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CONFIDENTIAL REPORT

FIRE RESISTANCE TEST IN ACCORDANCE WITH AS1530.4-1997, SECTIONS 2, 4 AND 10 AND AS4072.1-1992 AS APPROPRIATE ON FIRESOUND GREY TRIAL ACRYLIC SEALANT PROTECTING FOUR (4-OFF) JOINTS IN A CONCRETE FLOOR SLAB

Report for

HB Fuller Australia Company Pty Ltd,
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* For and on behalf of Warrington Fire Research Group.

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FIRE RESISTANCE TEST IN ACCORDANCE WITH AS1530.4-1997, SECTIONS 2, 4 AND 10 AND AS4072.1-1992 AS APPROPRIATE ON FIRESOUND GREY TRIAL ACRYLIC SEALANT PROTECTING FOUR (4-OFF) JOINTS IN A CONCRETE FLOOR SLAB

Report Sponsor	HB Fuller Australia Company Pty Ltd, 16-20 Red Gum Drive, Dandenong South, VIC 3175.

Test Laboratory	Warrington Fire Research (Aust) Pty Ltd, Unit 2, 409-411 Hammond Road, Dandenong South, Victoria, 3175.

Test Date	21st August 2001.

Test standards prescribed	Sections 2 and 4 of AS1530.4-1997, and AS4072.1-1992 as appropriate.

General description of tested specimens	The test assembly comprised four (4-off) control joints in a concrete floor slab protected by FireSound Grey Trial acrylic sealant material, designated Control Joints 1, 2, 3 and 4 for the purpose of this report. A detailed description of the test construction is contained within Appendix 1.
Separating Element	The separating element comprised a nominally 1750mm x 1200mm x 120mm thick normal weight reinforced concrete floor slab cut into 5 pieces to provide gaps of 20mm (2-off) and 50mm (2-off) between the pieces. The slab was cast in November 2000.
Penetrating Services	The four (4-off) control joints were protected by FireSound Grey Trial acrylic sealant material (Batch No. 36102741). Further details of the control joints are presented in Table 1.
Instrumentation	The instrumentation was provided in accordance with AS1530.4-1997 and AS4072.1-1992 as appropriate. The positions of the thermocouples are summarised in Table A2.1.
Test Procedures	The test procedures were as specified in AS1530.4-1997 and AS4072.1-1992 as appropriate. Control of the furnace temperature was maintained within the prescribed limits of variance from the time/temperature curve that are specified in Clause 2.9.2 of AS1530.4-1997 for the duration of the fire test. The furnace pressure was measured at a position approximately 100mm below the slab soffit, and was maintained at approximately 20 Pa above the laboratory atmosphere after the first 5 minutes and then for the duration of the fire test. Heating was terminated after 241 minutes at the request of the test sponsor.
Test Duration	241 minutes.

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Test Results	
Ambient Air Temperature	Approximately 15°C at the start of the test with no significant variations during the test period.
Temperatures Measured versus Time	Refer to tables and graphs in Appendix 2.
Observations	Refer to Table A2.2 in Appendix 2.
Performance Against the Criteria Specified in AS1530.4-1997	Refer to Table 2 for the results judged against each of the performance criteria specified in AS1530.4-1997.
FRL designation	For the purposes of the Building Code of Australia in Australia the specimen may be regarded as having achieved the fire resistance levels (FRL's) as shown in Table 3.

Table 2: Summary of the Performance of the Test Specimens based on the Criteria Specified in AS1530.4-1997

Control Joint Ref.	Structural Adequacy	Integrity (minutes)	Insulation (minutes)
1	Not Applicable	No failure at 241	65
2	Not Applicable	No failure at 241	145
3	Not Applicable	No failure at 241	166*
4	Not Applicable	No failure at 241	167*

* Recorded on unexposed slab surface – no failures recorded on control joint sealant before these times.

Table 3: Summary of Fire Resistance Levels Ascertained for the Purpose of the Building Code of Australia for the Tested Specimen

Control Joint Ref.	Description of fire protection system	FRL
1	50mm wide x 20mm deep bead of sealant on fire exposed side only	-/240/60
2	20mm wide x 10mm deep bead of sealant on fire and non-fire exposed sides	-/240/120
3	50mm wide x 20mm deep bead of sealant on fire and non-fire exposed sides	-/240/120
4	20mm wide x 10mm deep bead of sealant on fire exposed side only	-/240/120

LIMIT OF APPLICATION

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

The results of this fire test apply to the configuration as tested. Any variations to the test configuration may achieve different results. It is therefore recommended that any proposed variation to the tested configuration should be referred to Warrington Fire Research (Aust) Pty Ltd in the first instance.

APPENDIX 1

DESCRIPTION OF THE SPECIMEN

A1.1 GENERAL DESCRIPTION

A1.1.1 The test assembly simulated four (4-off) control joints in a concrete floor slab.

