



Ad-hoc ceiling system test report

Test standard: Sections 2 and 4 of AS 1530.4:2014

Test sponsor: Built Pty Ltd

Product: Coke breeze arch

Job number: FRT220115

Test date: 27 October 2022 Revision: R1.0

Quality management

Revision	Date	Information about the report			
R1.0	29 November 2022	Description	Initial issue		
		Name Signature	Prepared by	Reviewed by	Authorised by
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Executive summary

This report documents the findings of the fire resistance test of a non-loadbearing floor system in general accordance with sections 2 and 4 of AS 1530.4:2014. The testing was done on 27 October 2022.

Warringtonfire performed the test at the request of Built Pty Ltd.

Table 1 provides details of the test assembly, and Table 2 provides a summary of the test specimen. A summary of the results is provided in Table 3.

Table 1 Test assembly

Item	Detail	
Non-loadbearing ceiling system	Width	1440 mm
	Length	2130 mm
	Thickness – Arch	110 mm
	Height – Overall specimen	565 mm
Restraint conditions	Simply supported on the two bottom beams.	

Table 2 Test specimen

Item	Detail
Non-loadbearing ceiling system	<p>Test assembly comprised of:</p> <ul style="list-style-type: none"> • 110 mm thick coke breeze arch bedded into two steel 360UB 51 beams. • Two 200UC 59 steel beams were installed on top of the 360UB 51 steel beams at the western and eastern edges connecting them together. Additional M16 threaded mild steel rods were installed between 360UB 51 beams to complete the assembly and provide rigidity of the beams due to the lack of additional arches found in practice. • The gaps between the arch and the 360UB 51 steel beams were filled up with non-shrink mortar. • Nullifire SC902 intumescent coating was applied on the underside of the 360UB 51 steel beams. • Aithon A90H intumescent coating was applied to the underside and to the western and eastern side edges of the coke breeze arch.

Table 3 Test results

Criteria	Results	Fire resistance level (FRL)
Structural adequacy	Not applicable	Not assigned*
Integrity	Failure at 88 minutes	
Insulation	Failure at 88 minutes	

Note:

- *The FRL was not assigned due to the variations listed in Table 7
- The result only applies to the tested orientation.

Contents

1.	Introduction	5
2.	Test specimen	5
2.1	Schedule of components	5
2.2	Installation details	8
3.	Test procedure	8
4.	Test measurements and results	10
5.	Application of test results	11
5.1	Test limitations	11
5.2	Variations from the tested specimen	11
5.3	Uncertainty of measurements	11
Appendix A	Drawings of test assembly	12
Appendix B	Test observations	14
Appendix C	Instrumentation locations	15
Appendix D	Test data	19
Appendix E	Photographs	27

1. Introduction

This report documents the findings of the fire resistance test of a non-loadbearing floor system in general accordance with sections 2 and 4 of AS 1530.4:2014. The testing was done on 27 October 2022.

Warringtonfire performed the test at the request of the test sponsor listed in Table 4.

Table 4 Test sponsor details

Test sponsor	Address
Built Pty Ltd	Level 4/185 Clarence Street Sydney NSW 2000 Australia

2. Test specimen

2.1 Schedule of components

Table 5 describes the test specimen and lists the schedule of components. These were provided by the test sponsor and surveyed by Warringtonfire.

All measurements were done by Warringtonfire – unless indicated otherwise.

Detailed drawings of the test specimen are provided in Appendix A.

Table 5 Schedule of components

Item	Description		
Arch			
1.	Item name	Arch	
	Product name	Coke breeze arch	
	Product details	The west half of the arch was rendered on the exposed side with Sika MonoTop®-352 NFG repair mortar prior to testing.	
	Manufacturer / Supplier	Built Pty Ltd	
	Total mass	376 kg	
	Size	1360 mm long × 1215 mm wide × 210 mm tall	
	Average thickness	110 mm	
	Density	2069 kg/m ³ (nominally - including rendered portion)	
	Gaps – between the arch and the 360UB 51 steel beams	Average gaps:	
		North-west	25 mm
South-west		25 mm	
North-east		25 mm	
	South-east	30 mm	
Framing			
2.	Item name	Steel beam	
	Product name	360UB 51	
	Size	2130 mm long × 172 mm wide × 360 mm high	
	Average thickness of the flange	12.92 mm	
	Average thickness of web	7.71 mm	

Item	Description			
	Weight	50.7 kg/m		
	Surface treatment	None		
	Manufacturer / Supplier	Traditional Restoration Company		
3.	Item name	Steel beam		
	Product name	200UC 59		
	Size	1440 mm long x 204 mm wide x 210 mm high		
	Average thickness of the flange	10.20 mm		
	Average thickness of web	7.30 mm		
	Weight	59.5 kg/m		
	Surface treatment	None		
4.	Manufacturer / Supplier	Traditional Restoration Company		
	Item name	Threaded rod		
	Product description	M16 threaded mild steel rod		
4.	Size	M16 x 1500 mm long		
	Manufacturer / Supplier	Economy Bolts		
	Item name	Non-shrink mortar		
5.	Product name	SikaGrout® - Deep Pour		
	Manufacturer / Supplier	Sika®		
	Product details	High Thickness Structural Grout – installed between the arch and the 360UB 51 steel beams		
	Density	2610 kg/m ³		
	Batch number	318533 336440 0996		
	Coatings			
6.	Item name	Primer – arch		
	Product name	TREMproof 200 – Part A		
		TREMproof 200 – Part B		
	Product details	Part A	Part B	
		Batch number	7180683	7176719
		Dry film thickness	82 µm (provided by representatives of test sponsor)	
Manufacturer / Supplier	Permax Australia			
7.	Item name	Intumescent coating		
	Product name	AITHON A90H		
	Product details	Water based thin film intumescent coating applied on the coke breeze arch.		
	Batch number	20C0301221		
	Dry film thickness	1262 µm		

