



Fire resistance test report

Control joints tested in accordance with AS 1530.4:2014

Test sponsor: H.B. Fuller Australia

Job number: FRT180013

Test date: 24 April 2019 Revision: R2.0

Amendment schedule

Version	Date	Information relating to report			
R1.0	01/05/2019	Description	Initial issue		
			Prepared by	Reviewed by	Authorised by
		Name	Durai Krish	Steven Halliday	Steven Halliday
		Signature			
R2.0	02/05/2019	Description	Sealant name and service C FRL updated.		
			Prepared by	Reviewed by	Authorised by
		Name	Durai Krish	Steven Halliday	Steven Halliday
					

Contact information

Warringtonfire Australia Pty Ltd – ABN 81 050 241 524

Melbourne – NATA registered laboratory

Unit 2, 409-411 Hammond Road
Dandenong South, VIC 3175
Australia

T: +61 3 9767 1000

Brisbane

Suite 6, Level 12
133 Mary Street
Brisbane, QLD 4000
Australia

T: +61 7 3238 1700

Perth

Unit 22, 22 Railway Road
Subiaco, WA 6008
Australia

T: +61 8 9382 3844

Sydney

Suite 802, Level 8
383 Kent Street
Sydney, NSW 2000
Australia

T: +61 2 9211 4333

Canberra

Unit 2, 11 Murray Crescent
Griffith, ACT 2603
Australia

T: +61 2 6260 8488

General conditions of use

This report may only be reproduced in full without modifications by the report sponsor. Copies, extracts or abridgements of this report in any form must not be made, distributed or published by other organisations or individuals without permission in writing from a Director of Warringtonfire Australia Pty Ltd.

All work and services carried out by Warringtonfire Australia Pty Ltd are subject to, and conducted in accordance with, our standard terms and conditions. These are available on request or at <https://www.element.com/terms/terms-and-conditions>.

Exova Warringtonfire rebranded to Warringtonfire on 1 December 2018. Apart from the change to our brand name, no other changes have occurred. The introduction of our new brand name does not affect the validity of any existing documents we have previously issued.

Executive summary

This report documents the findings of the fire resistance test of control joints undertaken on 24 April 2019 in accordance with section 2 and 10 of AS 1530.4:2014.

Warringtonfire Australia did the test at the request of H.B. Fuller Australia.

The test specimen comprised of six control joints in a nominal 1600mm wide × 1600mm high × 96mm/90mm thick plasterboard wall. The control joints were protected by H.B. Fuller Firecaulk FR sealant. A summary of the control joints is provided in Table 1.

Table 1 Test summary

Control joint	Service	Local fire-stopping protection	Aperture size (mm)	Sealant depth (mm)	Fire resistance level (FRL)
A	Control joint	H.B. Fuller Fulacaulk FR	16 × 1570	16	-/120/60
B	Control joint	H.B. Fuller Fulacaulk FR	15 × 1570	16	-/120/60
C	Control joint	H.B. Fuller Fulacaulk FR	20 × 1000	16	-/120/90
D	Control joint	H.B. Fuller Fulacaulk FR	15 × 1570	13	-/60/60
E	Control joint	H.B. Fuller Fulacaulk FR	20 × 584	13	NA
F	Control joint	H.B. Fuller Fulacaulk FR	13 × 1570	13	-/60/60

Note: Control joint E did not meet the minimum length requirements of the standard so no FRL can be assigned.

Contents

Amendment schedule	2
Executive summary	4
Contents	5
1. Introduction	6
2. Construction details	6
3. Schedule of components	9
4. Test procedure	12
5. Test measurements and results	13
6. Application of test results	14
6.1 Test limitations	14
6.2 Variations from the tested specimen	14
6.3 Uncertainty of measurements	14
Appendix A Drawings of test assembly	15
Appendix B Test observations	19
Appendix C Direct field of application	22
Appendix D Instrumentation locations	24
Appendix E Test data	27
Appendix F Photographs	34

1. Introduction

This report documents the findings of the fire resistance test of control joints undertaken on 24 April 2019 in accordance with section 2 and 10 of AS 1530.4:2014. Warringtonfire Australia did the test at the request of H.B. Fuller Australia.

Table 2 Test sponsor details

Test Sponsor	Address
H.B. Fuller Australia	16 - 22 Redgum drive Dandenong south 3175 VIC Australia

2. Construction details

Table 3 provides details of the test assembly. Table 4 provides a summary of the test specimen. A full description of the specimen is provided in Appendix A and section 3.

Table 5 shows the installation method and orientation of the test specimen.

Table 3 Test assembly

Item	Detail	
Separating element	Wall system	
Nominal separating element size	Width (w): Height (h): Thickness (t):	1600mm 1600mm 96mm & 90mm
Number of control joints	Six	
Restraint conditions	Restrained on all edges	

Table 4 Test specimen

Control joint	Service	Local fire-stopping protection	Aperture size (mm)	Sealant depth (mm)
A	Control joint	H.B. Fuller Fulacaulk FR	16 × 1570	16
B	Control joint	H.B. Fuller Fulacaulk FR	15 × 1570	16
C	Control joint	H.B. Fuller Fulacaulk FR	20 × 1000	16
D	Control joint	H.B. Fuller Fulacaulk FR	15 × 1570	13
E	Control joint	H.B. Fuller Fulacaulk FR	20 × 584	13
F	Control joint	H.B. Fuller Fulacaulk FR	13 × 1570	13

Table 5 Installation method and orientation

Item	Detail
Start date of separating element construction	14 March 2019
Start date of control joints installation	14 March 2019
Completion date of test specimen construction and installation	20 March 2019
Separating element constructed by	Representatives of Warringtonfire Melbourne.
Control joints installed by	The test sponsor.
Orientation	symmetrical, through the cross-section of the specimen

3. Schedule of components

Table 6 lists the schedule of components for the test specimen which were provided by the test sponsor and surveyed by Warringtonfire Australia.

Table 6 Schedule of components

Item	Description	
Separating element		
1.	Item name	Fire rated plasterboard
	Product name	USG Boral firestop
	Size	1600mm high × 1000mm wide × 16mm thick
	Density	831.3 kg/m ³ (measured)
	Installation	Plasterboard was installed on the west side 16mm in over steel framing (item 3) on exposed and unexposed sides. Item 7 used at nominal 300mm horizontal and vertical centres and 50mm in from the edges to secure the plasterboard.
2.	Item name	Fire rated plasterboard
	Product name	USG Boral firestop
	Size	1600mm high × 584mm wide × 13mm thick
	Density	923.1 kg/m ³ (measured)
	Installation	Plasterboard was installed on the east side 13mm in over steel framing (item 3) on exposed and unexposed sides. Item 7 used at nominal 300mm horizontal and vertical centres and 50mm in from the edges to secure the plasterboard.
Framing		
3.	Item name	Steel frame
	Product name	Rondo 64mm × 0.50BMT
	Installation	The steel frame comprises of eight studs and a top and bottom track. Item 6 used to secure the steel frame. The studs are placed next to each other in varying distance to create a control joint(s). Item 8 used to secure the steel frame at nominal 400mm centre on all four sides to the test frame. See Figure 1 and Figure 2 in Appendix A for more details
Fire-stopping protections		
Sealant		
4.	Item name	Fire rated sealant
	Product name	H.B. Fuller Fulacaulk FR
	Density	1606 kg/m ³ (measured)
	Installation	The sealant was installed in the control joints as detailed in various control joint descriptions below
Backing Rod		
5.	Item name	Open cell backing rod
	Material	Polyethylene
	Size	20mm high × 20mm wide × 1570mm long

Item	Description	
	Installation	The backing rod of varying size were installed at all control joints as detailed in various service descriptions below
Fixings		
6.	Item name	8g ×12mm button head needle point screws
7.	Item name	6g × 32mm long needle point laminated plasterboard screws
8.	Item name	M6 Dynabolt × 40mm long
Control joint A		
A	Service size	16mm wide × nominally 1570mm long; 16mm deep.
	Main fire-stopping protection	
	Protection details	Backing rod (item 5) was installed into the control joint at a depth of 16mm from both exposed and unexposed faces of the wall. The sealant (item 4) was applied into the control joint to the depth of backing rod and finished flush with both the exposed & unexposed faces of wall. See Figure 1 to Figure 6 in Appendix A for more details.
Control joint B		
B	Service size	15mm wide × nominally 1570mm long; 16mm deep.
	Main fire-stopping protection	
	Protection details	Backing rod (item 5) was installed into the control joint at a depth of 16mm from both exposed and unexposed faces of the wall. The sealant (item 4) was applied into the control joint to the depth of backing rod and finished flush with both the exposed & unexposed faces of wall. See Figure 1 to Figure 6 in Appendix A for more details.
Control joint C		
C	Service size	20mm wide × nominally 1000mm long; 16mm deep.
	Main fire-stopping protection	
	Protection details	Backing rod (item 5) was installed into the control joint at a depth of 16mm from both exposed and unexposed faces of the wall. The sealant (item 4) was applied into the control joint to the depth of backing rod and finished flush with both the exposed & unexposed faces of wall. See Figure 1 to Figure 6 in Appendix A for more details.
Control joint D		
D	Service size	15mm wide × nominally 1570mm long; 13mm deep.
	Main fire-stopping protection	
	Protection details	Backing rod (item 5) was installed into the control joint at a depth of 13mm from both exposed and unexposed faces of the wall. The sealant (item 4) was applied into the control joint to the depth of backing rod and finished flush with both the exposed & unexposed faces of wall. See Figure 1 to Figure 6 in Appendix A for more details.
Control joint E		
E	Service size	20mm wide × nominally 584mm long; 13mm deep.
	Main fire-stopping protection	
	Protection details	Backing rod (item 5) was installed into the control joint at a depth of 13mm from both exposed and unexposed faces of the wall. The sealant (item 4) was applied into the control joint to the depth of backing rod and finished flush with both the exposed & unexposed faces of wall. See Figure 1 to Figure 6 in Appendix A for more details.