A1.1.2 A normal weight reinforced concrete slab was cut into five (5-off) pieces as shown in Table A1.1 below.

Table A1.1: Details of Concrete Pieces

Size	Qty
220mm wide x 1750mm long	1
215mm wide x 1750mm long	2
195mm wide x 1750mm long	2

A1.1.3 These sections were bolted together at both ends to form up a slab section of nominal dimension 1200mm wide x 1750mm long and having full thickness gaps of 50mm (2-off) and 20mm (2 off). The gaps were formed by using rigid insulation boards, 4-off 50mm thick and 4-off 20mm thick, as permanent spacers. The gaps were measured along each control joint at each thermocouple location. These values were averaged to give the values as shown in Table A1.2.

A1.1.4 Flexible urethane foam backing rods, refer Table A1.3 for details, were inserted into the full length of each control joint slot, to a depth appropriate to the required amount of sealant. These depths were measured along each control joint at each thermocouple location. These values were averaged to give the values as shown in Table A1.2.

Table A1.2: Control joint details.

Control joint Ref.	Average joint width (mm)	Average depth for sealant (mm)		Sealant flush with Exposed or Unexposed face of slab (E/U) or both
		E	U	
1	52.2	20.1	-	E
2	21.1	10.1	9.9	Both
3	52.6	20.5	20.1	Both
4	22.1	10.4	-	E

Table A1.3: Flexible urethane foam backing rods

Control joint Ref.	Sealant on Exposed or Unexposed face of slab (E/U)	Backing rod dimension (width x thickness – mm)
1	E	60 x 60
2	U	30 x 30
	E	30 x 30
3	U	30 x 60
	E	30 x 60
4	E	30 x 30

A1.1.5 The sealant material, designated by the test sponsor as "FireSound Grey Trial – Batch No. 36102741", was then applied to the control joints. The sealant material was initially over-applied then scraped back flush with the concrete surface. The sealant material was provided by the test sponsor in a 20 litre bucket.

A1.1.6 The sealant was then left to cure for a period of 16 weeks after which the shrinkage of the sealant was measured along each control joint at each thermocouple location. These values were averaged to give the values as shown in Table A1.4.

Table A1.4: Average deflection of cured sealant

Control joint Ref.	Sealant on Exposed or Unexposed face of slab (E/U)	Average deflection of cured sealant from face of slab – E/U (mm)
1	E	4.0
2	U	1.8
	E	1.8
3	U	4.9
	E	2.9
4	E	1.5

A1.1.7 Details of the test construction are shown schematically on Drawing No. 40869-TS-01.

A1.1.8 The control joint sealing system were supplied and installed by the test sponsor, with staff of Warrington Fire Research (Aust) Pty Ltd preparing the concrete slab and attaching thermocouples after the specimen construction had been completed.

A1.2 SEPARATING ELEMENT

A1.2.1 The separating element comprised a nominally 1750mm x 1200mm x 120mm thick normal weight reinforced concrete slab.

A1.2.2 The concrete slab was cut into five (5-off) pieces as shown in Table A1.5 below.