Item	Description			
	Manufacturer / Supplier	Permax Australia		
8.	Item name	Primer – steel		
	Product name	Nullifire PMO536 – Part A		
		Nullifire PMO536 – Part A		
	Product details		Part A	Part B
		Batch number	N536BB6080	N536C020
		Dry average thickness	85 µm	
Manufacturer / Supplier	Permax Australia			
9.	Item name	Intumescent coating		
	Product name	Nullifire SC902 – Part A		
		Nullifire SC902 – Part B		
	Product details		Part A	Part B
		Batch number	DECO031926	FOR060903
		Applied to both the underside and top surface of the bottom flanges of the 360UB 51 steel beams		
	Dry film thickness	5115 µm		
Manufacturer / Supplier	Permax Australia			
Installation method				
Ceiling system	Overall size	1440 mm wide × 2130 mm long × 565 mm high		
	Restraint conditions	Simply supported.		
	Installation	<p>Test assembly comprised of:</p> <ul style="list-style-type: none"> • 110 mm thick coke breeze arch (item 1), located at the centre of the assembly, bedded into two 360UB 51 steel beams (item 2). • Two 360UB 51 steel beams (item 2) were installed parallel to each other at 1240 mm apart. • Two 200UC 59 steel beams (item 3) were installed perpendicular on top of the 360UB 51 steel beams (item 2), on the western and eastern edges. • Non-shrink mortar (item 5) was used to fill up the gaps between the coke breeze arch (item 1) and the 360UB 51 steel beams (item 3). • TREMproof 200 primer (item 6) was applied on the underside of coke breeze arch (item 1). • AITHON A90H intumescent coating (item 7) was applied on the underside of the coke breeze arch (item 1) over TREMproof 200 primer. • Nullifire PMO536 primer (item 8) was applied on the underside of the 360UB 51 steel beams (item 2). • Nullifire SC902 intumescent coating (item 9) was applied on the underside of the coke breeze arch (item 2). • 6 threaded rods (item 4) were installed within the 360UB 51 steel beams (item 2), with washers and double M16 bolts, on the eastern and western corners of the specimen, as per Figure 2 		

2.2 Installation details

Table 6 lists the installation details for the test specimen.

Table 6 Installation details

Item	Detail
Start date for construction of test specimen	5 October 2022
Specimen assembly – Sponsor representatives (Traditional Restoration Company)	5 October 2022
TREMproof 200 primer – Sponsor representatives (Action Alliance)	16 October 2022
AITHON A90H intumescent coating – Sponsor representatives (Action Alliance)	19 October 2022
Nullifire PMO536 primer – Sponsor representatives (Action Alliance)	16 October 2022
Nullifire SC902 intumescent coating – Sponsor representatives (Action Alliance)	18 October 2022
Completion date for construction of test specimen	26 October 2022
Ceiling system constructed by	Representatives of the test sponsor
Symmetry	<p>Asymmetrical:</p> <ul style="list-style-type: none"> • The curvature of the coke breeze arch • Application of render to half of the underside (exposed face) of the arch. • The arch was installed resting on the bottom flange of the 360UB 51 steel beams • Both primers and intumescent coatings were applied on the underside only.

3. 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 general accordance with the requirements of sections 2 and 4 of AS 1530.4:2014 appropriate for a non-loadbearing floor system.
Variations	<p>The tested specimen was smaller than the full size specified in clause 2.9.2 of AS 1530.4:2014. This means that the test was not conducted in strict accordance with AS 1530.4:2014, so an FRL cannot be assigned. The data obtained is for information purposes only.</p> <p>The pressure was up to 6 Pa below the limits prescribed in the standard during the 65 – 70 minute period. The pressure and temperature were within the limits for the rest of the test. Due to the nature of the specimen and the fact that no significant events occurred during this time period, this under pressure is unlikely to have invalidated the test result.</p>
Pre-test conditioning	The final intumescent coat was applied to the test specimen on 19 August 2022. The test specimen was subjected to normal laboratory temperatures and curing conditions between the final intumescent coat application date 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.

Item	Detail	
	The results obtained during the test only apply to the test samples as received and tested by Warringtonfire.	
Ambient laboratory temperature	Start of the test	19 °C
	Minimum temperature	19 °C
	Maximum temperature	20 °C
Test duration	94 minutes	
Instrumentation and equipment	<p>The instrumentation was provided in accordance with AS 1530.4:2014 as follows:</p> <ul style="list-style-type: none"> • The furnace temperature was measured by four mineral insulated metal sheathed (MIMS) Type K thermocouples – with wire diameters not greater than 1 mm, an overall diameter of 3 mm, and the measuring junction insulated from the sheath. The thermocouples protruded a minimum of 25 mm from steel supporting tubes. • The unexposed side specimen temperatures were measured by Type K thermocouples with wire diameters less than 0.5 mm soldered to 12 mm diameter x 0.2 mm thick copper discs covered by 30 mm x 30 mm x 2.0 mm thick inorganic insulating pads. • The exposed side specimen temperatures were measured by Type K thermocouples with wire diameters less than 0.5 mm soldered to 12 mm diameter x 0.2 mm thick copper discs with the organic cover pads removed. • The thermocouple positions are shown in Table 10 and in Figure 4 to Figure 7 in Appendix C. • The internal temperatures of the specimen were measured by mineral insulated metal sheathed (MIMS) Type K thermocouples with wire diameters not greater than 0.5 mm, an overall diameter of 1.5 mm, and the measuring junction insulated from the sheath. • A roving thermocouple was available to measure temperatures at positions that appeared hotter than the positions monitored by the fixed thermocouples. • Cotton pads were available during the test to assess the performance of the specimen under the criteria of integrity. • Gap gauges were available during the test to assess the performance of the specimen under the criteria of integrity. • Deflection measurements were taken from wire drawn encoders at the positions shown in Table 11 and in Figure 4 in Appendix C. • The furnace pressure was measured at approximately 100 mm below the 360UB 51 steel beams. 	