Item		Description
Control joint F		
F	Service size	13mm wide × nominally 1570mm long; 13mm deep.
	Main fire-stopping protection	
	Protection details	Backing rod (item 5) was installed into the control joint at a depth of 13mm from both exposed and unexposed faces of the wall. The sealant (item 4) was applied into the control joint to the depth of backing rod and finished flush with both the exposed & unexposed faces of wall. See Figure 1 to Figure 6 in Appendix A for more details.

4. Test procedure

Table 7 details the test procedure for this fire resistance test.

Table 7 Test procedure

Item	Detail	
Statement of compliance	The test was performed in accordance with the requirements of section 2 and 10 of AS 1530.4:2014 appropriate for service penetrations and control joints.	
Variations	Control joint E was only 584mm long and thus did not meet the minimum length requirements of section 10 and as such, no FRL could be assigned.	
Pre-test conditioning	The construction and installation of the test specimen was completed on 20 March 2019. The test specimen was subjected to normal laboratory temperatures and conditions between the completion of construction of the test specimen and the start of the test.	
Sampling / specimen selection	The laboratory was not involved in sampling or selecting the test specimen for the fire resistance test.	
Ambient laboratory temperature	Start of the test	19°C
	Minimum temperature	19°C
	Maximum temperature	23°C
Test duration	121 minutes	
Instrumentation and equipment	The instrumentation was provided in accordance with AS 1530.4:2014 as follow: - The furnace temperature was measured by four mineral insulated metal sheathed Type K thermocouples – with wire diameters not greater than 1mm, an overall diameter of 3mm, and the measuring junction insulated from the sheath. The thermocouples protruded a minimum of 25mm from steel supporting tubes. - The non-fire side specimen temperatures were measured by Type K thermocouples with wire diameters less than 0.5mm soldered to 12mm diameter × 0.2mm thick copper discs covered by 30mm × 30mm × 2.0mm inorganic insulating pads. The thermocouple positions are shown in Table 10 and Figure 7 in Appendix D. - A roving thermocouple was available to measure temperatures at positions that appeared hotter than the positions monitored by the fixed thermocouples. - The furnace pressure was measured at 30mm above mid-height of the control joint. - Cotton pads were available during the test to assess the performance of the specimen under the criteria for integrity.	

5. Test measurements and results

The measurements taken for the pressure and temperature of the furnace and test specimen are included in Appendix E. Table 9 in Appendix B includes observations of any significant behaviour of the specimen and details of the occurrence of the various performance criteria specified in AS 1530.4:2014. Photographs of the specimen are included in Appendix F.

Table 8 summarises the results the specimen achieved against the performance criteria listed in sections 2 and 10 of AS 1530.4:2014.

Table 8 Test results

Penetration system/ control joint	Criteria	Results	Fire resistance level (FRL)
A	Integrity	No failure at 121 minutes	-/120/60
	Insulation	Failure at 87 minutes	
B	Integrity	No failure at 121 minutes	-/120/60
	Insulation	Failure at 79 minutes	
C	Integrity	Failure at 121 minutes	-/120/90
	Insulation	Failure at 92 minutes	
D	Integrity	No failure at 73 minutes	-/60/60
	Insulation	Failure at 62 minutes	
E	Integrity	No failure at 73 minutes	NA
	Insulation	No failure at 73 minutes	
F	Integrity	No failure at 73 minutes	-/60/60
	Insulation	No failure at 65 minutes	

Note: Control joint E did not meet the minimum length requirements of the standard so no FRL can be assigned.

6. Application of test results

6.1 Test limitations

The results of these fire tests may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.

These results only relate to the behaviour of the specimen of the element of the construction under the particular conditions of the test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, and they do not necessarily reflect the actual behaviour in fires.

6.2 Variations from the tested specimen

This report details methods of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in AS 1530.4:2014. Any significant variation with respect to size, construction details, loads, stresses, edge or end conditions, other than that allowed under the field of direct application in the relevant test method, is not covered by this report.

It is recommended that any proposed variation to the tested configuration – other than as permitted under the field of direct application specified in Appendix C – should be referred to the test sponsor. They should then obtain appropriate documentary evidence of compliance from Warringtonfire Australia Pty Ltd or another registered testing authority.

6.3 Uncertainty of measurements

It is not possible to provide a stated degree of accuracy for the results, because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance.

Appendix A Drawings of test assembly

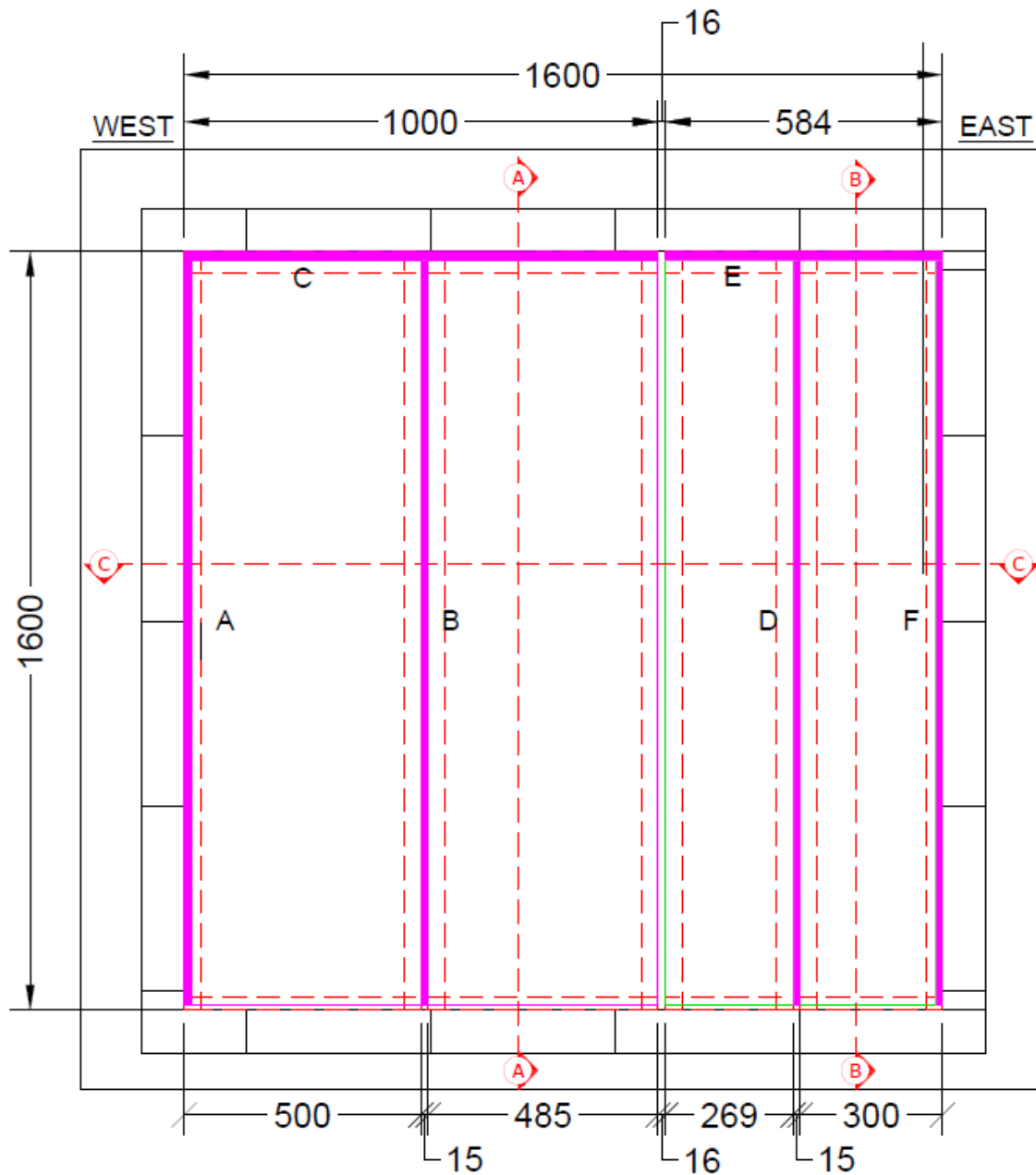


Figure 1 Elevation view of test specimen (unexposed side)