Table A1.5: Details of Concrete Pieces

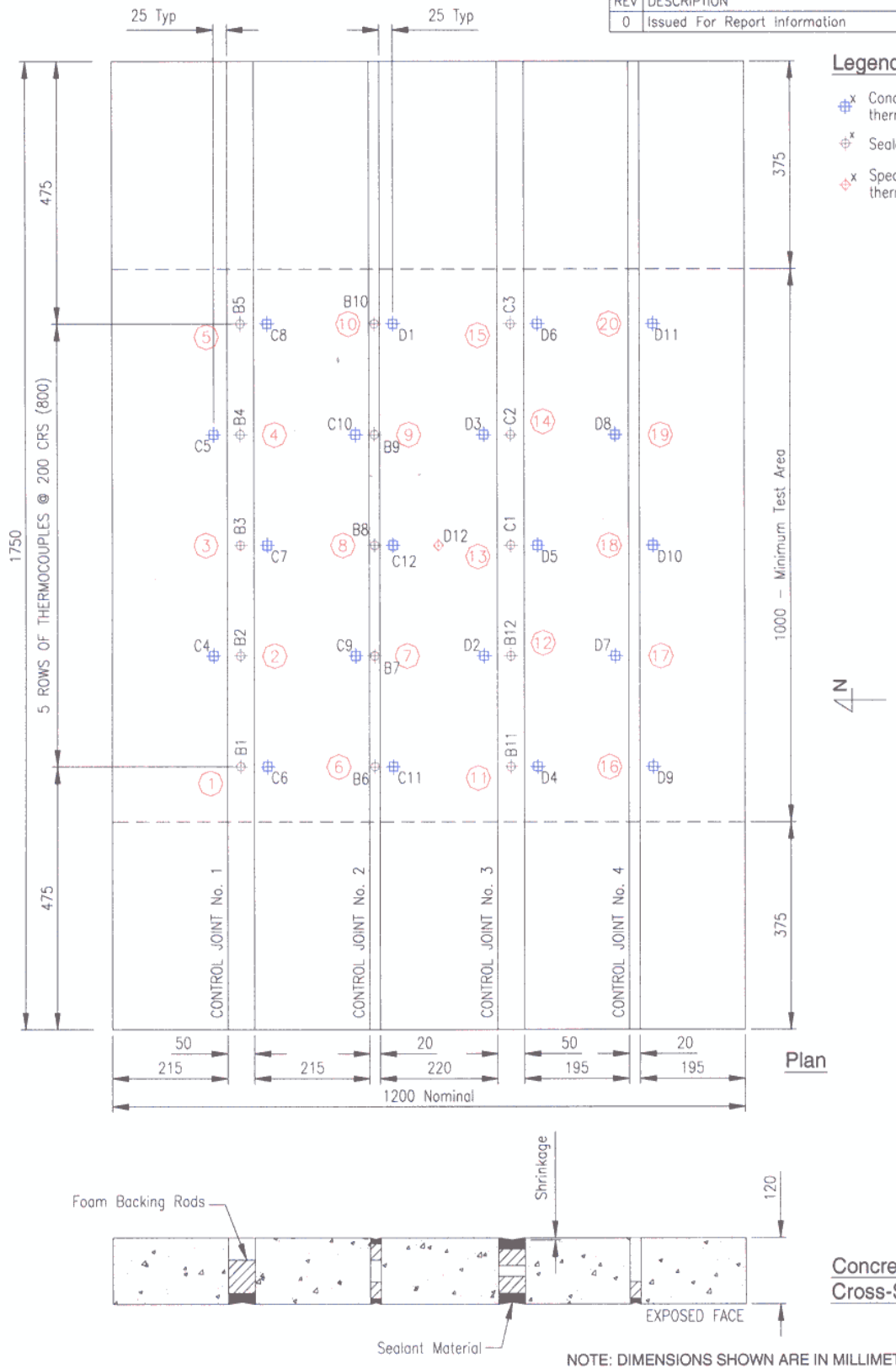
Size	Qty
220mm wide x 1750mm long	1
215mm wide x 1750mm long	2
195mm wide x 1750mm long	2

A1.2.3 The concrete slab was supplied by Warrington Fire Research (Aust). The slab was cast in November 2000.

A1.3 DRAWINGS OF SPECIMEN

Drawing Designation	Description
40869-TS-01	Thermocouple locations and Control Joint Details

REVISIONS				
REV	DESCRIPTION	BY	DATE	APP
0	Issued For Report Information	AR	5/9/01	



NOTE: DIMENSIONS SHOWN ARE IN MILLIMETRES AND NOMINAL

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SIGNATURES		
	SIGNED	DATE
DRAWN	A F Rayner	5/9/01

Scale	Project
1:10	40869

DRG No. 40869-TS-01

CAD Ref. 40869-PENTEST-00

Title: Test 40869 Thermocouple locations and Joint Details

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APPENDIX 2

TEST DATA AND OBSERVATIONS

Table A2.1: Specimen Temperatures

Control Joint Ref	T/C No.	Surface	DESCRIPTION	TEMP (°C) at t (minutes)					LIMIT (mins)*
				t=0	t=60	t=120	t=180	t=240	
1	B1	Sealant	200mm from western edge of slab on C/L of backing rod	13	105	#	#	#	75
	B2	Sealant	400mm from western edge of slab on C/L of backing rod	13	120	#	#	#	75
	B3	Sealant	600mm from western edge of slab on C/L of backing rod	13	136	#	#	#	65
	B4	Sealant	800mm from western edge of slab on C/L of backing rod	13	95	#	#	#	76
	B5	Sealant	1000mm from western edge of slab on C/L of backing rod	13	166	#	#	#	66
	C4	Slab	25mm from northern edge of slot, 400m from western edge of slab	12	77	122	185	220	188
	C5	Slab	25mm from northern edge of slot, 1075mm from western edge of slab	12	74	124	190	225	182
	C6	Slab	25mm from southern edge of slot, 475mm from western edge of slab	12	79	127	191	226	180
	C7	Slab	25mm from southern edge of slot, 875mm from western edge of slab	12	79	133	197	231	173
	C8	Slab	25mm from southern edge of slot, 1275mm from western edge of slab	12	78	126	198	234	172
2	B6	Sealant	475mm from western edge of slab on C/L of bead	12	89	137	229	274	147
	B7	Sealant	675mm from western edge of slab on C/L of bead	12	88	138	226	268	147
	B8	Sealant	875mm from western edge of slab on C/L of bead	12	88	146	229	272	145
	B9	Sealant	1075mm from western edge of slab on C/L of bead	12	86	129	220	262	153
	B10	Sealant	1275mm from western edge of slab on C/L of bead	12	87	114	210	250	161
	C9	Slab	25mm from northern edge of slot, 675mm from western edge of slab	12	87	132	229	280	151
	C10	Slab	25mm from northern edge of slot, 1075mm from western edge of slab	12	81	136	228	279	152
	C11	Slab	25mm from southern edge of slot, 475mm from western edge of slab	12	85	133	226	276	153
	C12	Slab	25mm from southern edge of slot, 875mm from western edge of slab	12	85	137	232	281	149
	D1	Slab	25mm from southern edge of slot, 1275mm from western edge of slab	12	86	133	231	284	152