4. Test measurements and results

Table 8 summarises the results the specimen achieved against the performance criteria listed in sections 2 and 4 of AS 1530.4:2014.

Appendix D includes details of the measurements taken during the test.

Appendix C includes instrumentation details of the specimen.

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 E.

Table 8 Test results

Criteria	Results	Fire resistance level (FRL)
Structural adequacy	Not applicable	Not assigned*
Integrity	Failure at 88 minutes	
Insulation	Failure at 88 minutes	

Note:

- *The FRL was not assigned due to the variations listed in Table 7
- The result only applies to the tested orientation.

5. Application of test results

5.1 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 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.

5.2 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 here 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 should be referred to the test sponsor. They should then obtain appropriate documentary evidence of compliance from Warringtonfire or another accredited testing authority.

5.3 Uncertainty of measurements

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 for the result.

Appendix A Drawings of test assembly

The leaders in the drawings represent the items listed in section 2.1. All measurements – unless indicated – are in millimetres.

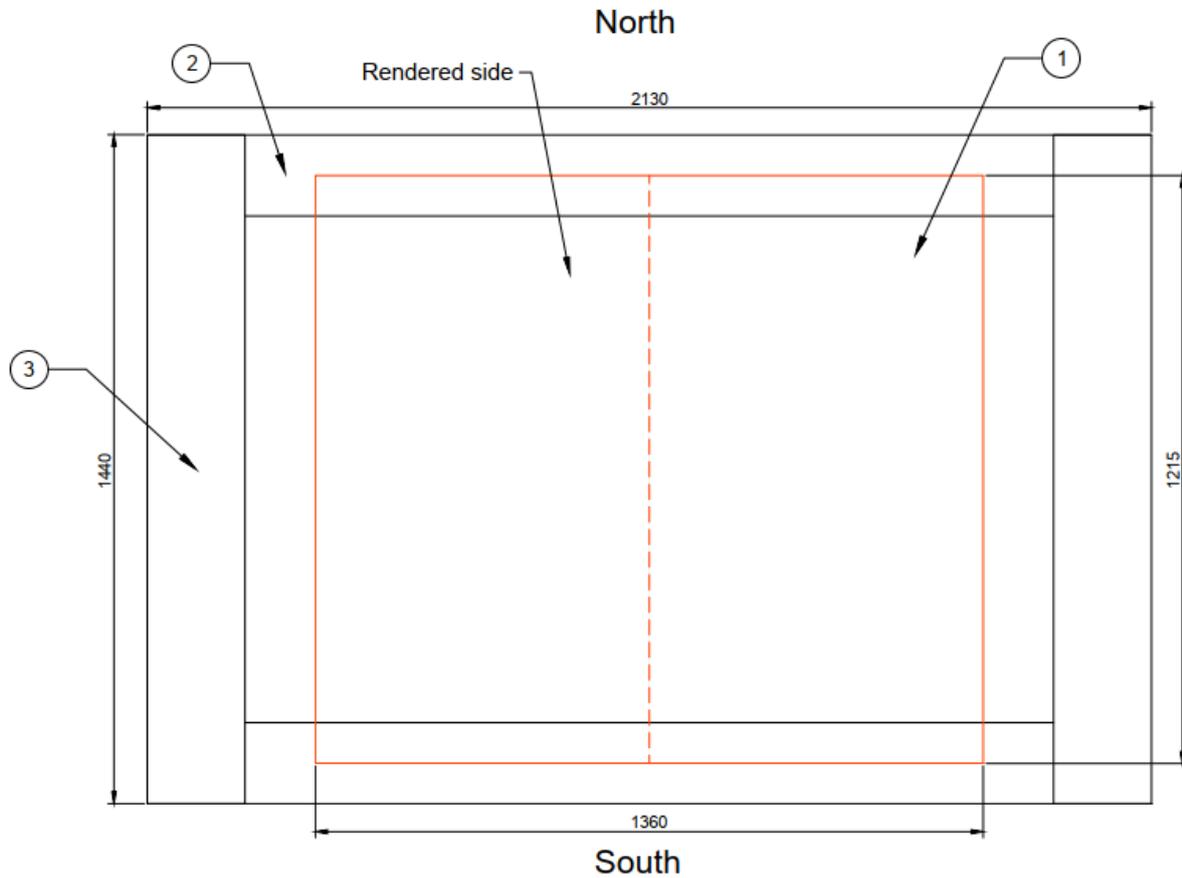


Figure 1 Plan view of test specimen (unexposed side)

