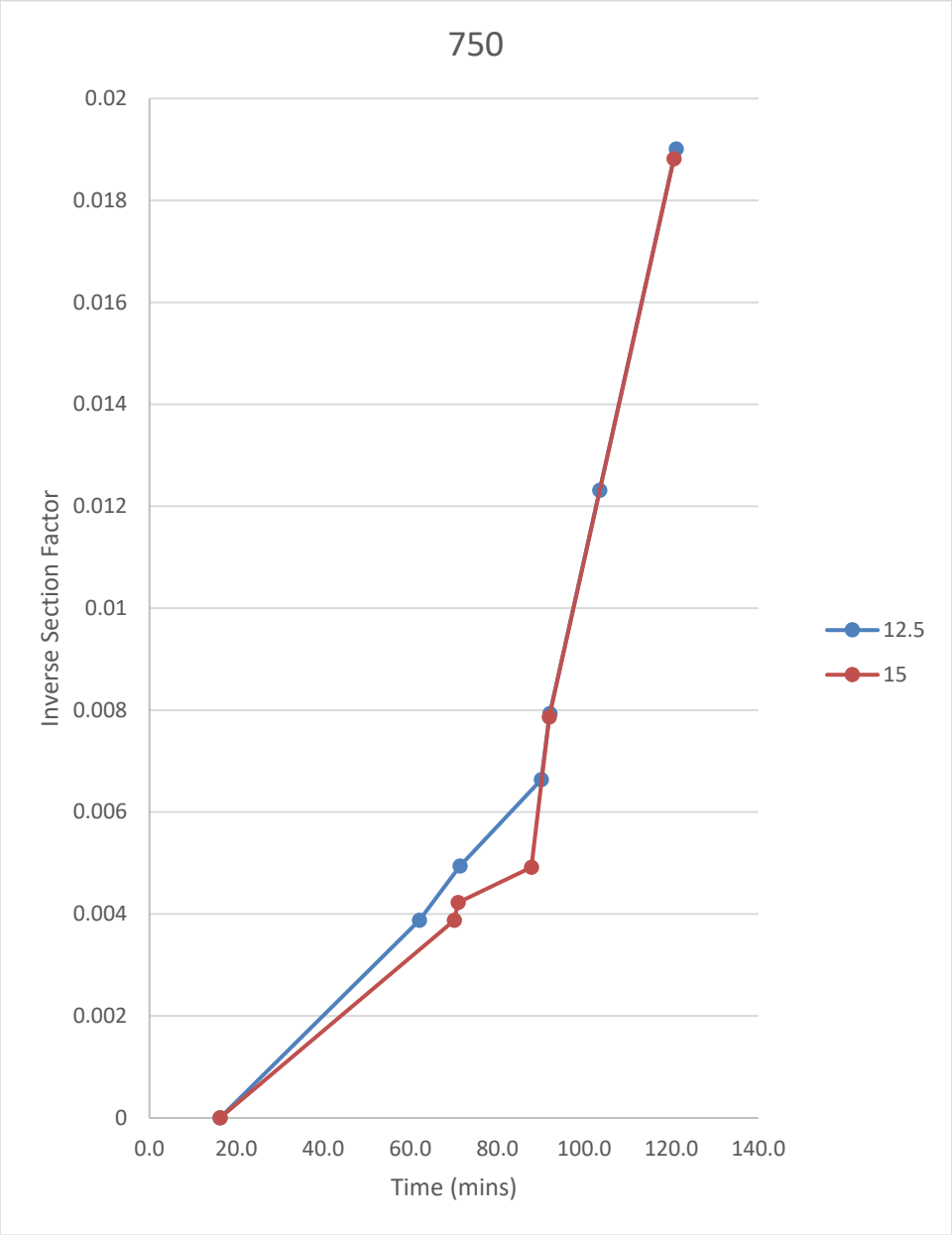

Figure 20. 750˚C graphical chart.