Notes: * Limit time is the time to the nearest whole minute at which the temperature recorded by the thermocouple does not rise by more than 180 K above the initial temperature.
'-' indicates the temperature limit was not exceeded during the test period.

Table A2.1: Specimen Temperatures (continued…)

Control Joint Ref	T/C No.	Surface	DESCRIPTION	TEMP (°C) at t (minutes)					LIMIT (mins)*
				t=0	t=60	t=120	t=180	t=240	
3	B11	Sealant	475mm from western edge of slab on C/L of bead	12	66	87	98	133	-
	B12	Sealant	675mm from western edge of slab on C/L of bead	12	72	87	99	136	-
	C1	Sealant	875mm from western edge of slab on C/L of bead	12	75	90	111	152	-
	C2	Sealant	1075mm from western edge of slab on C/L of bead	12	75	89	110	154	-
	C3	Sealant	1275mm from western edge of slab on C/L of bead	12	75	88	104	143	-
	D2	Slab	25mm from northern edge of slot, 675mm from western edge of slab	11	82	122	206	262	169
	D3	Slab	25mm from northern edge of slot, 1075mm from western edge of slab	12	81	129	211	268	166
	D4	Slab	25mm from southern edge of slot, 475mm from western edge of slab	12	75	116	192	246	180
	D5	Slab	25mm from southern edge of slot, 875mm from western edge of slab	12	76	124	204	255	169
	D6	Slab	25mm from southern edge of slot, 1275mm from western edge of slab	12	79	120	200	256	173
4	D7	Slab	475mm from western edge of slab on C/L of bead	12	75	120	194	235	177
	D8	Slab	675mm from western edge of slab on C/L of bead	12	77	128	197	238	173
	D9	Slab	875mm from western edge of slab on C/L of bead	12	76	130	204	245	167
	D10	Slab	1075mm from western edge of slab on C/L of bead	12	77	121	197	238	175
	D11	Slab	1275mm from western edge of slab on C/L of bead	12	76	128	206	252	167

Notes: * Limit time is the time to the nearest whole minute at which the temperature recorded by the thermocouple does not rise by more than 180 K above the initial temperature.
'-' indicates the temperature limit was not exceeded during the test period.