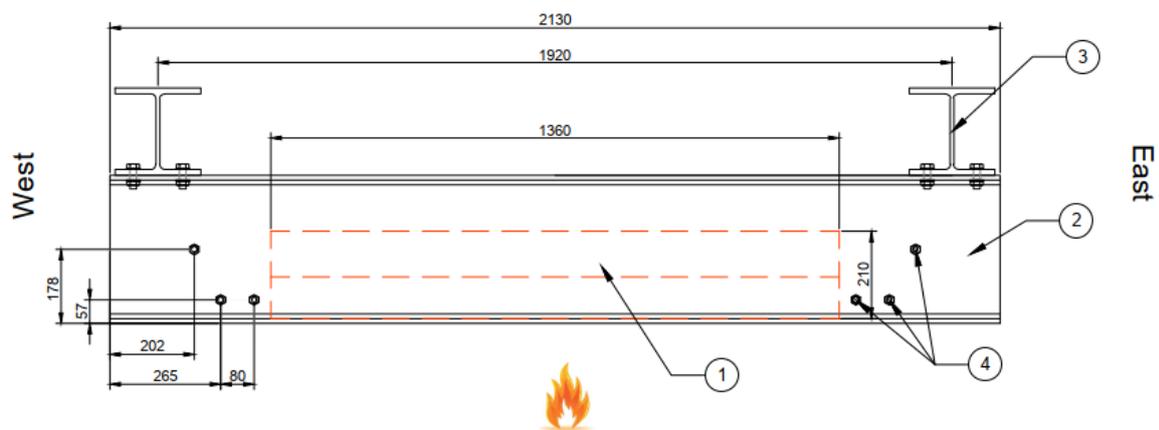


Figure 2 Front view of test specimen

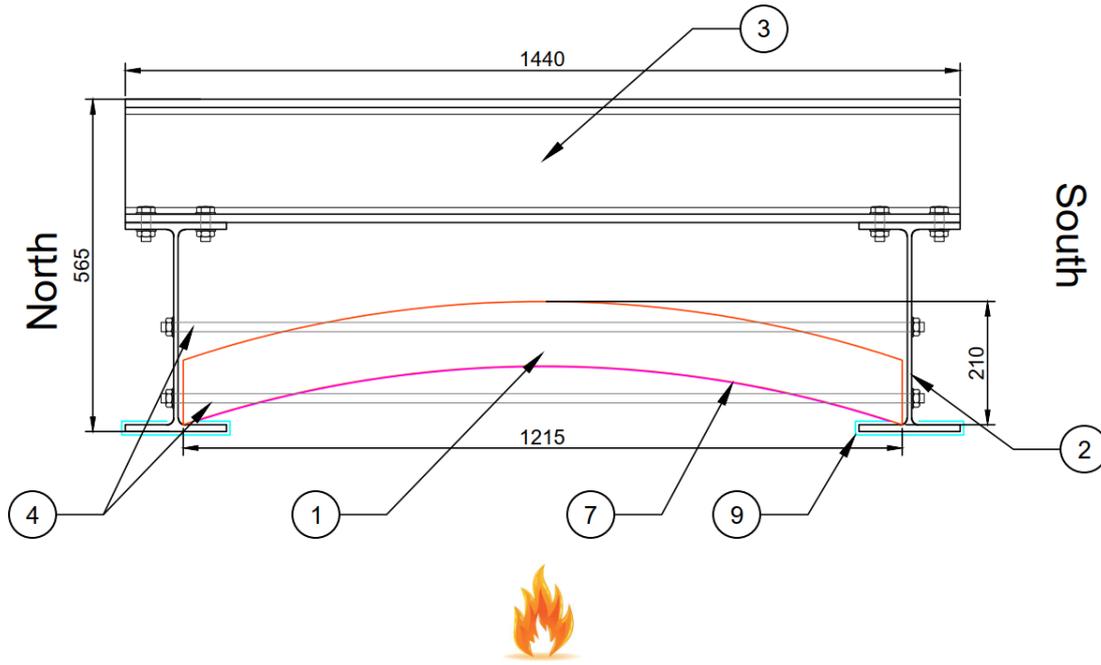


Figure 3 Side view of the test specimen

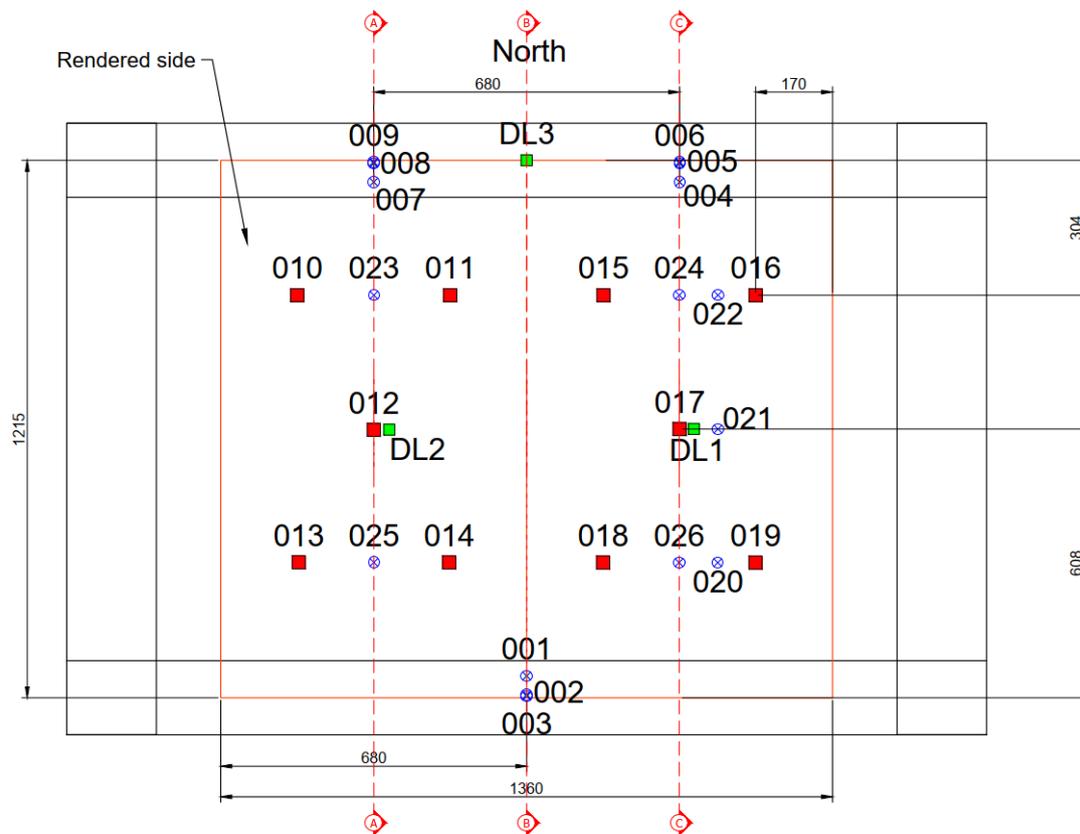
Appendix B Test observations

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

Table 9 Test observations

Time		Observation
Min	Sec	
00	00	The fire resistance test started. The initial temperature of the test specimen was approximately 19 °C.
04	28	Smoke emitting from the overall perimeter of the test specimen.
11	57	The smoke from the overall perimeter of the test specimen had stopped.
15	00	The test specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
30	00	The test specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
44	34	Cracks had started to appear around the south half of the arch.
45	00	The test specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
47	19	Smoke emitting from surface crack on the south half surface of the arch.
57	45	One surface crack had developed throughout the whole length of the arch.
60	00	The test specimen continued to maintain integrity and insulation in accordance with AS 1530.4:2014.