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Box Graphs
350˚C A/V TABLE

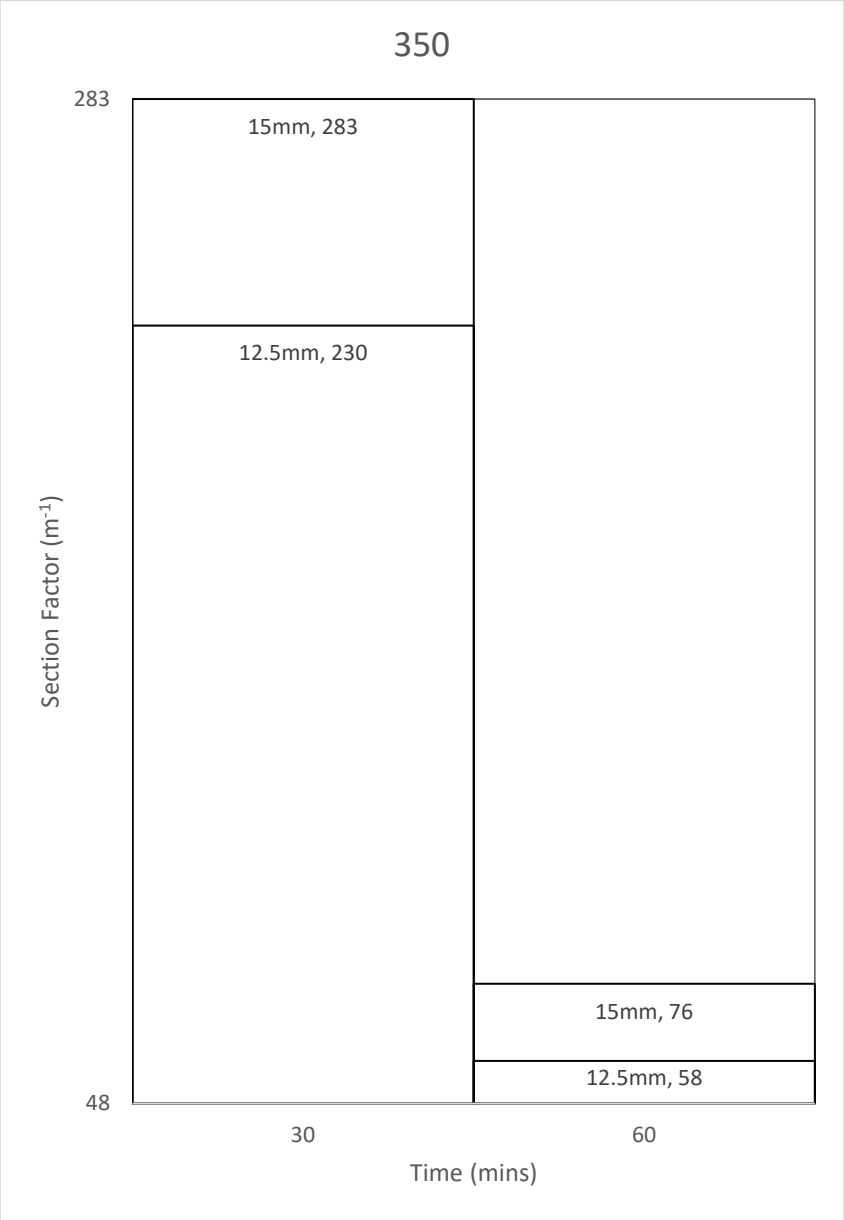

Figure 21. 350˚C A/V table.

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400˚C A/V TABLE

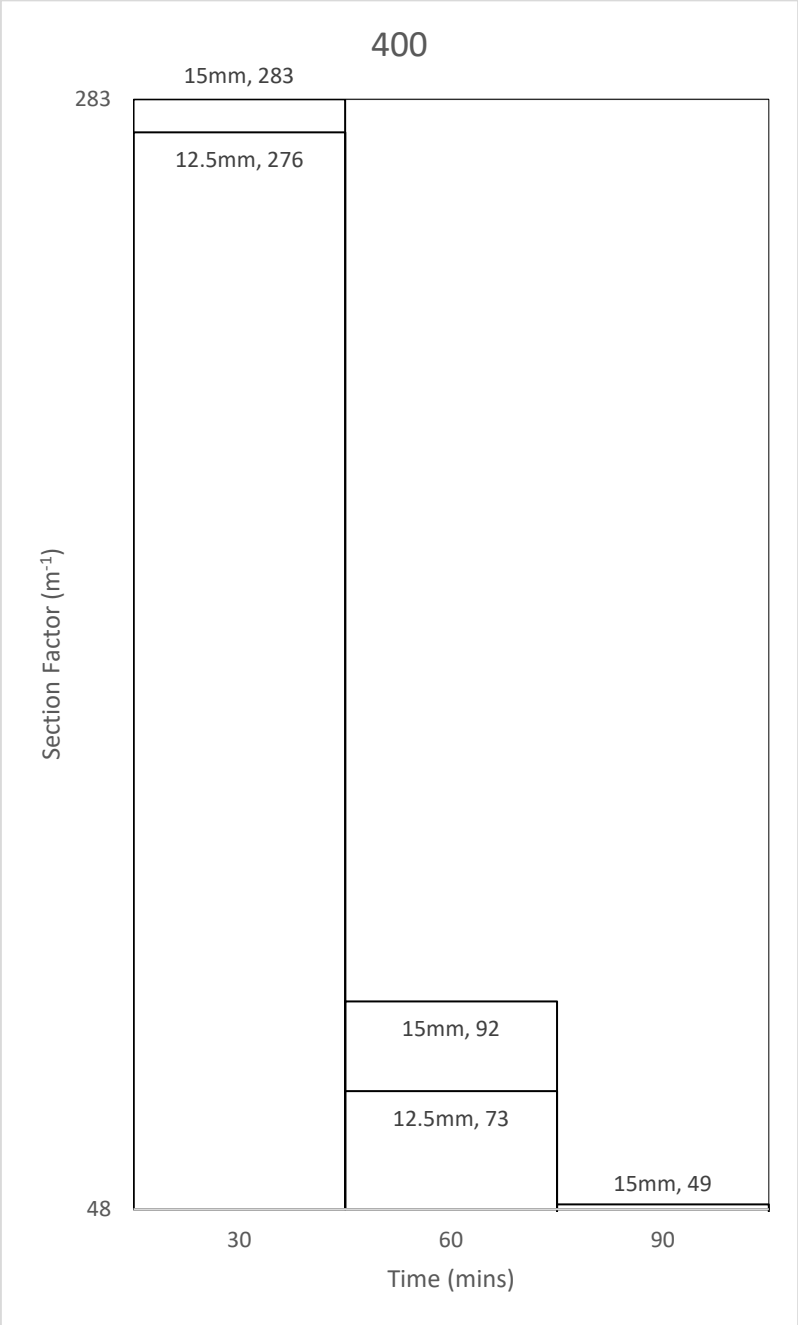

Figure 22. 400˚C A/V table.