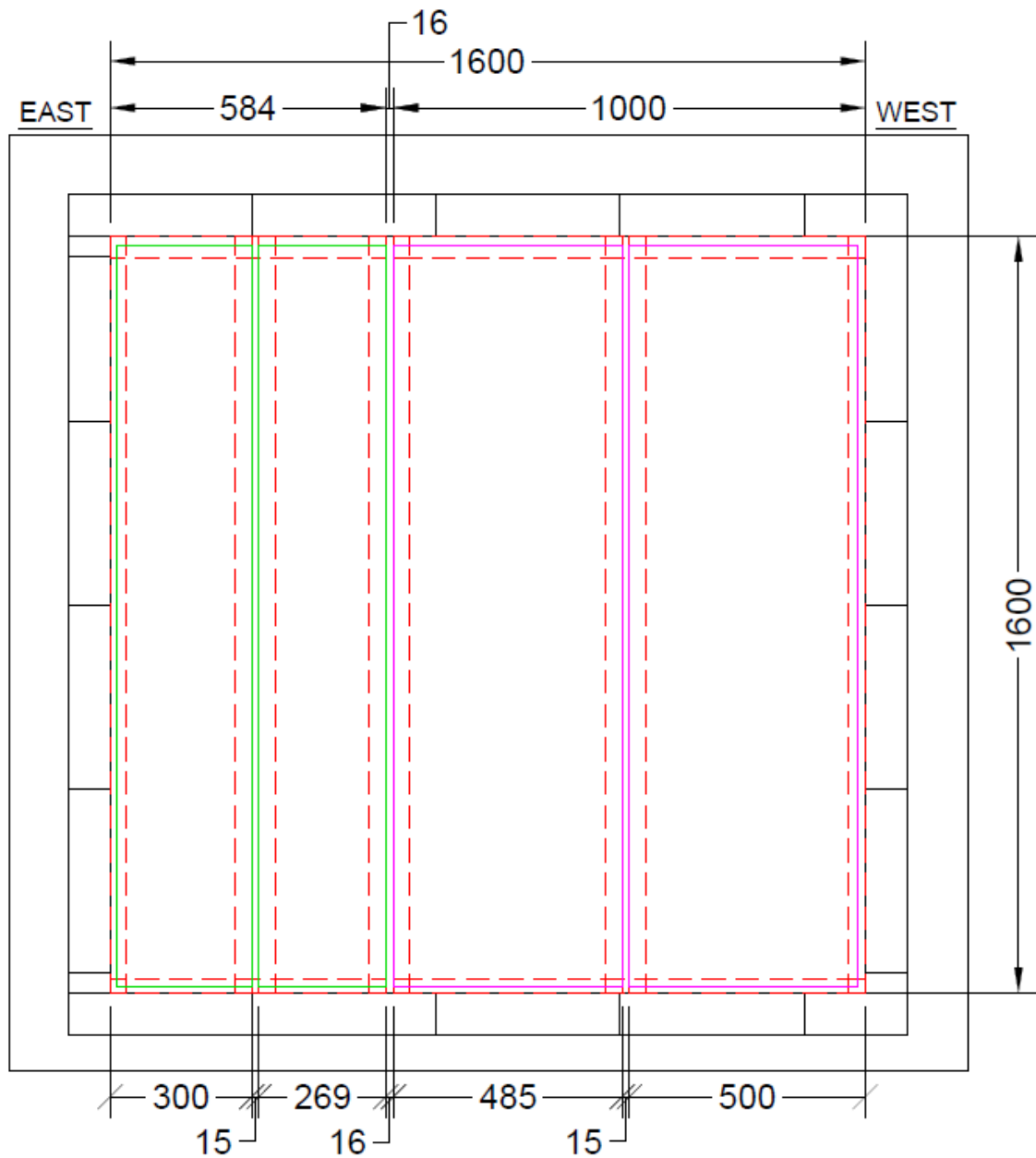


Figure 2 Elevation view of test specimen (exposed side)