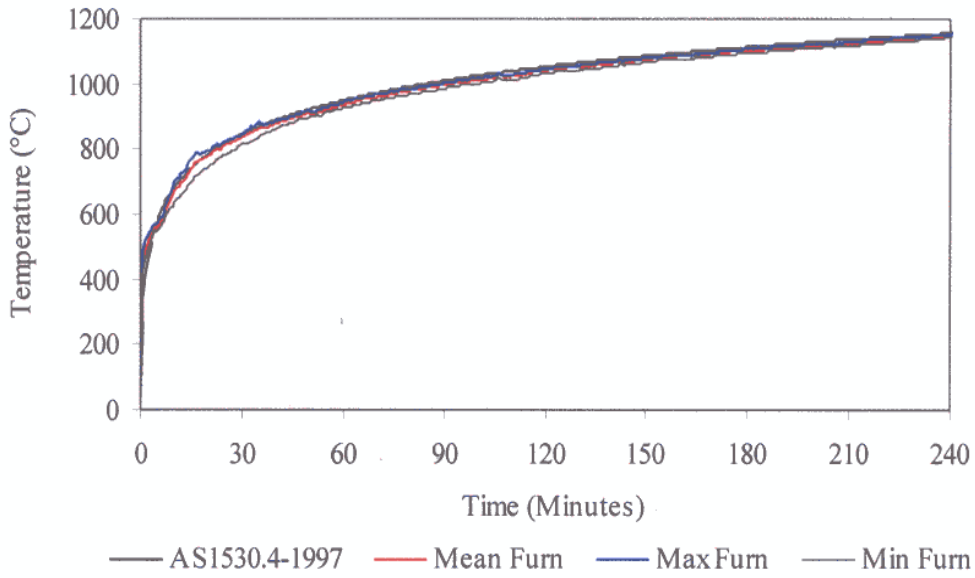

***Figure A2.1**: Furnace Temperatures versus Time*

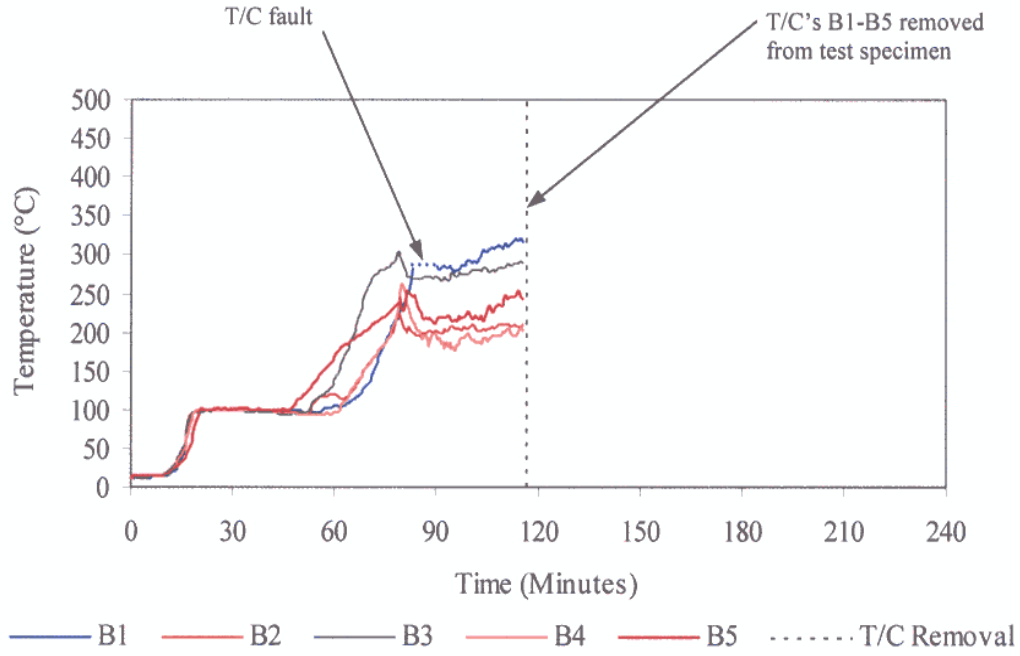

***Figure A2.2**: Control Joint #1 Sealant Temperatures versus Time*

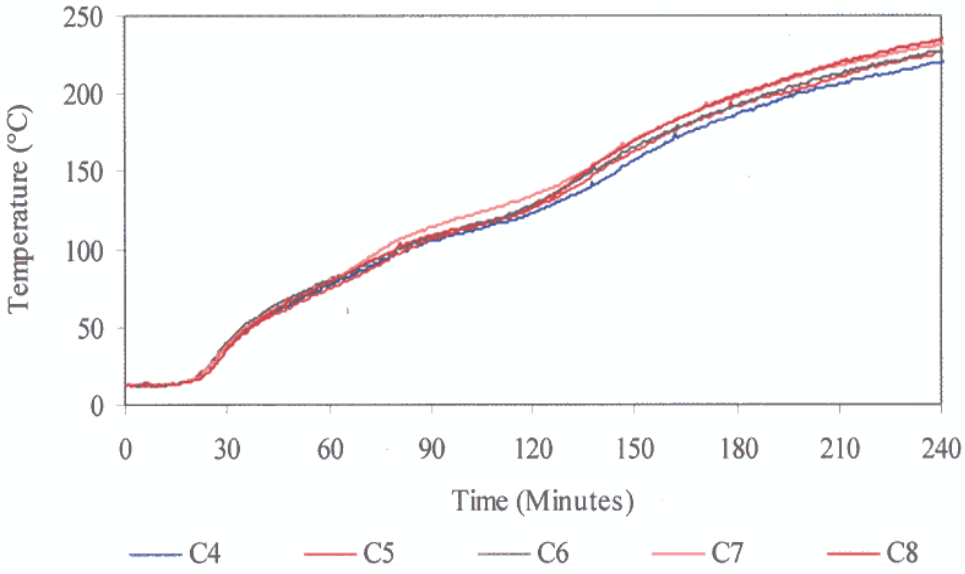

Figure A2.3: *Control Joint #1 Concrete Temperatures versus Time*

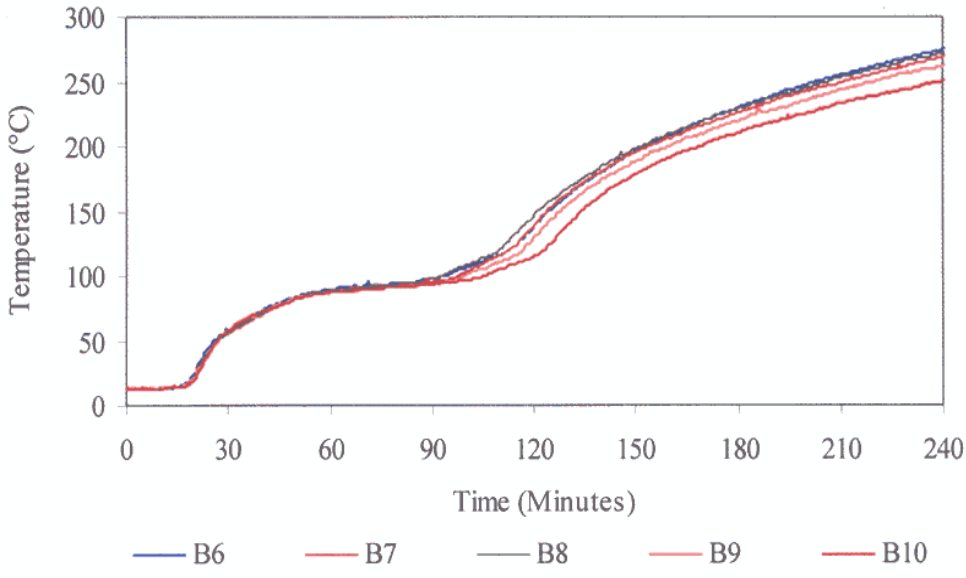

Figure A2.4*: Control Joint #2 Sealant Temperatures versus Time*

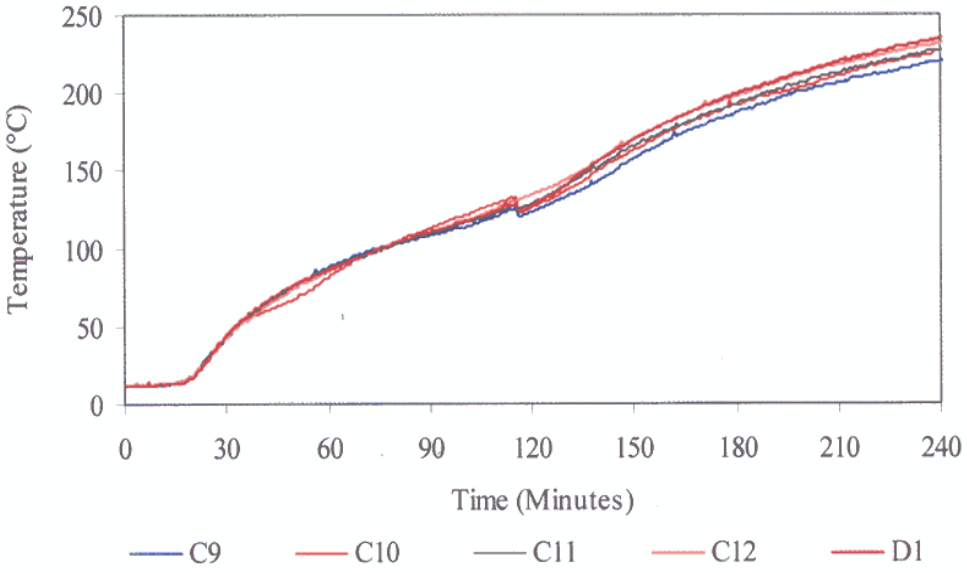

Figure A2.5: *Control Joint #2 Concrete Material Temperatures versus Time*

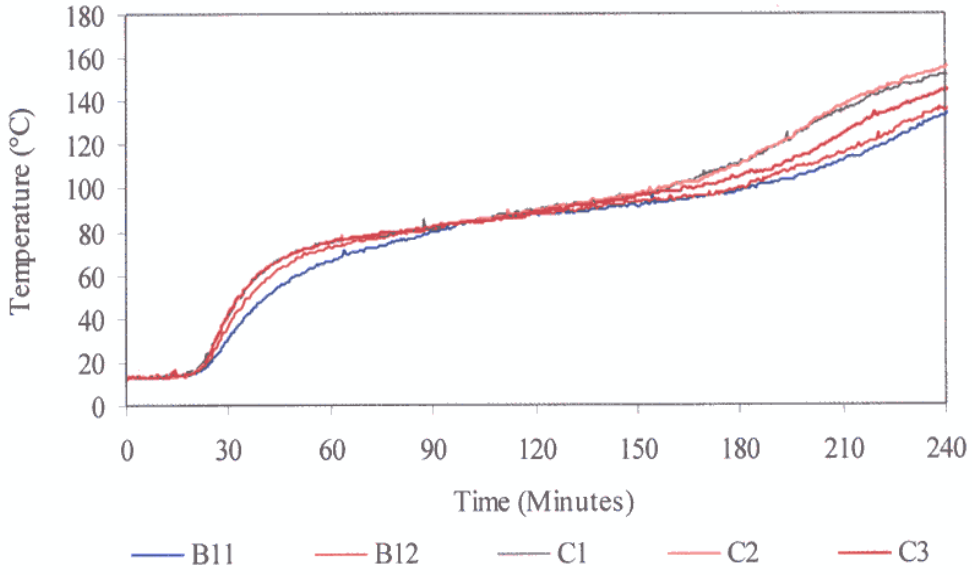

Figure A2.6*: Control Joint #3 Sealant Temperatures versus Time*

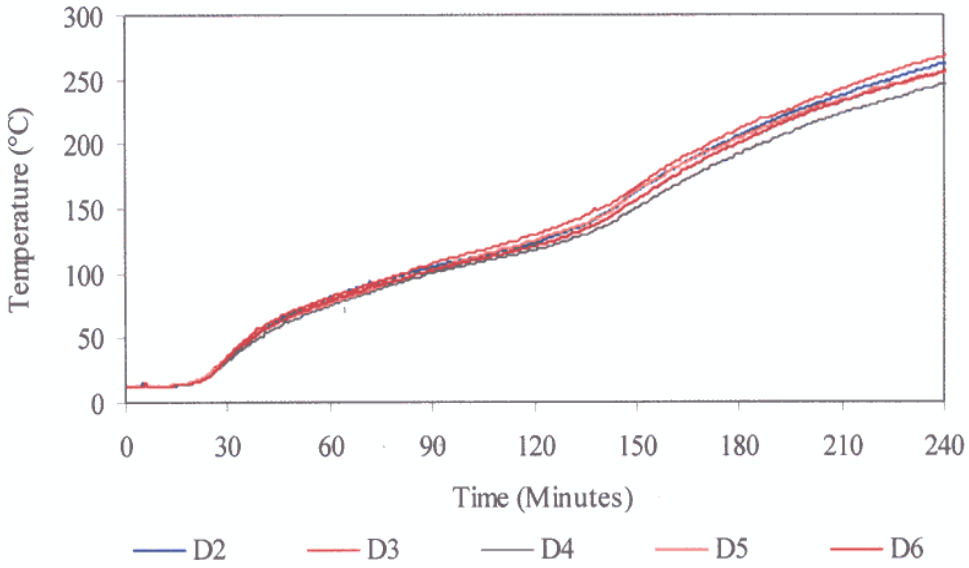

Figure A2.7: *Control Joint #3 Concrete Material Temperatures versus Time*

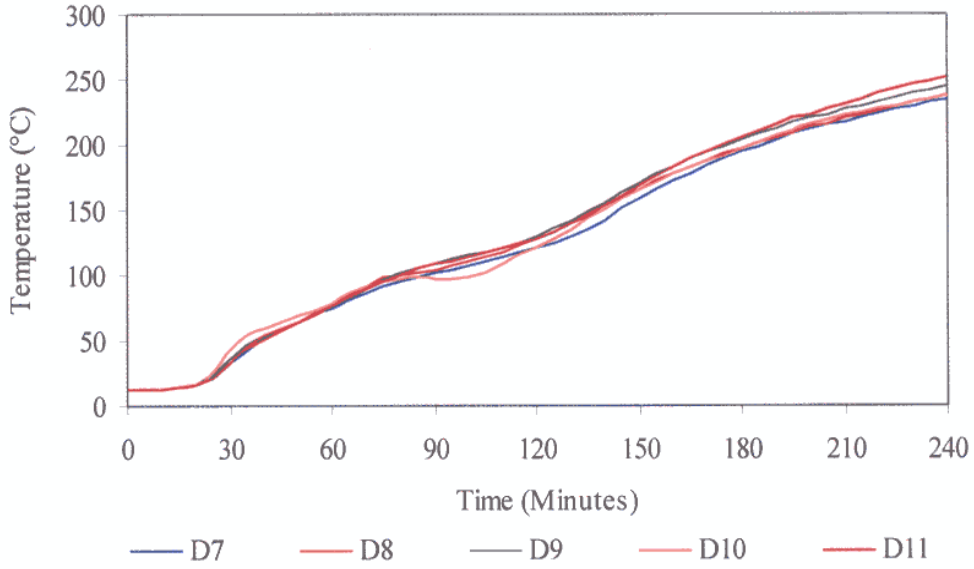

Figure A2.8*: Control Joint #4 Sealant Temperatures versus Time*

Table A2.2: Test Observations

Time		Test Observations 40869
Min	**Sec**	
0	00	Ignition of furnace, commencement of the fire resistance test.
15	00	Moisture patches had formed about transverse surface hairline cracks on unexposed surface.
17	00	There was an increase in the area of the moisture patches that had formed and steam was emitted from Control joints 1 and 4.
20	00	There was a further increase in both water and steam emission. Condensation appeared against the thermocouple pad of D10 which was adjacent to one of the cracks.
30	00	No further changes had occurred other than condensation in the furnace pressure tube was cleared and furnace pressure was found to be correct with no adjustments required.
40	00	Small brown coloured patches had appeared on the surface of the backing rod in Control joint 4. The moisture patches appeared to had dried up slightly. However there appeared to be no reduction in the amount of steam that was emitted from the unexposed surface of the specimen. Maximum furnace pressure developed by the furnace was reading slightly under 20Pa.