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450˚C A/V TABLE

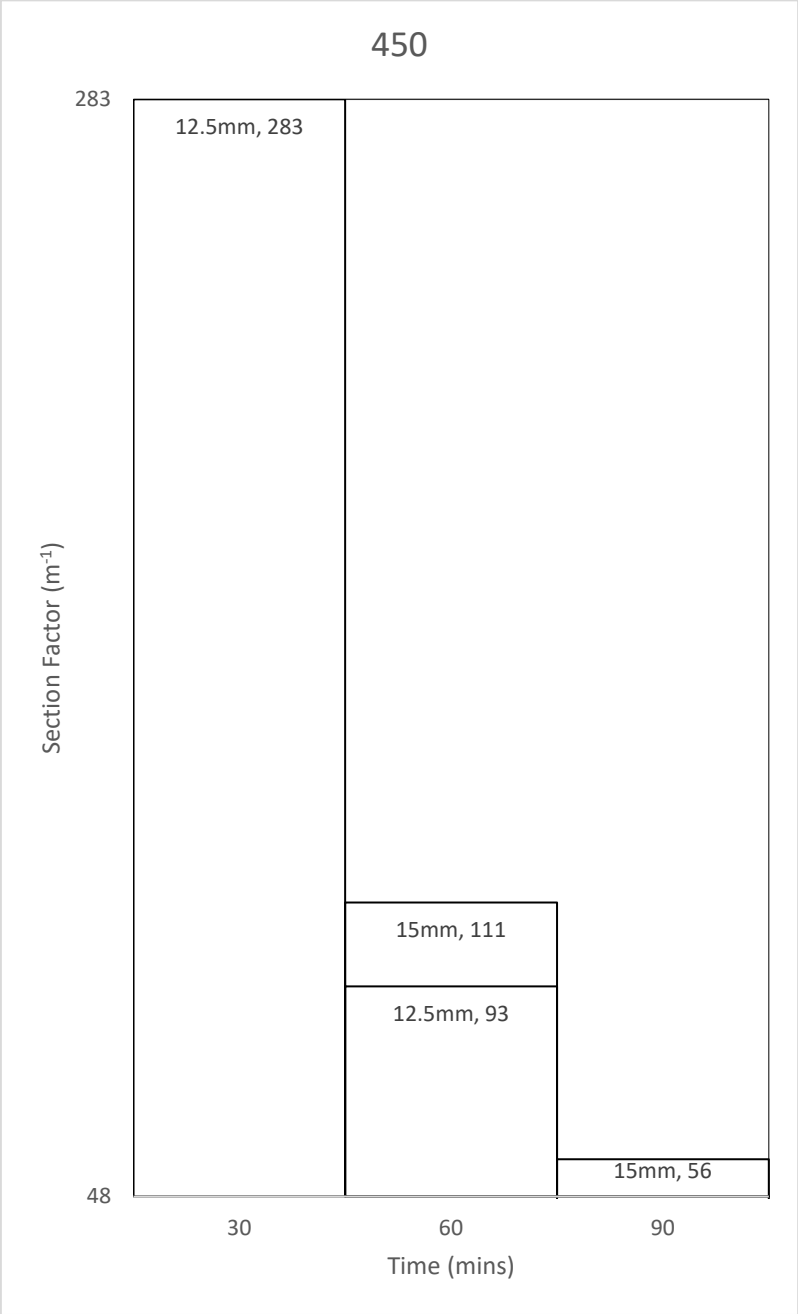

Figure 23. 450˚C A/V table.