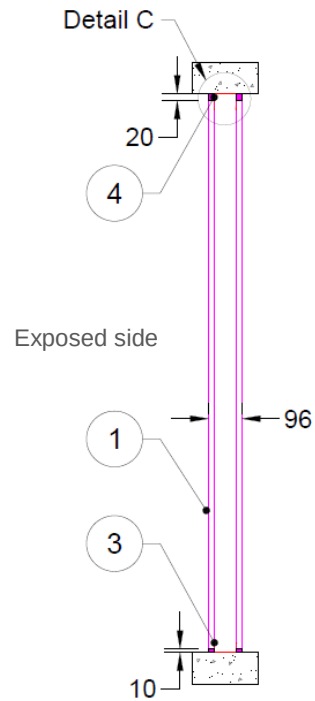


Figure 3 Cross-section A-A

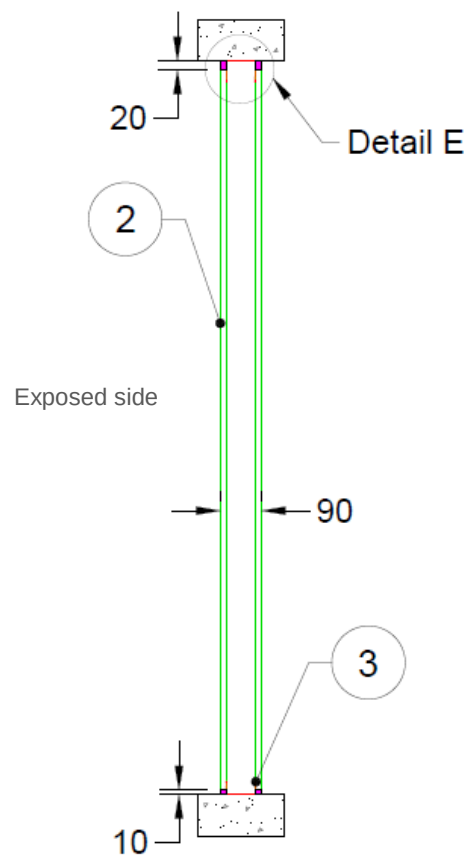


Figure 4 Cross-section B-B

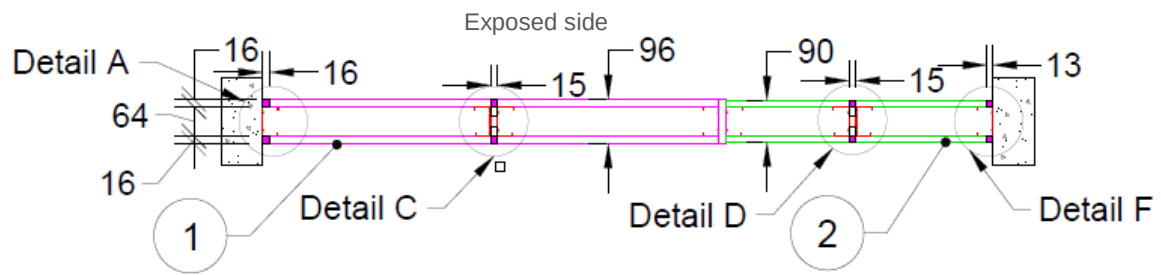


Figure 5 Cross-section C-C

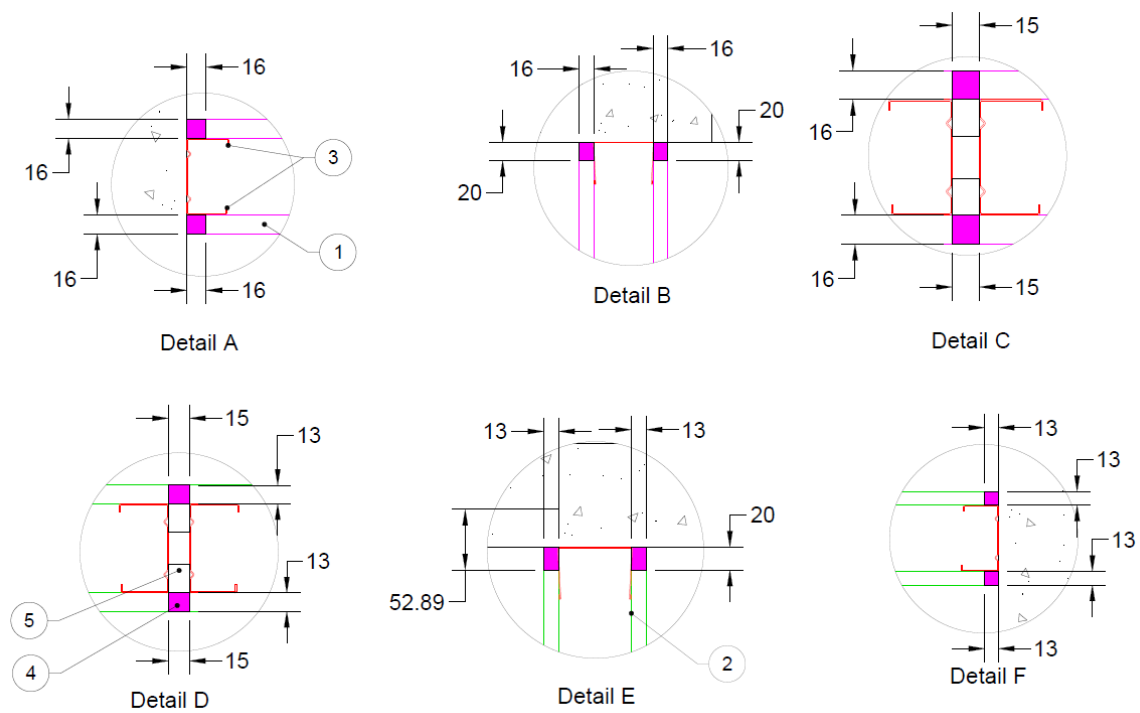


Figure 6 Detail view

Appendix B Test observations

Table 9 shows observations of any significant behaviour of the specimen during the test.

Table 9 Test observations

Time		Observation
Min	Sec	
Control joint A		
00	00	Test started
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
33	40	Top side of the joint slightly bulging.
42	57	Bottom edged of the plasterboard was started discolouring.
43	50	Bottom edged of the plasterboard was discoloured
52	40	Plasterboard fixing are discoloured
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
79	46	Control joint top side continued to bulge
87	00	TC 017, on the plasterboard, 250mm above the control joint mid-height, recorded a temperature of 199°C. Failure of insulation in accordance with AS 1530.4:2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 017 exceeded the initial temperature by more than 180K.
90	00	Specimen continued to maintain integrity in accordance with AS 1530.4:2014
88	21	Plasterboard colour changed to light yellow
120	00	Specimen continued to maintain integrity in accordance with AS 1530.4:2014
121	00	Fire resistance test terminated
Control joint B		
00	00	Test started
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
42	57	Bottom edged of the plasterboard was started discolouring.
43	50	Bottom edged of the plasterboard was discoloured
52	40	Plasterboard fixing are discoloured
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
79	00	TC 022, on the control joint mid-height, recorded a temperature of 199°C. Failure of insulation in accordance with AS 1530.4:2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 022 exceeded the initial temperature by more than 180K.
90	00	Specimen continued to maintain integrity in accordance with AS 1530.4:2014
88	21	Plasterboard colour changed to light yellow
120	00	Specimen continued to maintain integrity in accordance with AS 1530.4:2014
121	00	Fire resistance test terminated
Control joint C		
00	00	Test started

Time		Observation
Min	Sec	
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
35	28	Sealant on the east side bulging slightly.
42	57	Bottom edged of the plasterboard was started discolouring
43	50	Bottom edged of the plasterboard was discoloured
52	40	Plasterboard fixing are discoloured
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
88	21	Plasterboard colour changed to light yellow
90	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
92	00	TC 034, on the plasterboard, 250mm west from the control joint mid-width recorded a temperature of 200°C. Failure of insulation in accordance with AS 1530.4:2014 clause 2.13.3(b), where the maximum temperature of Thermocouple TC 022 exceeded the initial temperature by more than 180K.
120	00	Specimen continued to maintain integrity in accordance with AS 1530.4:2014
121	00	Fire resistance test terminated
Control joint D		
00	00	Test started
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
40	00	Sealant bubbling and plasterboard bowing towards the furnace
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
71	00	Thermocouples removed.
73	00	Service covered with ceramic wool.
121	00	Fire resistance test terminated
Control joint E		
00	00	Test started
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
40	00	Plasterboard bowing towards the furnace
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
71	00	Thermocouples removed.
73	00	Service covered with ceramic wool.
121	00	Fire resistance test terminated
Control joint F		
00	00	Test started
30	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
40	00	Plasterboard bowing towards the furnace
60	00	Specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014
71	00	Thermocouples removed.

Time		Observation
Min	Sec	
73	00	Service covered with ceramic wool.
121	00	Fire resistance test terminated

Appendix C Direct field of application

The text, figures and tables in this appendix have been taken from section 10 of AS 1530.4:2014.

C.1 General

The results of the fire test contained in the test report are directly applicable without reference to the testing authority to similar constructions where one or more of the changes set out in clauses 10.12.2 to 10.12.6 of AS 1530.4:2014 have been made.

C.2 Separating elements

Results obtained for sealing systems in various types of masonry and concrete construction may be applied as follows:

- for elements manufactured from similar types of concrete or masonry, the results of the prototype test may be applied to materials of density within $\pm 15\%$ of the tested specimen. For greater variations, the opinion of a registered testing authority shall be obtained.
- test results obtained in conjunction with hollow concrete blocks may be used in a solid concrete element of the same overall thickness. The reverse does not apply.
- results obtained from framed wall systems may be applied to the performance of a system in concrete, masonry or solid gypsum blocks of greater or equal thickness to that of the tested prototype. The reverse does not apply.
- results obtained from framed wall systems may be applied to similar walls having studs of the same material with sizes greater than the tested prototype.
- results obtained from a prototype test may be applied to framed wall systems of similar construction but having thicker facings of the same material applied to the studs.

C.3 Control joints

The following variations are permitted:

- Results obtained from single test on a butt joints may be applied to contoured joints, provided the joints have —
 - equal width and equal or greater depth of sealant; and
 - equal or greater thickness of fire-separating element.

Note: Examples of butt and contoured control joints are shown in Figure 10.12.6 of AS 1530.4:2014.
- Facings may be applied to the surface of the fire-stopping system.