50	00	A hole about 50mm in length and of full width had appeared in the backing rod of Control joint 4. The sealant material beneath this hole was visible and was red in colour.
54	00	The backing rod in Control joint 1 had discoloured.
60	00	Approximately 80% of the backing rod in Control joint 4 had melted or shrunk away exposing the sealant material which was red in colour along its centre. Further browning of the surface of the backing rod in Control joint 1 had occurred. The unexposed surface had dried up but only a slight reduction in the amount of steam emitted was observed.
70	00	A hole about 150mm long by the full width had appeared at about the centre of the backing rod of Control joint 1. The sealant material directly below this hole was grey in colour. The backing rod in Control joint 4 had completely disappeared, forming a white ash along the surface of the mastic material which had a red colour section along the centre.
87	00	Glowing was observed behind Control joint 4.
90	00	The urethane foam in Control joint 1 had blackened and twisted, exposing the backing rod and the sealant behind. No through gaps were evident. Control joint 4 was still glowing red in places.
110	00	No further changes were observed.
115	00	Thermocouples B1, B2, B3, B4 and B5 were removed from the specimen. These thermocouples were in the air cavity of Control joint 1, about 50mm above the mastic sealant material and were only measuring the air temperature.

Table A2.2: Test Observations (continued…)

Time		Test Observations 40869
Min	Sec	
120	00	All Control joints were intact with no through gaps evident. The mastic material along Control joints 2 and 3 was changing shape from concave to convex. The change in shape was uniform along the full length (1200mm) of the sealant material. This barrelling was about 5mm for Control joint 3 and about 3mm for Control joint 2. There were no splits in the material.