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500˚C A/V TABLE

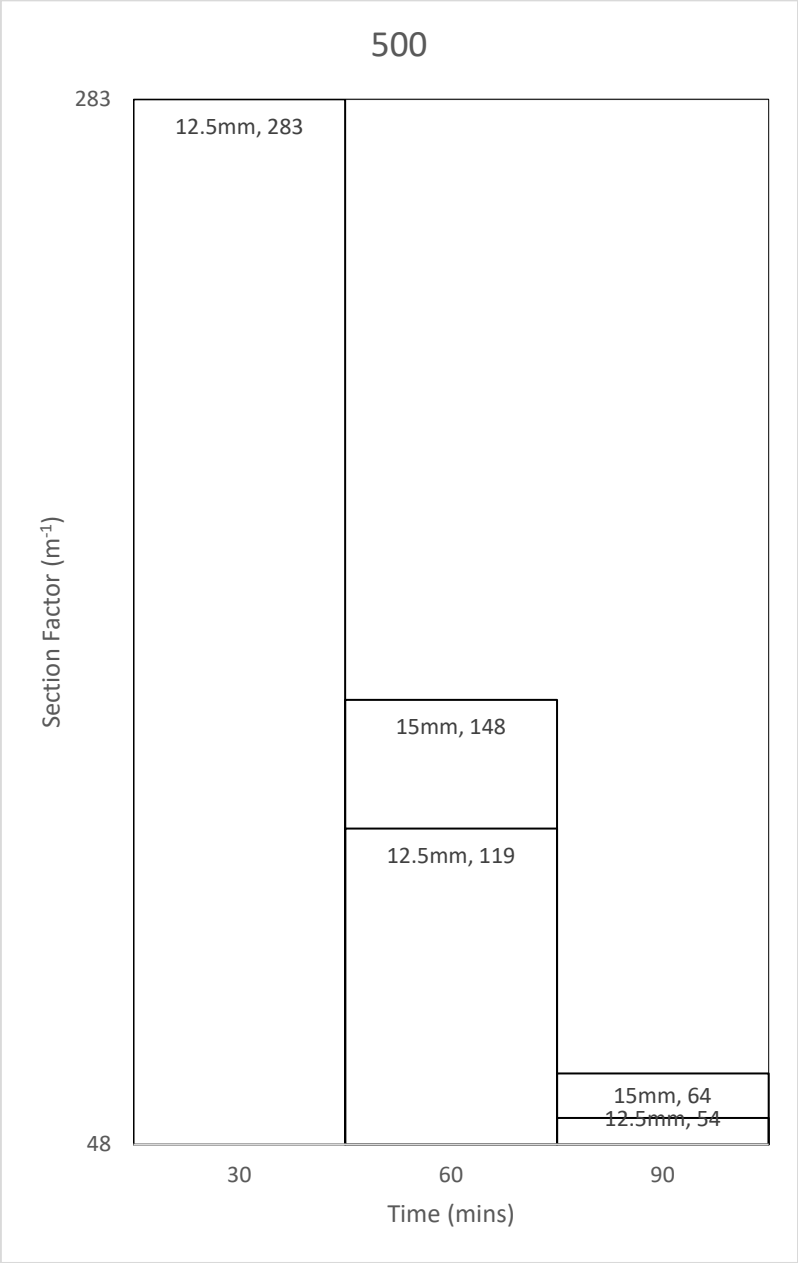

Figure 24. 500˚C A/V table.

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550˚C A/V TABLE

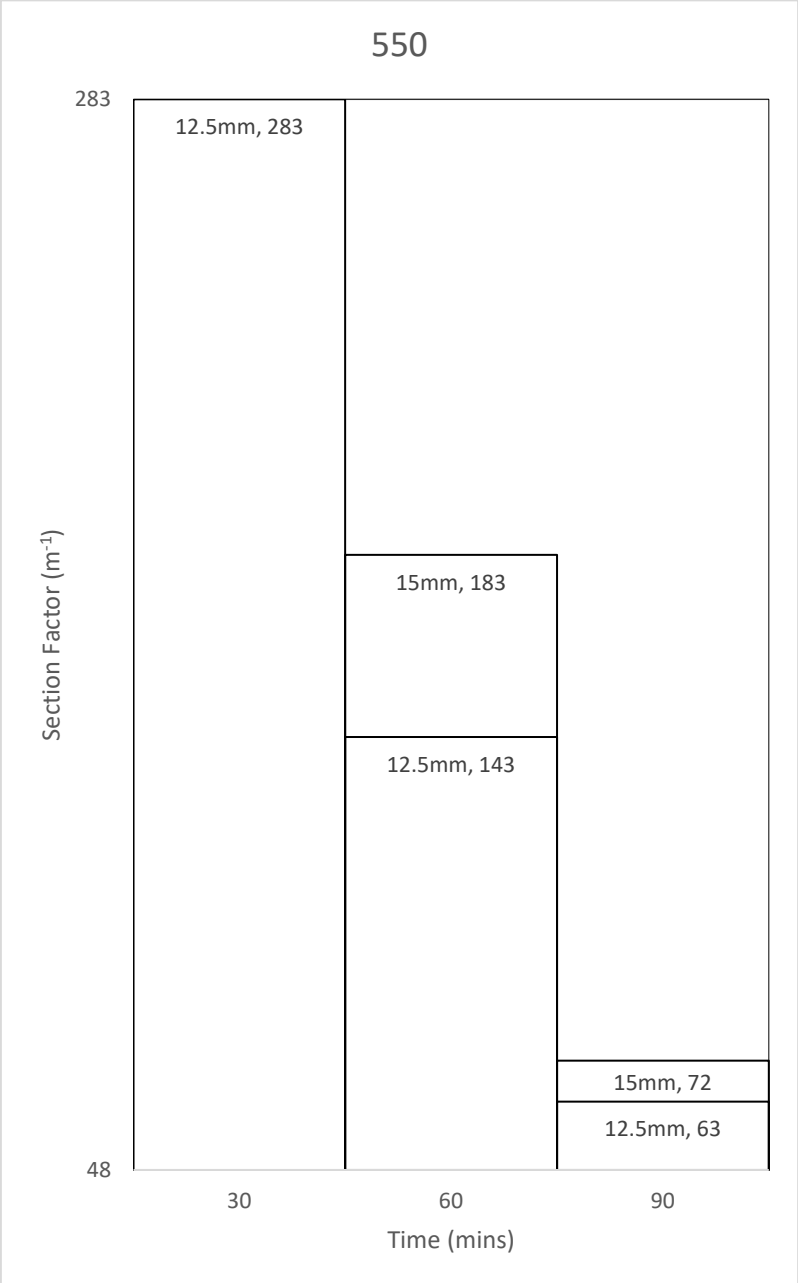

Figure 25. 550˚C A/V table.