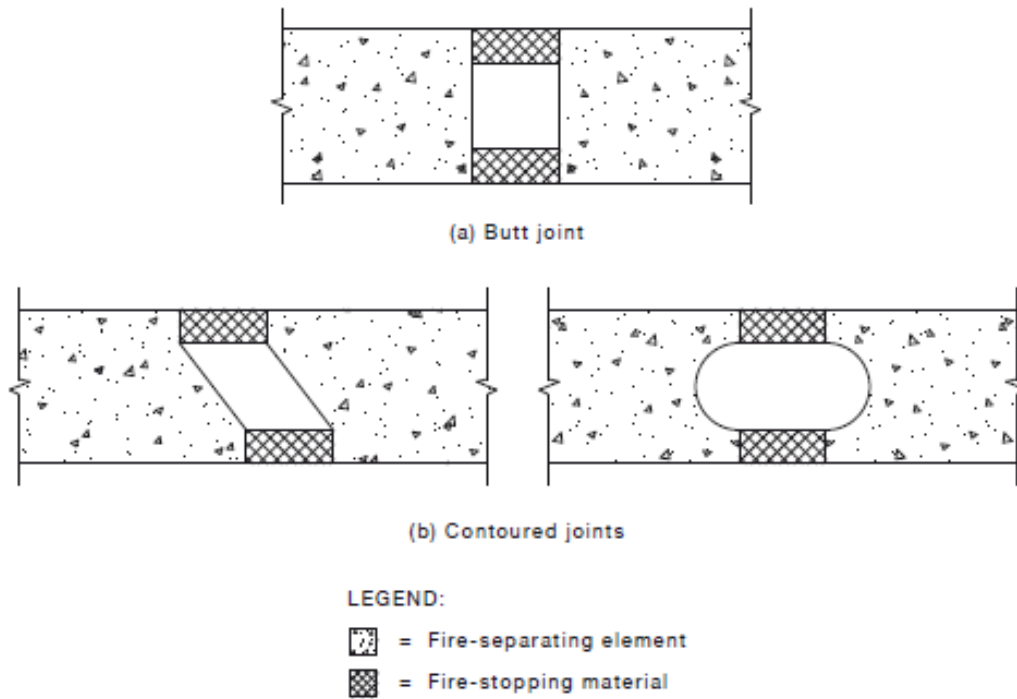


FIGURE 10.12.6 CONTOURED CONTROL JOINTS

Appendix D Instrumentation locations

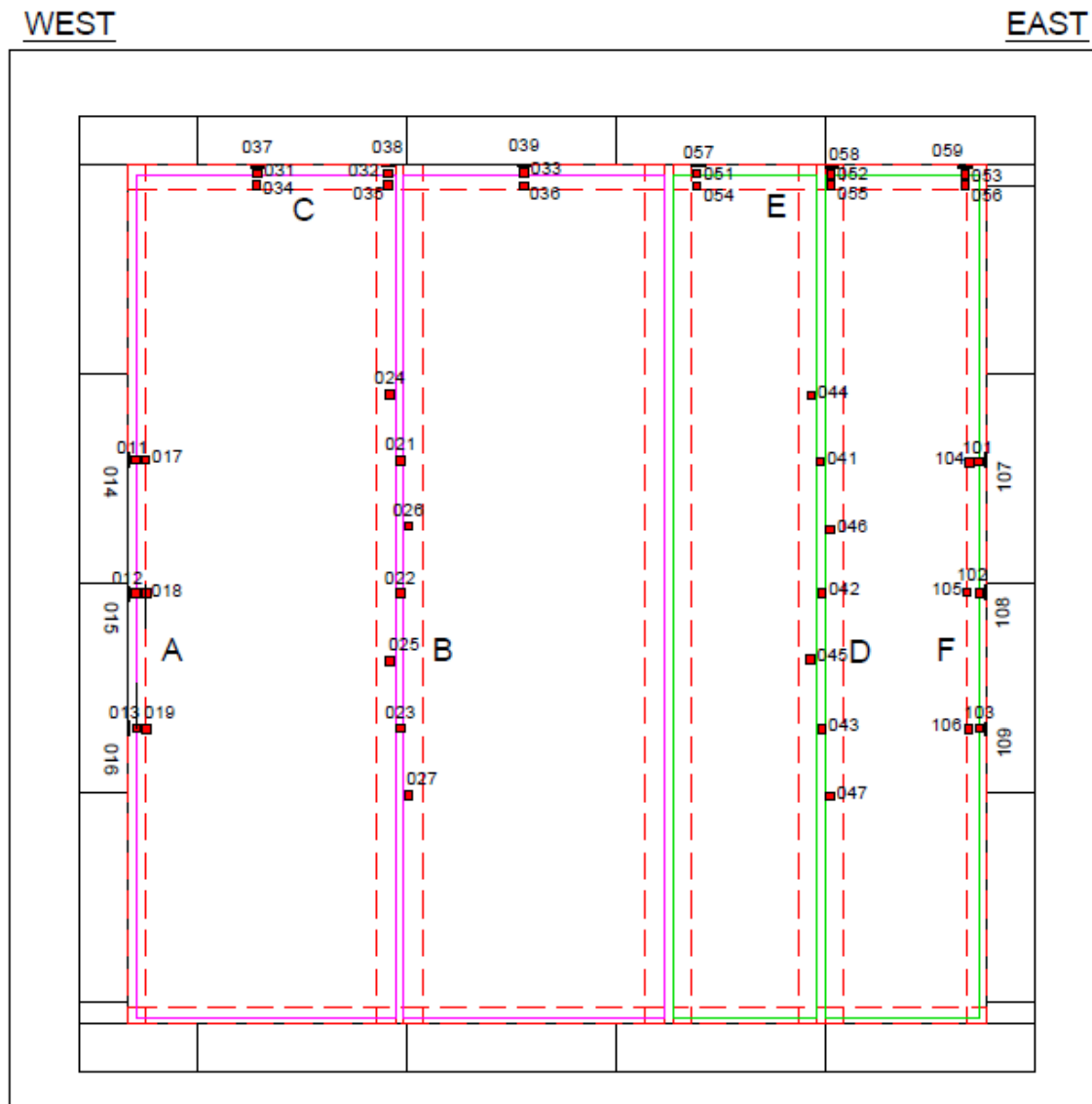


Figure 7 Control joint system

Table 10 Thermocouple locations

Control joint	T/C no.	Description
A	011	On control joint, 250mm above from the mid-height
	012	On control joint, at the mid-height
	013	On control joint, 250mm below from the mid-height
	014	25mm from control joint, 250mm above from the mid-height on the concert block
	015	25mm from control joint, on the mid-height
	016	25mm from control joint, 250mm below from the mid-height on the concert block
	017	25mm from control joint, 250mm above from the mid-height on the plasterboard
	018	25mm from control joint, on the mid-height on the plasterboard
	019	25mm from control joint, 250mm below from the mid-height on the plasterboard
B	021	On control joint, 250mm above from the mid-height
	022	On control joint, at the mid-height
	023	On control joint, 250mm below from the mid-height
	024	25mm from control joint, 375mm above from the mid-height on the plasterboard
	025	25mm from control joint, 125mm below from the mid-height on the plasterboard
	026	25mm from control joint, 125mm above from the mid-height on the plasterboard
	027	25mm from control joint, 375mm below from the mid-height on the plasterboard
C	031	On control joint, 250mm west from the mid-width
	032	On control joint, at the mid-width
	033	On control joint, 250mm east from the mid-width
	034	25mm from control joint, 250mm west from the mid-width on the plasterboard
	035	25mm from control joint, on the mid-width
	036	25mm from control joint, 250mm east from the mid-width on the plasterboard
	037	25mm from control joint, 250mm west from the mid-width on the concert block
	038	25mm from control joint, on the mid-height
	039	25mm from control joint, 250mm east from the mid-width on the concert block
D	041	On control joint, 250mm above from the mid-height
	042	On control joint, at the mid-height
	043	On control joint, 250mm below from the mid-height
	044	25mm from control joint, 375mm above from the mid-height on the plasterboard
	045	25mm from control joint, 125mm below from the mid-height on the plasterboard
	046	25mm from control joint, 125mm above from the mid-height on the plasterboard
	047	25mm from control joint, 375mm below from the mid-height on the plasterboard
E	051	On control joint, 250mm west from the mid-width
	052	On control joint, at the mid-width
	053	On control joint, 250mm east from the mid-width
	054	25mm from control joint, 250mm west from the mid-width on the plasterboard
	055	25mm from control joint, on the mid-width
	056	25mm from control joint, 250mm east from the mid-width on the plasterboard
	057	25mm from control joint, 250mm west from the mid-width on the concert block

Control joint	T/C no.	Description
	058	25mm from control joint, on the mid-height
	059	25mm from control joint, 250mm east from the mid-width on the concert block
F	101	On control joint, 250mm above from the mid-height
	102	On control joint, at the mid-height
	103	On control joint, 250mm below from the mid-height
	104	25mm from control joint, 250mm above from the mid-height on the plasterboard
	105	25mm from control joint, on the mid-height
	106	25mm from control joint, 250mm below from the mid-height on the plasterboard
	107	25mm from control joint, 250mm above from the mid-height on the concert block
	108	25mm from control joint, on the mid-height
	109	25mm from control joint, 250mm below from the mid-height on the concert block
Internal TC	111	Inner face of exposed 16mm PB between control joints A and B, 1200mm above the sill
	112	Inner face of unexposed 16mm PB between control joints A and B, 1200mm above the sill
	113	Inner face of unexposed 16mm PB between control joint B and the blanking separator, 1200mm above the sill
	114	Inner face of exposed 13mm PB between control joint D and the blanking separator, 1200mm above the sill
	115	Inner face of unexposed 13mm PB between control joint D and the blanking separator, 1200mm above the sill
	116	Inner face of unexposed 13mm PB between control joints D and F, 1200mm above the sill