80	50	A 30 second cotton pad test was carried out at the surface crack of the arch, on the west half side, in accordance with clause 2.13.2.2 of AS 1530.4:2014. There was no ignition of the cotton pad, so no failure.
85	23	A 30 second cotton pad test was carried out at the surface crack of the arch, on the west half side, in accordance with clause 2.13.2.2 of AS 1530.4:2014. There was no ignition of the cotton pad, so no failure.
88	22	A 30 second cotton pad test was carried out at the surface crack of the coke breeze arch, on the west half side, resulting in the ignition of the cotton pad at 88 minutes and 52 seconds. Failure of integrity of the specimen in accordance with clause 2.13.2.2 of AS 1530.4:2014, where ignition of the cotton pad has occurred.
94	00	Test stopped.

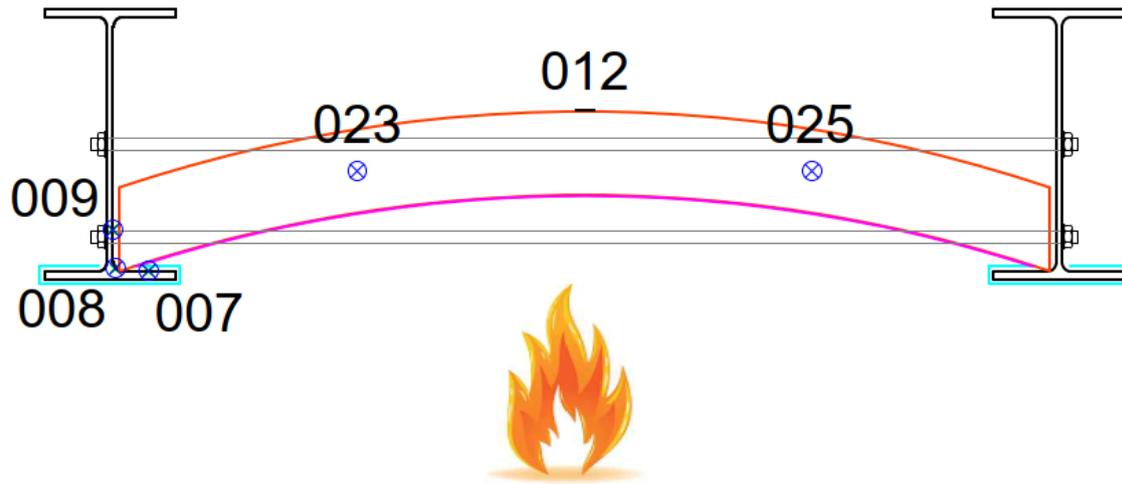
Appendix C Instrumentation locations



Note:

- Red squares show surface thermocouple locations.
- Blue dots show internal thermocouple locations.
- Green squares show deflection locations.

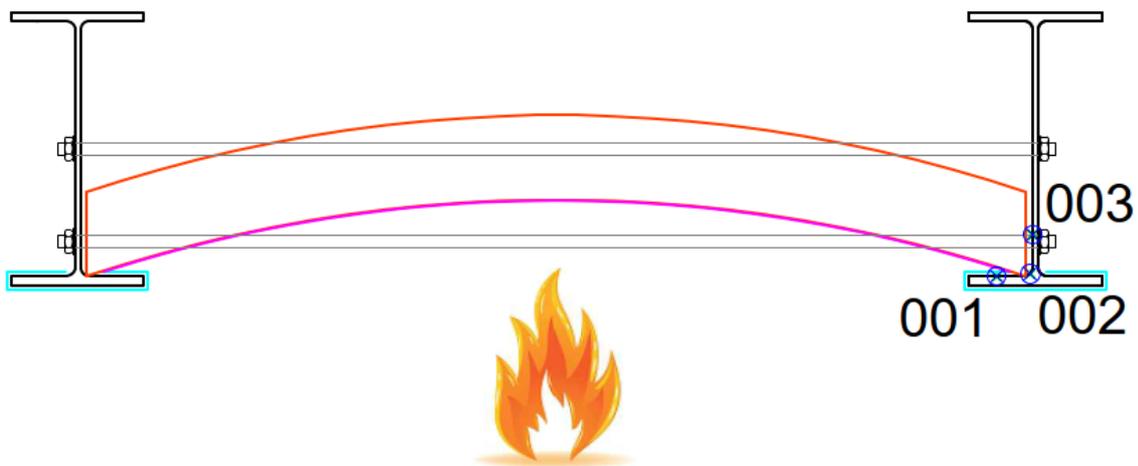
Figure 4 Instrumentation locations



Note:

- Red squares show surface thermocouple locations.
- Blue dots show internal thermocouple locations.