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600˚C A/V TABLE

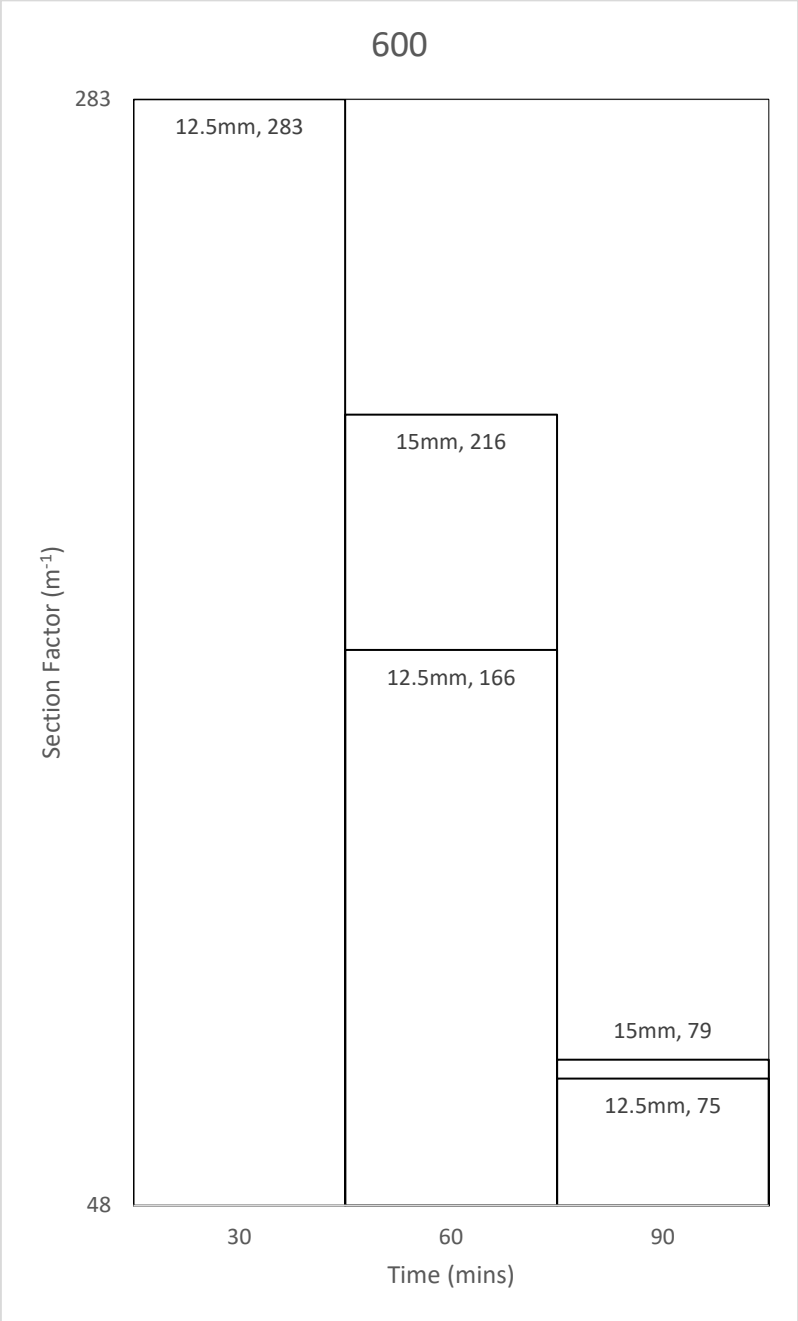

Figure 26. 600˚C A/V table.