Appendix E Test data

E.1 Furnace temperature

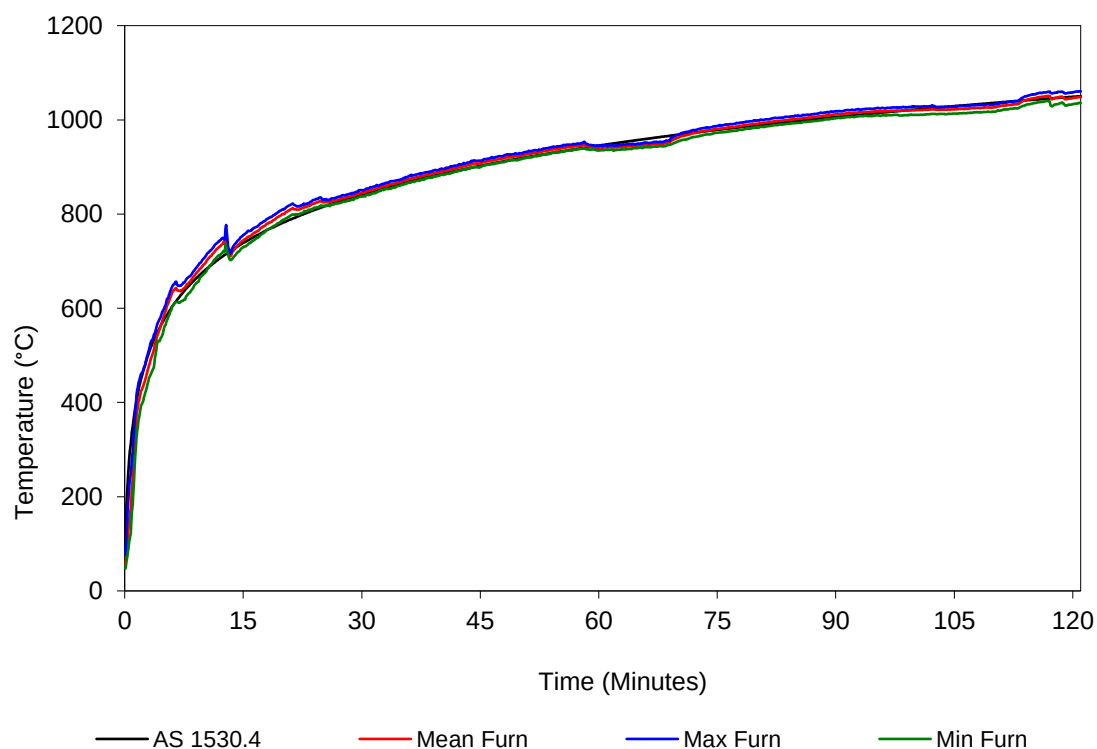


Figure 8 Furnace thermocouple temperature vs time

E.2 Furnace pressure

The furnace pressure was measured at the mid-height of the vertical control joints.

Table 11 Furnace pressure

Time (minutes)	Pressure (Pa) average	Time (minutes)	Pressure (Pa) average	Time (minutes)	Pressure (Pa) average
5-10	16	45-50	15	85-90	16
10-15	18	50-55	16	90-95	15
15-20	16	55-60	16	95-100	15
20-25	15	60-65	16	100-105	16
25-30	16	65-70	16	105-110	16
30-35	17	70-75	15	110-115	16
35-40	15	75-80	14	115-120	15
40-45	14	80-85	15		