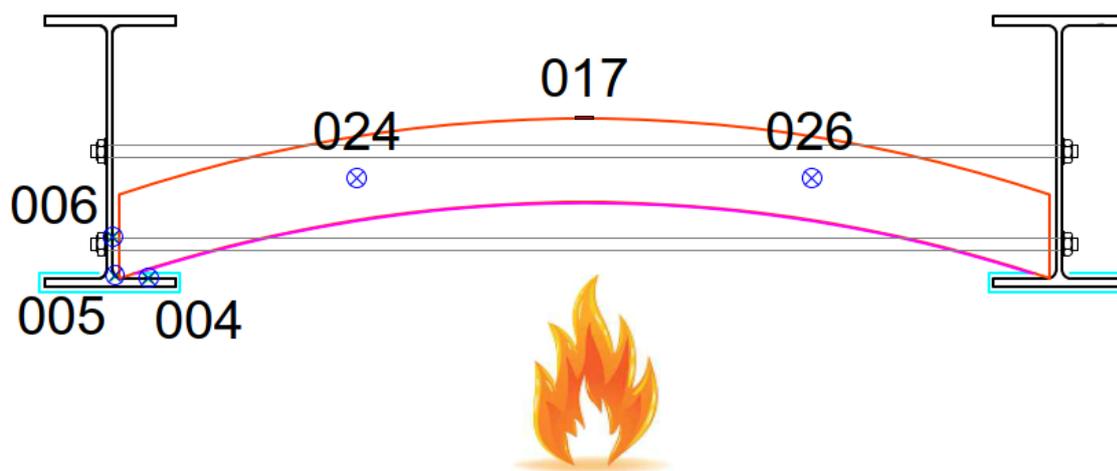
Note: Figure 5 Instrumentation locations: Cross-section AA



Note:

- Blue dots show internal thermocouple locations.

Note: Figure 6 Instrumentation locations: Cross-section BB



Note:

- Red squares show surface thermocouple locations.
- Blue dots show internal thermocouple locations.

Note: Figure 7 Instrumentation locations: Cross-section CC

Table 10 Thermocouple locations

Location	T/C #	Description
On the south 360UB51 beam	001	At mid-length of the south steel beam, 6 mm deep from the top side of the inside bottom flange.
	002	At mid-length of the south steel beam, 6 mm deep on the interface fillet between the web and the bottom flange, on the inside of the beam.
	003	At mid-length of the south steel beam, 4 mm deep at 55 mm high from the inside bottom flange.
On the north 360UB51 beam	004	At 325 mm away from the east end of the arch, 6 mm deep from the top side of the inside bottom flange.
	005	At 325 mm away from the east end of the arch, 6 mm deep on the interface fillet between the web and the bottom flange, on the inside of the beam.
	006	At 325 mm away from the east end of the arch, 4 mm deep at 55 mm high from the inside bottom flange.
	007	At 325 mm away from the west end of the arch, 6 mm deep from the top side of the inside bottom flange.
	008	At 325 mm away from the west end of the arch, 6 mm deep on the interface fillet between the web and the bottom flange, on the inside of the beam.
	009	At 325 mm away from the west end of the arch, 4 mm deep at 55 mm high from the inside bottom flange.
Quarter points and centre - unexposed (rendered section)	010	North-west quarter point
	011	Northeast quarter point
	012	Centre of section
	013	South-west quarter point
	014	South-east quarter point

Location	T/C #	Description
Quarter points and centre - unexposed (non-rendered section)	015	North-west quarter point
	016	Northeast quarter point
	017	Centre of section
	018	South-west quarter point
	019	South-east quarter point
Underside of the arch, non-rendered section	020	At the south corner
	021	At the middle of the section.
	022	At the north corner
Embedded TCs, at mid-depth of the arch	023	North-west quarter of the specimen
	024	North-east corner of the specimen
	025	South-west quarter of the specimen
	026	South-east quarter of the specimen

Table 11 Deflection locations

Part of specimen	Ref	Description
Unexposed surface of arch	DL1	At centre of non-rendered section, unexposed side
	DL2	At centre of rendered section, unexposed side
Top of 360UB51 beams	DL3	Measured between 360UB51 steel beams.