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620˚C A/V TABLE

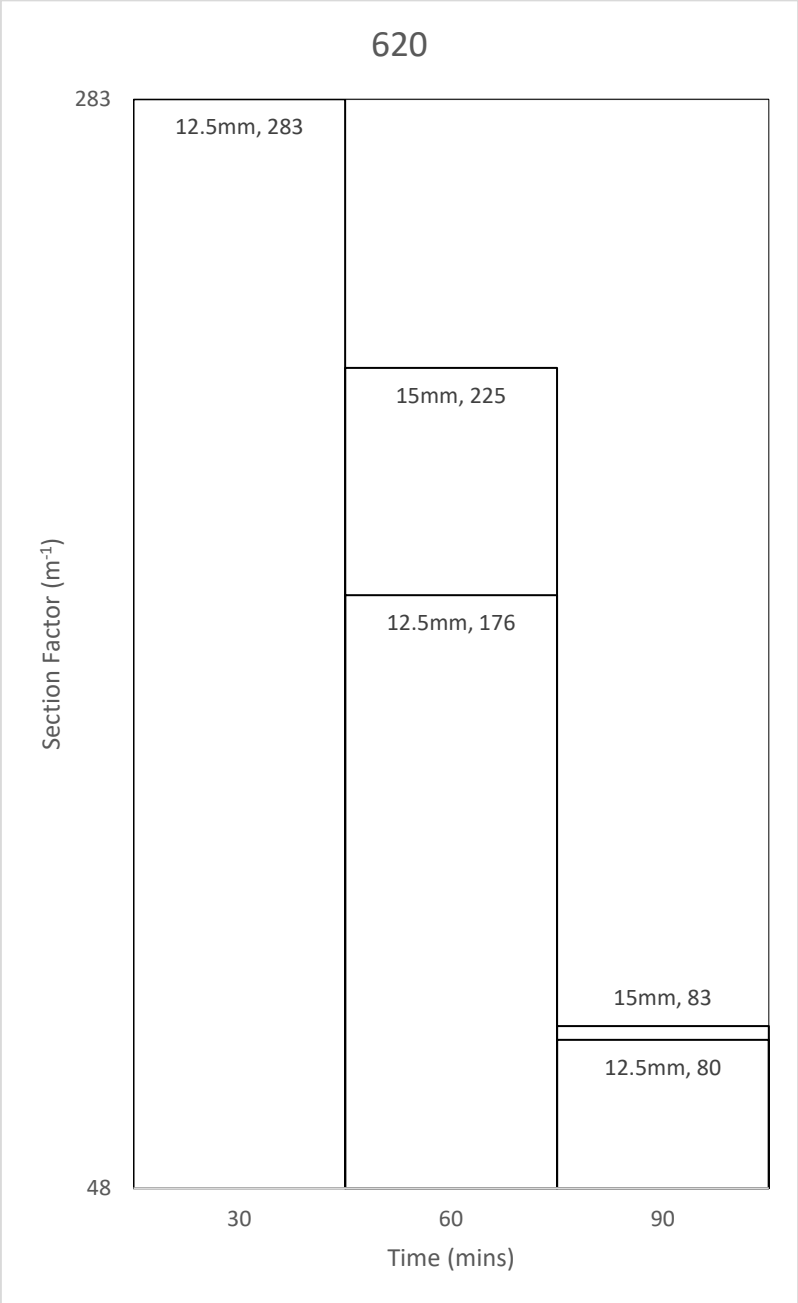

Figure 27. 620˚C A/V table.