E.3 Specimen temperatures

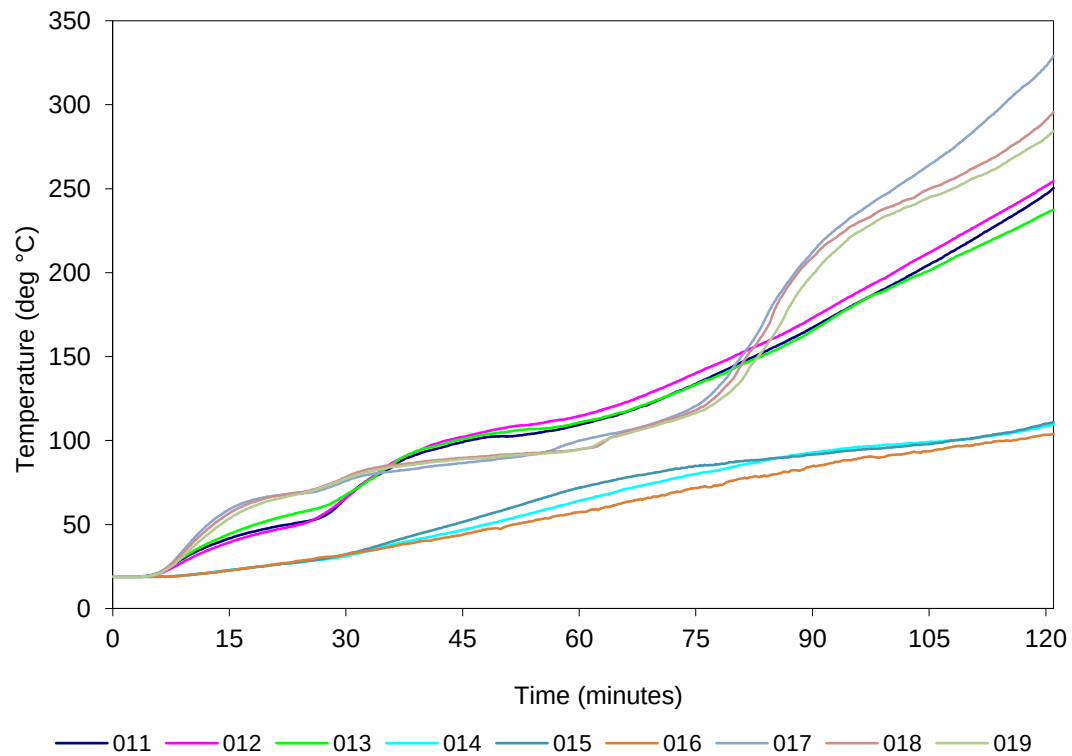


Figure 9 Control joint A – temperature vs time

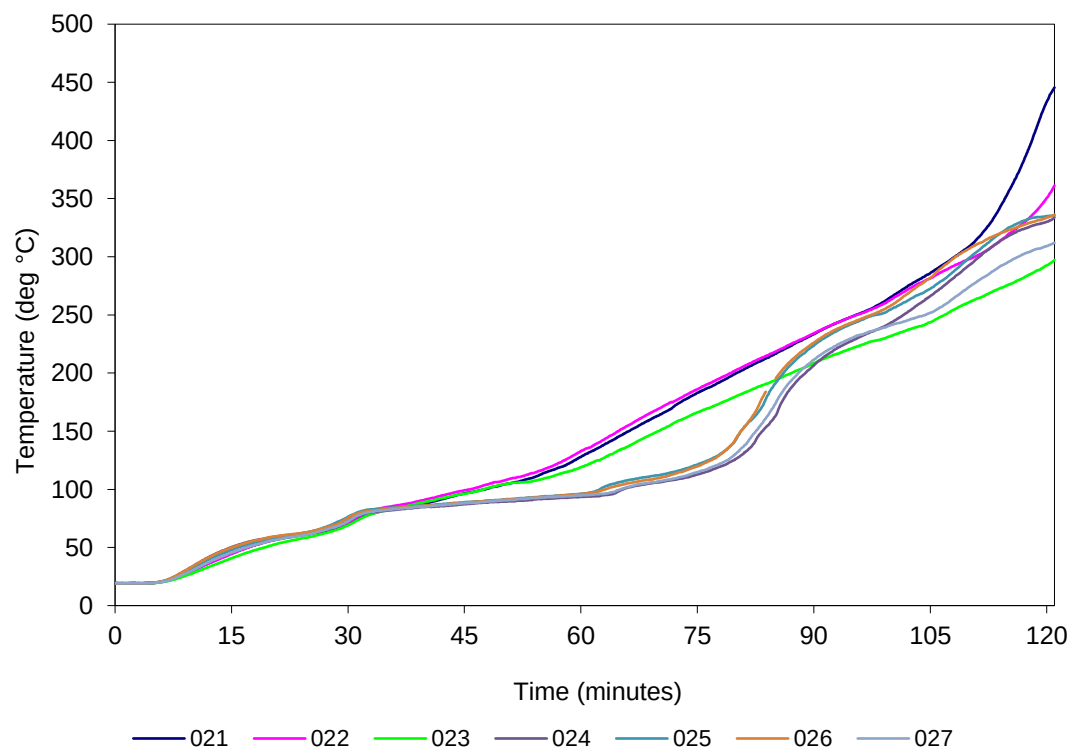


Figure 10 Control joint B – temperature vs time

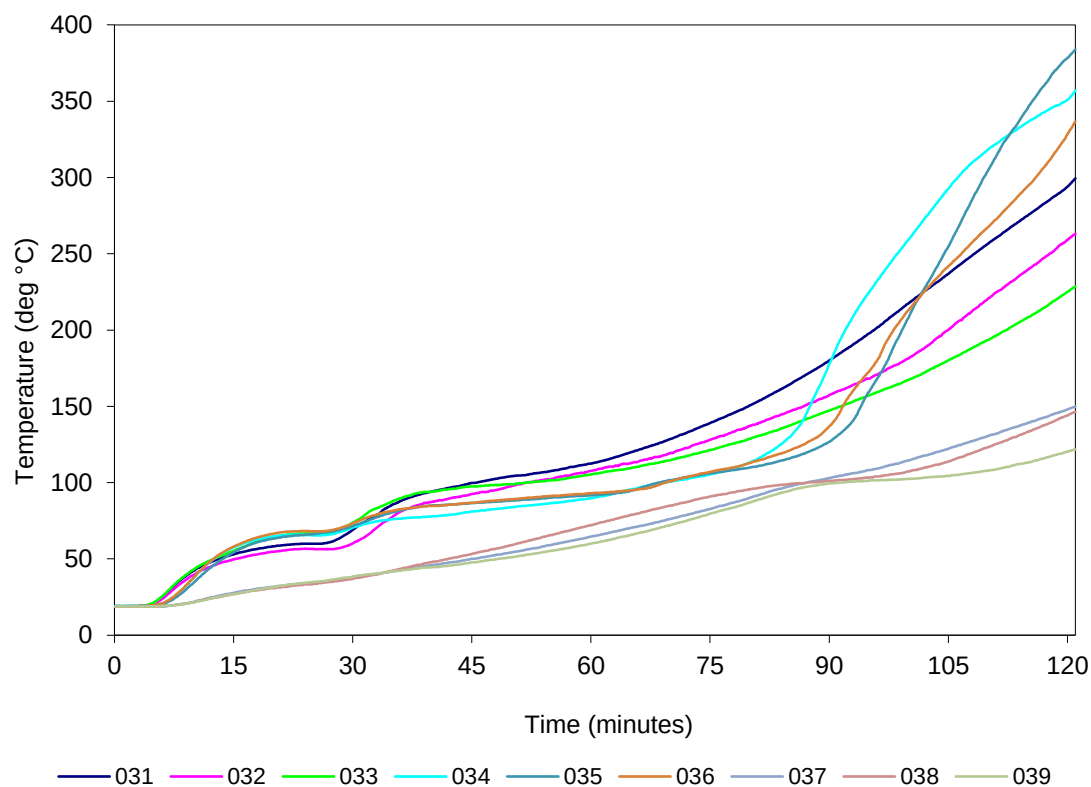


Figure 11 Control joint C – temperature vs time

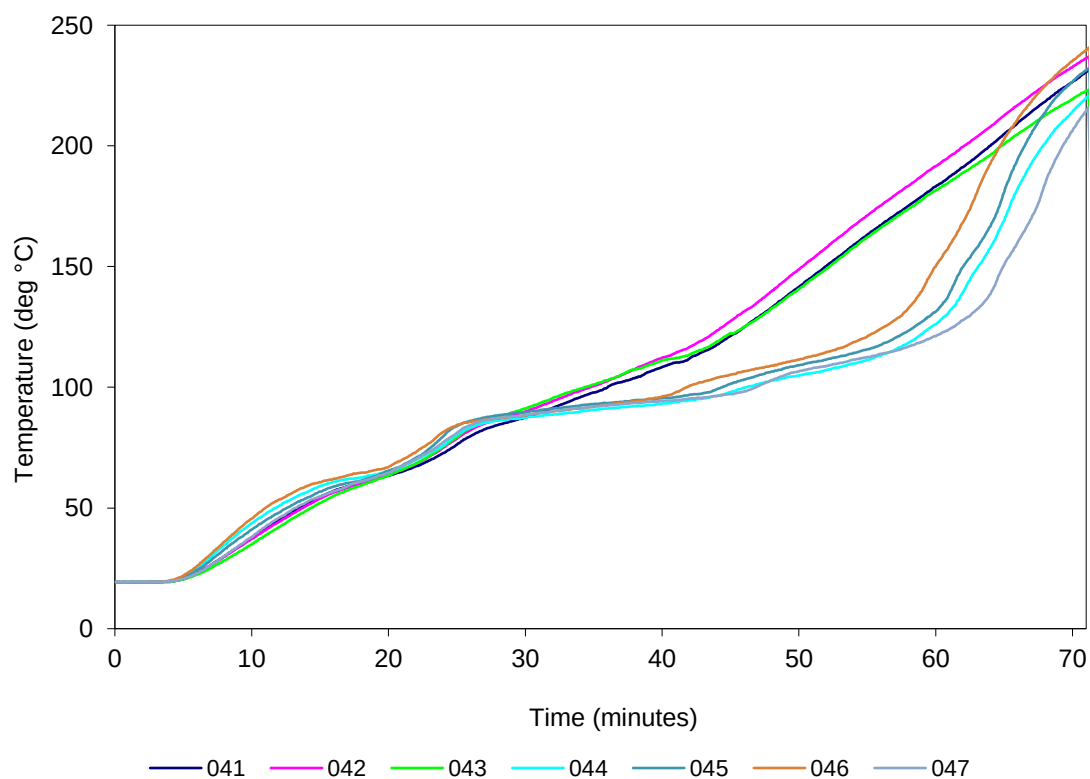


Figure 12 Control joint D – temperature vs time

Note – thermocouples were removed at 71 minutes

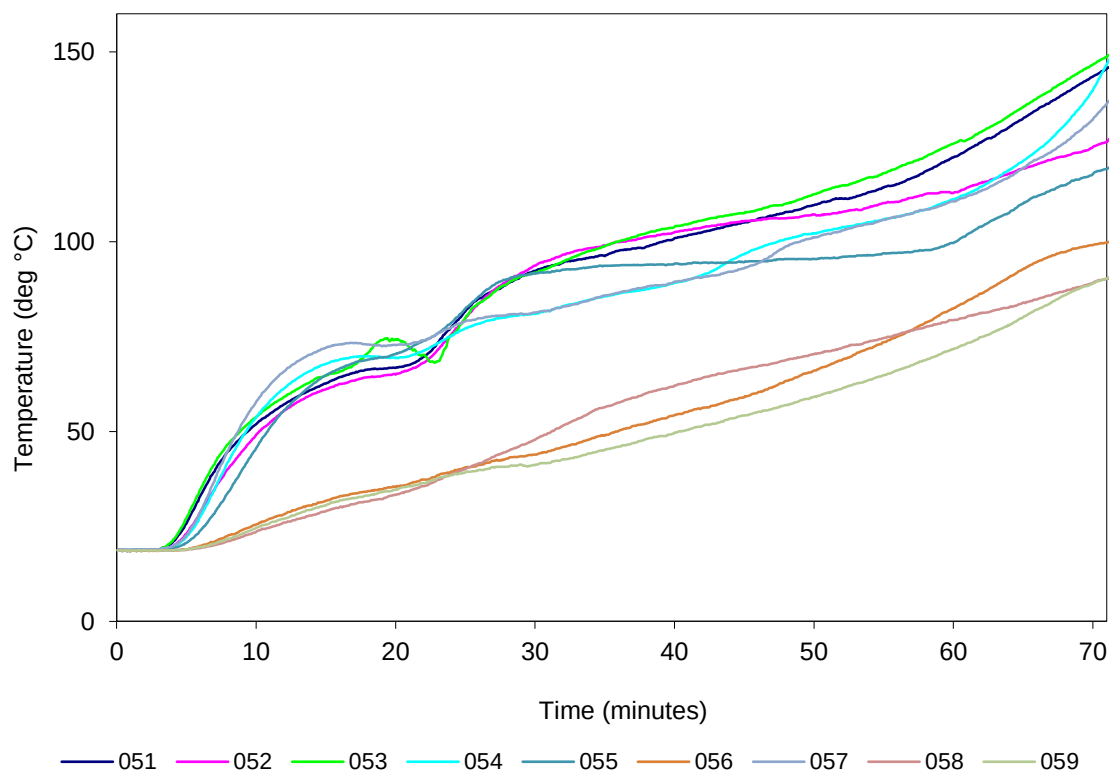


Figure 13 Control joint E – temperature vs time

Note – thermocouples were removed at 71 minutes

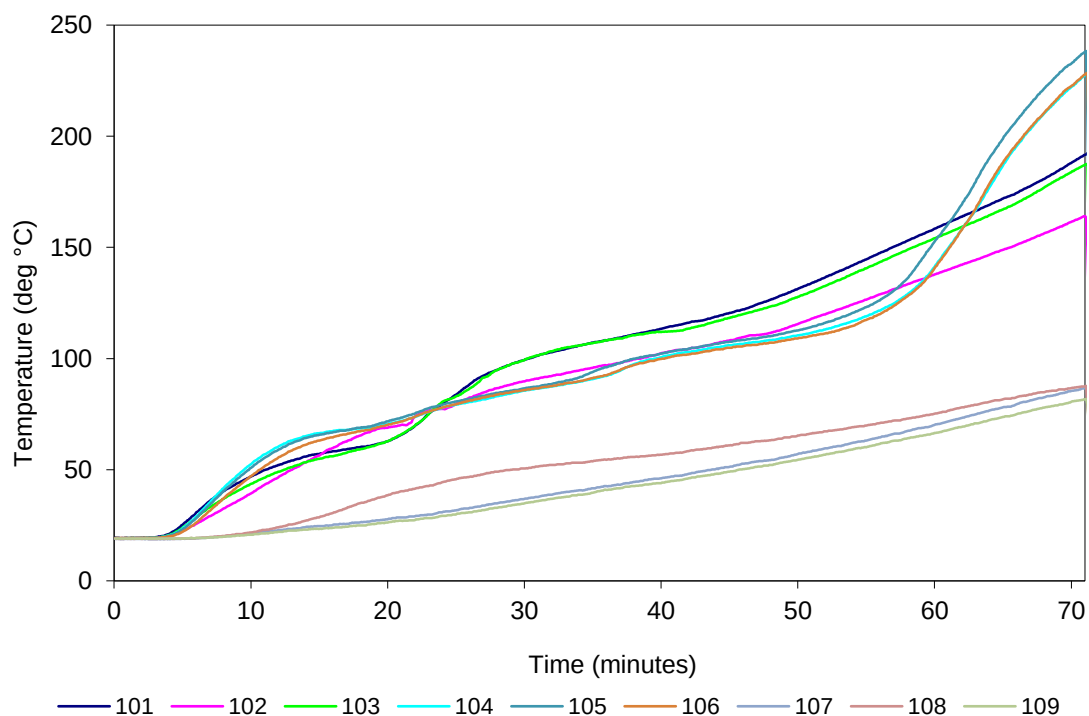


Figure 14 Control joint F – temperature vs time

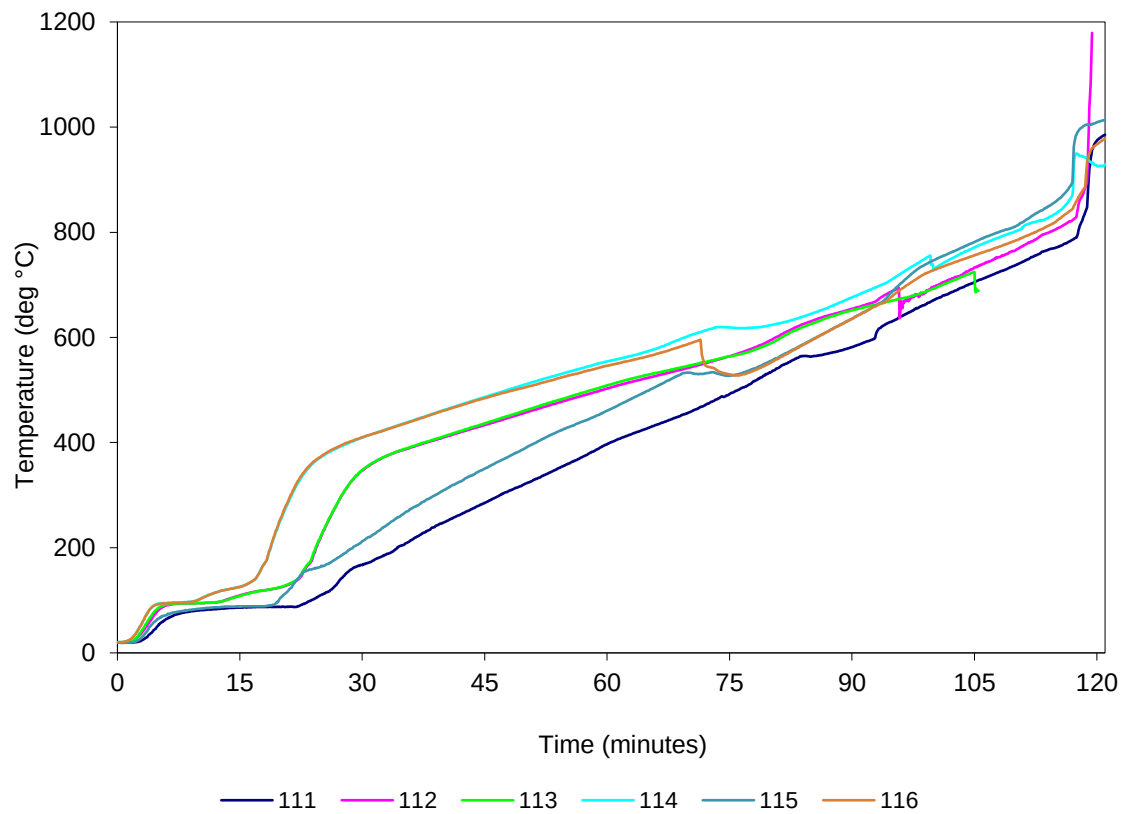


Figure 15 Internal thermocouples – temperature vs time

Note – Thermocouple 113 failed at 105 minutes and 112 failed at 119 minutes.

Table 12 Test specimen temperatures

Control joint	T/C no.	Description ²	Temp (°C) at t (minutes)					Limit ¹ (minutes)
			t=0	t=30	t=60	t=90	t=120	
A	011	On control joint	19	67	110	166	246	103
	012	On control joint	19	66	115	172	251	103
	013	On control joint	19	68	111	164	235	104
	014	25mm from the control joint	19	31	64	93	108	-
	015	25mm from the control joint	19	32	72	91	110	-
	016	25mm from the control joint	19	32	57	84	103	-
	017	25mm from the control joint	19	76	100	210	323	87
	018	25mm from the control joint	19	79	95	207	290	88
	019	25mm from the control joint	19	77	95	197	280	90
B	021	On control joint	19	71	128	232	432	80
	022	On control joint	19	72	133	233	350	79
	023	On control joint	19	70	119	207	292	87
	024	25mm from the control joint	19	74	94	204	330	89
	025	25mm from the control joint	19	77	96	222	335	86
	026	25mm from the control joint	19	76	96	224	333	86
	027	25mm from the control joint	19	73	95	209	309	88
C	031	On control joint	19	70	113	179	294	95
	032	On control joint	19	61	108	156	259	105
	033	On control joint	19	74	105	146	225	112
	034	25mm from the control joint	19	71	90	172	351	92
	035	25mm from the control joint	19	72	92	126	378	99
	036	25mm from the control joint	19	74	93	135	328	98
	037	25mm from the control joint	19	38	65	103	148	-
	038	25mm from the control joint	19	37	72	101	144	-
	039	25mm from the control joint	19	39	60	99	120	-
D	041	On control joint	19	88	184	#	#	64
	042	On control joint	19	90	192	#	#	62
	043	On control joint	19	92	182	#	#	65
	044	25mm from the control joint	19	88	127	#	#	68