Appendix D Test data

D.1 Furnace temperature and severity

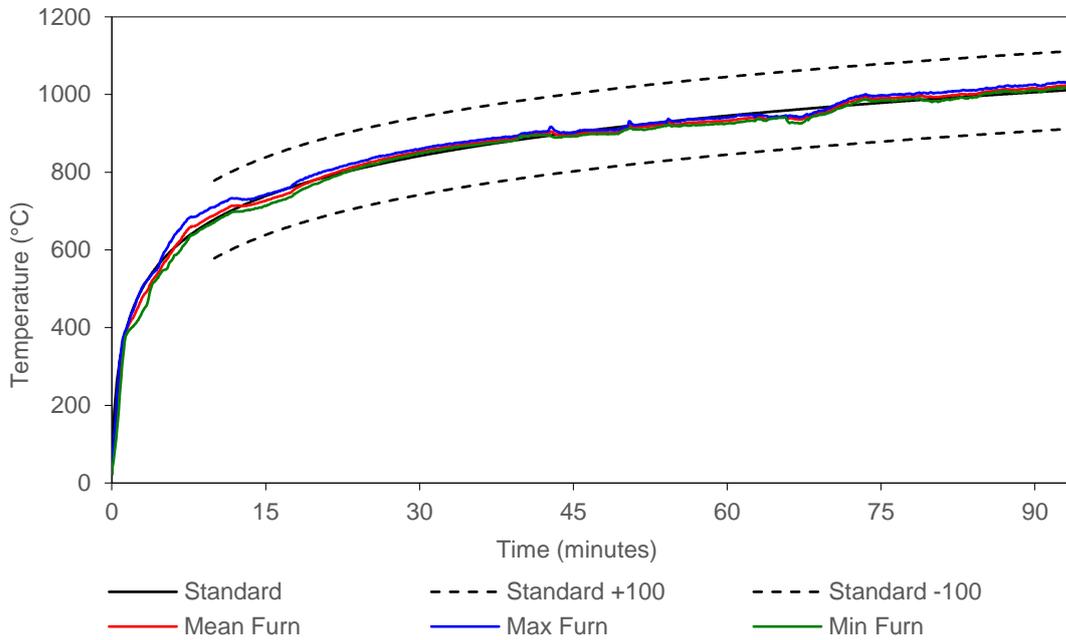


Figure 8 Furnace thermocouple temperature vs time

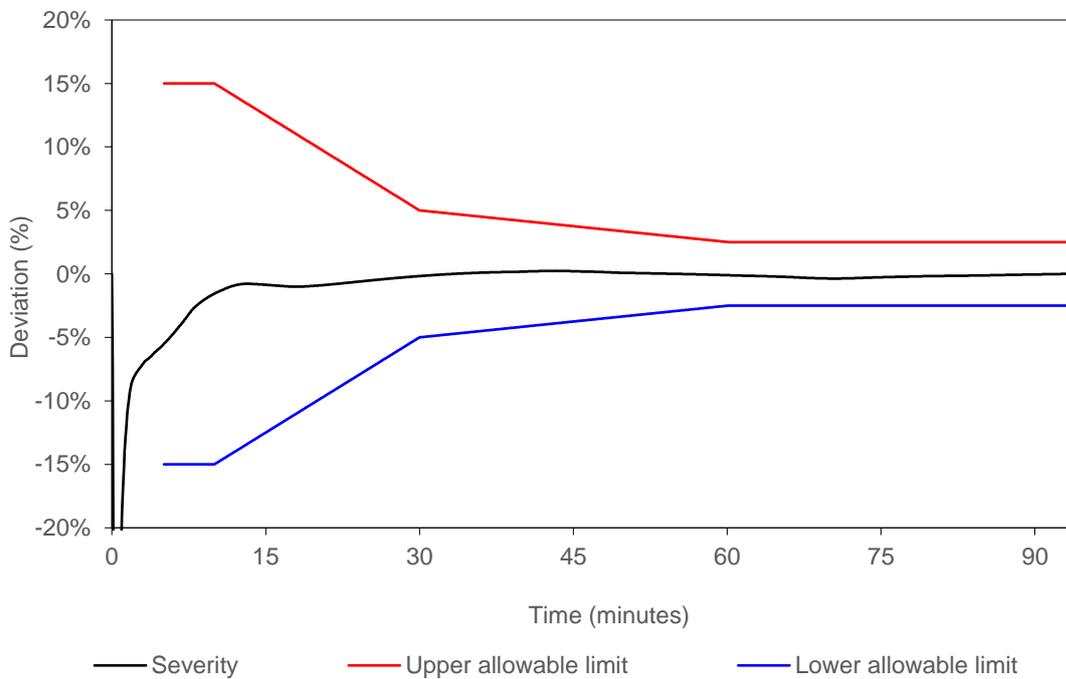


Figure 9 Percentage deviation of exposure severity vs time

D.2 Furnace pressure

The furnace pressure was measured at approximately 100 mm below the 360UB 51 steel beams.

Table 12 Furnace pressure

Time (minutes)	Average pressure (Pa)	Time (minutes)	Average pressure (Pa)	Time (minutes)	Average pressure (Pa)
5-10	20	35-40	21	65-70	14
10-15	20	40-45	19	70-75	17
15-20	22	45-50	21	75-80	22
20-25	21	50-55	19	80-85	21
25-30	22	55-60	21	85-90	21
30-35	20	60-65	19	90-94	20