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650˚C A/V TABLE

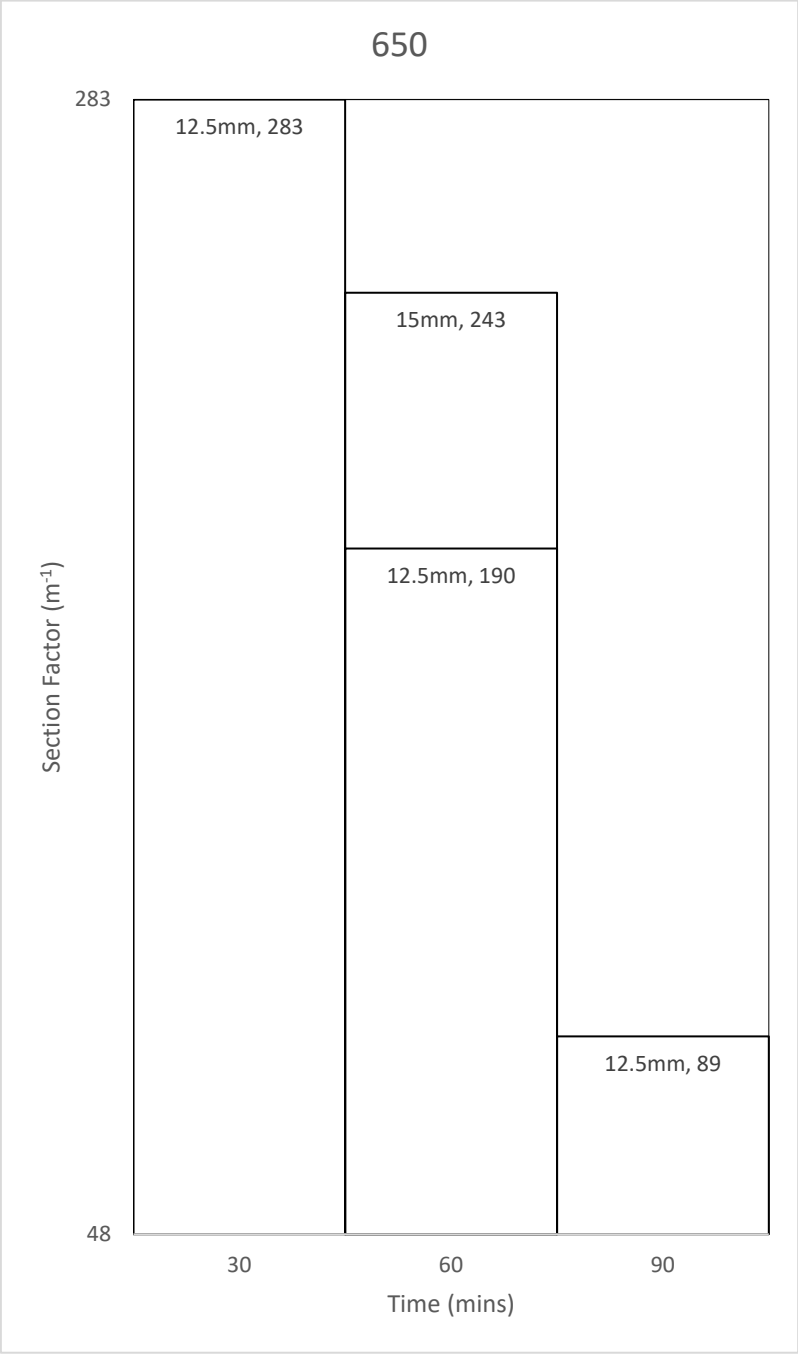

Figure 28. 650˚C A/V table.

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700˚C A/V TABLE

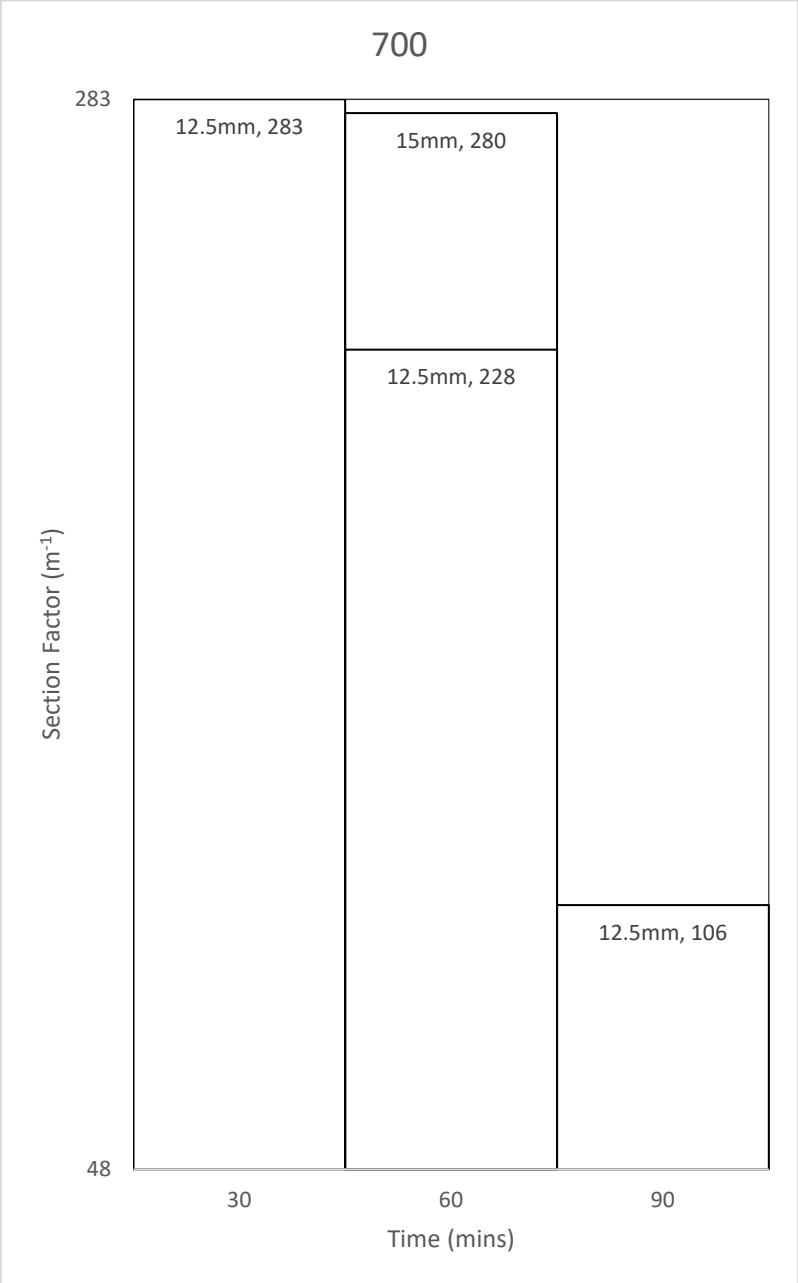

Figure 29. 700˚C A/V table.