	045	25mm from the control joint	19	90	132	#	#	66
	046	25mm from the control joint	19	89	151	#	#	65
	047	25mm from the control joint	20	89	122	#	#	69
E	051	On control joint	19	93	122	#	#	-
	052	On control joint	19	94	113	#	#	-
	053	On control joint	19	92	126	#	#	-
	054	25mm from the control joint	19	81	111	#	#	-
	055	25mm from the control joint	19	92	100	#	#	-
	056	25mm from the control joint	19	44	83	#	#	-

Control joint	T/C no.	Description ²	Temp (°C) at t (minutes)					Limit ¹ (minutes)
			t=0	t=30	t=60	t=90	t=120	
F	057	25mm from the control joint	19	81	111	#	#	-
	058	25mm from the control joint	19	48	79	#	#	-
	059	25mm from the control joint	19	41	72	#	#	-
	101	On control joint	19	100	159	#	#	-
	102	On control joint	19	90	138	#	#	-
	103	On control joint	19	100	154	#	#	-
	104	25mm from the control joint	19	86	142	#	#	67
	105	25mm from the control joint	19	87	153	#	#	65
	106	25mm from the control joint	19	86	141	#	#	66
Internal TCs	107	25mm from the control joint	19	37	70	#	#	-
	108	25mm from the control joint	19	51	75	#	#	-
	109	25mm from the control joint	19	35	67	#	#	-
	111	Inner face of exposed 16mm PB	19	169	398	580	972	NA
	112	Inner face of unexposed 16mm PB	20	349	503	653	#	NA
	113	Inner face of unexposed 16mm PB	20	350	509	650	#	NA
	114	Inner face of exposed 13mm PB	20	410	555	673	928	NA
	115	Inner face of unexposed 13mm PB	19	214	461	633	1009	NA
	116	Inner face of unexposed 13mm PB	20	411	547	632	966	NA

- Notes
- ¹ Limit time is the time to the nearest whole minute, rounded down to the nearest minute, at which the temperature recorded by the thermocouple does not rise by more than 180K above the initial temperature.
 - ² Refer to Appendix D for locations of thermocouples as only a generic description is included in the table.
 - ³ No insulation failure before thermocouple failure.
 - # Thermocouple failure.
 - * Integrity failure of the control joint.
 - Under limit column indicates the temperature limit was not exceeded during the test period or up until the time of integrity failure if a failure occurred.

Appendix F Photographs

West



East

Figure 16 Unexposed face of specimen before the start of test

East



West

Figure 17 Exposed face of the specimen before the start of test



Figure 18 Unexposed face of specimen at the end of test



Figure 19 Exposed face of the specimen at the end of test