135	00	The barrelling of the material of Control joint 3 had increased to about 10mm above the surface of the concrete and about 5mm for Control joint 2. The sealant material in Control joint 4 was glowing bright red along the full length but there were no through gaps evident. The sealant material in Control joint 1 was still grey in colour except for a couple of short lengths of red lines about 300mm from the cast end of this control joint.
150	00	The barrelling of the material of Control joint 3 was now about 20mm above the concrete surface whereas Control joint 2 was still about 5mm. Control joint 4 continued to glow bright red in colour but there were no through gaps evident. The surface of Control joint 1 was still grey in colour. There were no splits in the sealant material of Control joints 2 and 3 and this material was still firmly in contact with the edges of the concrete sections.
158	00	The material in Control joint 3 was beginning to lose contact along the interface with the concrete slab.
165	00	No further changes were observed.
180	00	No further changes were observed. All control joints were free from cracks or gaps. The barrelling appeared to have stabilized at about 5mm for Control joint 2 and 25-30mm for Control joint 3. Downwards deflection of the slab over a segment of 1300mm at the centre was 25mm.
210	00	No further changes have occurred. All control joints were still fully intact and free of cracks or gaps. The colour of Control joint 1 was still basically grey.
220	00	No further changes had occurred.
230	00	No further changes had occurred.
235	00	No further changes had occurred.
240	00	No further changes had occurred. All control joints were intact with no gaps or cracks visible.
241	00	The furnace was shut down and the fire resistance test was terminated at the request of the test sponsor.

Note: All observations were taken from the unexposed face of the specimen.

A2.3 POST-TEST OBSERVATIONS (21/08/01)