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750˚C A/V TABLE

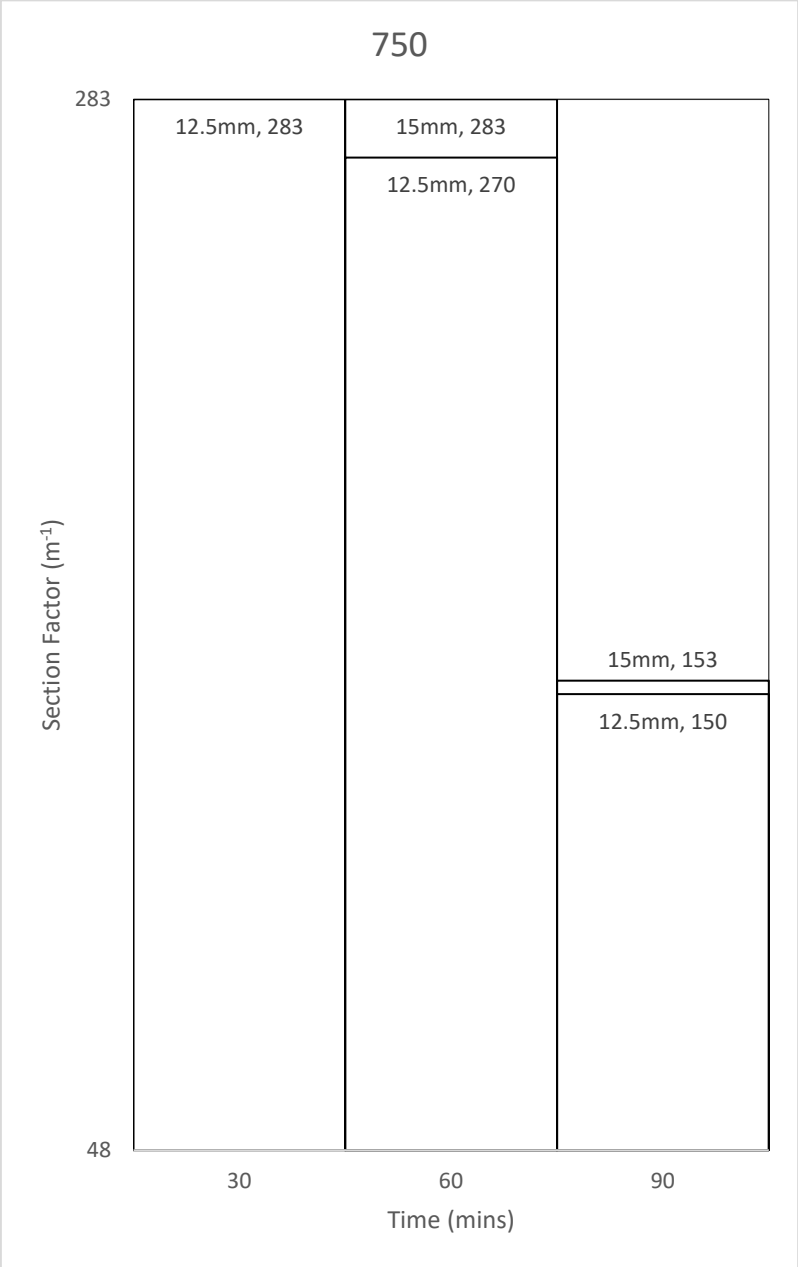

Figure 30. 750˚C A/V table.

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LIMITS OF APPLICABILITY OF THE APPRAISAL

The results from this test method and the assessment procedure are applicable to fire protection systems over the range of fire protection material thicknesses tested, the values of steel section factor A/V tested and the maximum temperatures established during the test.

For an assessment to be valid for any fire resistance period, the loaded sections protected with the maximum protection thickness shall achieve a load bearing capacity performance as defined in 10.3.1 and 10.3.2 within 85% of this period.

The results of the appraisal are applicable to all other grades of steel to that tested and as given in EN 10025-1 as specified in 6.1 and with the limitations given therein. The results of the assessment may also be applicable to fabricated sections.

The maximum beam web depth shall be limited to the web depth of the loaded beam plus 50%.

The maximum depth of a column, (h) shall be limited to the depth of the loaded beam plus 100%. This is subject to a maximum permitted depth of 600mm for boxed fire protection systems. The assessment is applicable to the method of application used in the test specimen preparation.

The distance of boards of the fire protection system from the steel members shall be as follows;

Tested distance -5mm to +50mm with no change of fixing.

The method of fixing boards is confined to the method used for the test specimens since it may not be suitable for other situations. The suitability of the tested fixing system for different situations shall be demonstrated by appropriate testing.

The appraisal results from single layer fire protection systems and are only applicable to single layer fire protection systems. Double layer systems must be tested and assessed separately (6.6.1).

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APPLICABILITY OF THE RESULTS TO SECTION OTHER THAN I OR H

Test data exists on structural hollow section (SHS) as compression and flexural members which together with recent research have indicated comparability between SHS sections and 'I' or 'H' sections in terms of the fire protection thickness related to the section factor. The test information has been analysed for rectangular, square and circular sections to establish comparability with respect to the fire protection thickness, section factor and fire resistance performance and the approaches below for boxed and profiled systems are recommended for both three and four sided protection to both beams and columns.

Boxed systems

No change in thickness is required, i.e. the thickness for a structural hollow section of a given A/V value is equal to that for the 'I' or 'H' section of the same 'box' A/V value.

Profiled systems

For profiled systems, a correction to the thickness is required; see BS EN 13381-4:2013 Annex A.3.

The rules outlined above may be used providing that the different section shape does not require new fixing techniques and does not affect the physical performance of the fire protection system.