A2.3.1 After the termination of the fire test the specimen was immediately removed from the furnace and the following observations were noted regarding the condition of the exposed face of the specimen.

(i) The mastic material was still in place in each of the control joints with no gaps evident in any of the joints either in the material or the edges.

(ii) Some of the material had flaked off during the test and had fallen onto the floor of the furnace.

(iii) Barrelling of the mastic material had occurred along each control joint about 25 to 30mm for Control joints 1 and 3 and about 6mm for Control joints 2 and 4. About half of this portion of material was still in place with the remaining portion fallen off during the test. The barrelling effect had been caused by the material intumescing.

(iv) The exposed face of the concrete had covered with craze cracking together with transverse full depth cracking across the concrete segments at or about the midspan of the specimen.

(v) Spalling of the concrete had occurred at one spot at about the centre of Control joint 2 south edge.

A2.4 POST-TEST OBSERVATIONS (22/08/01)

A2.4.1 The specimen was left to cool down naturally overnight and samples of the mastic material were obtained by HB Fuller personnel (test sponsor).

APPENDIX 3

PHOTOGRAPHS

PLATE 1:	Unexposed face before commencement of the fire resistance test.
PLATE 2:	Exposed face before commencement of the fire resistance test.
PLATE 3:	Unexposed face after completion of the fire resistance test.
PLATE 4:	Exposed face after completion of the fire resistance test.

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***Plate 1**: Unexposed face before commencement of the fire resistance test*

***Plate 2**: Exposed face before commencement of the fire resistance test*

***Plate 3**: Unexposed face after completion of the fire resistance test*

***Plate 4**: Exposed face after completion of the fire resistance test*