D.3 Specimen temperatures

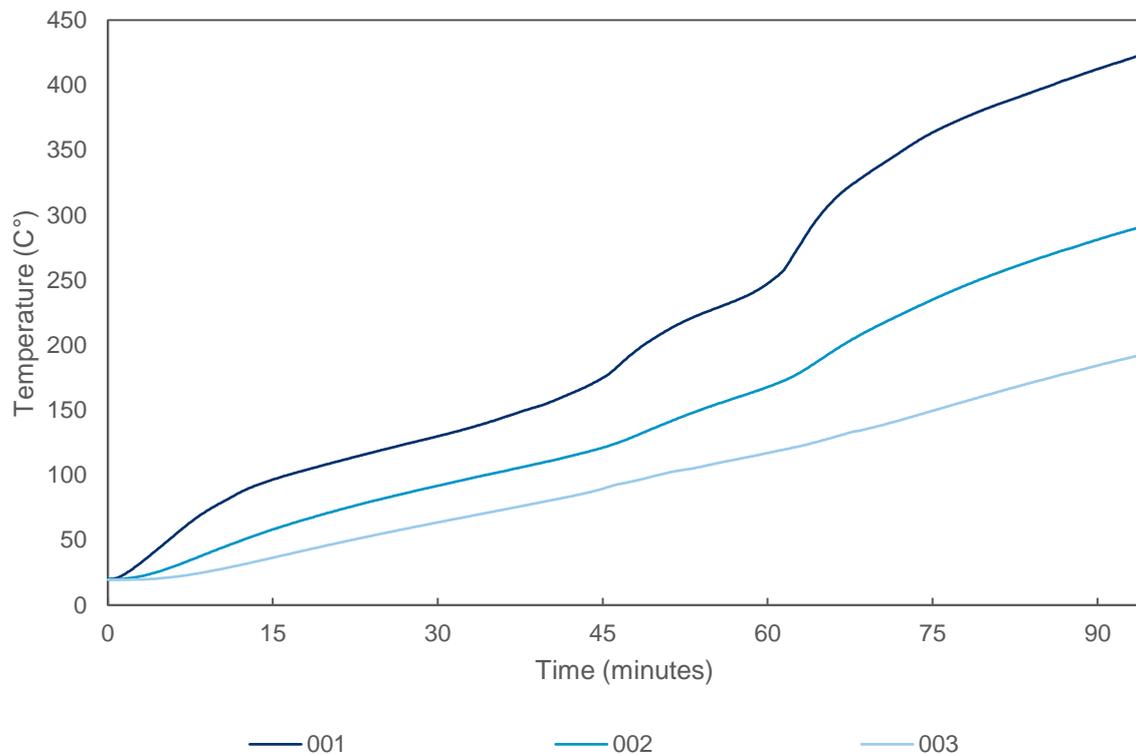


Figure 10 On the south 360UB51 beam – temperature vs time

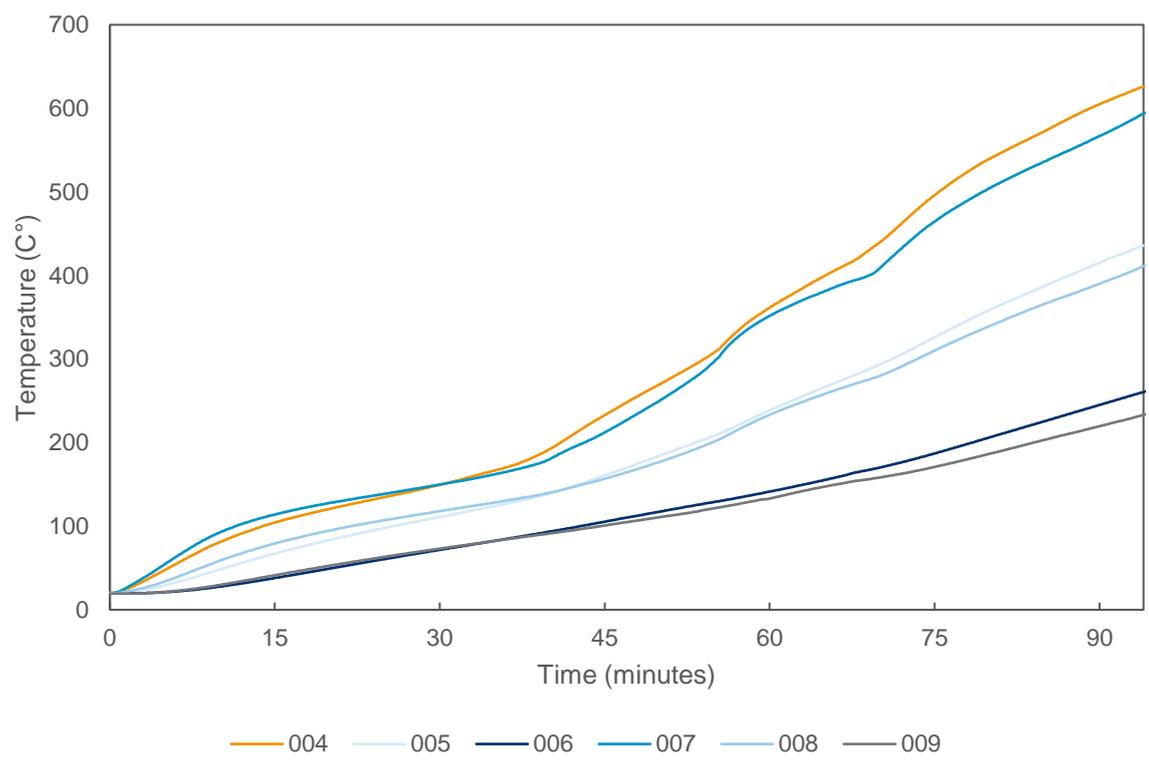


Figure 11 On the north 360UB51 beam – temperature vs time

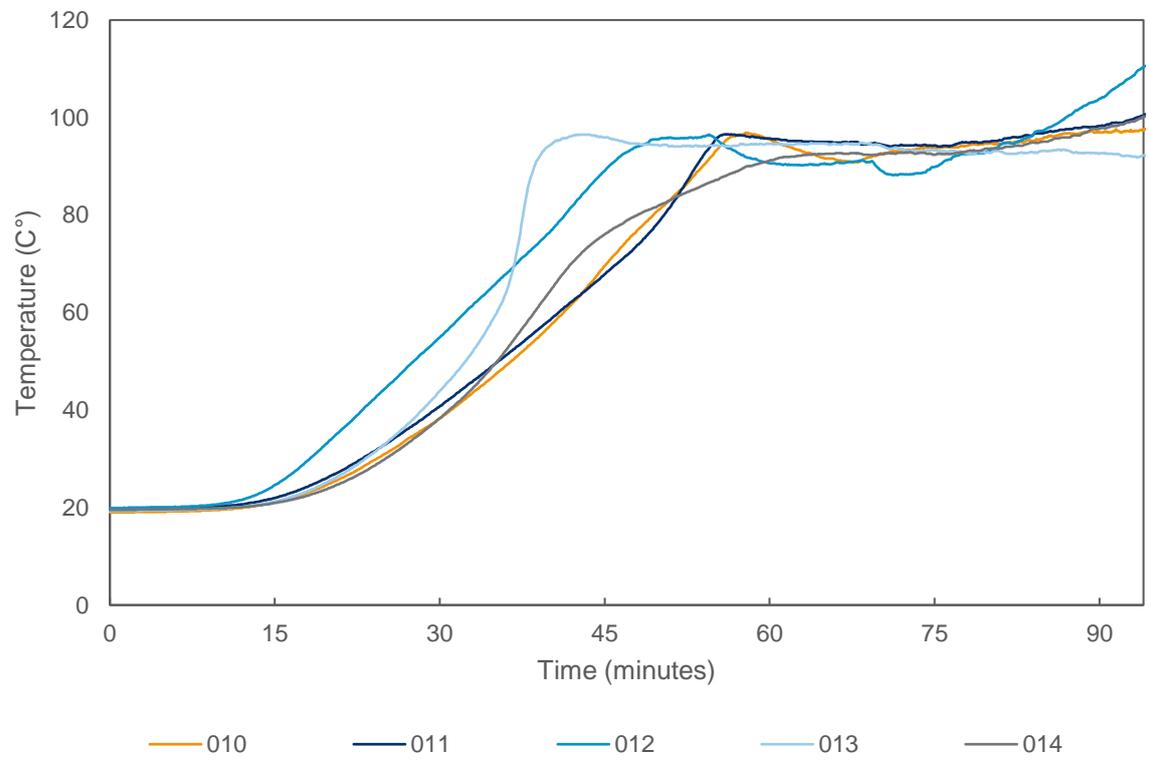


Figure 12 Quarter points and centre -unexposed (rendered section) – temperature vs time

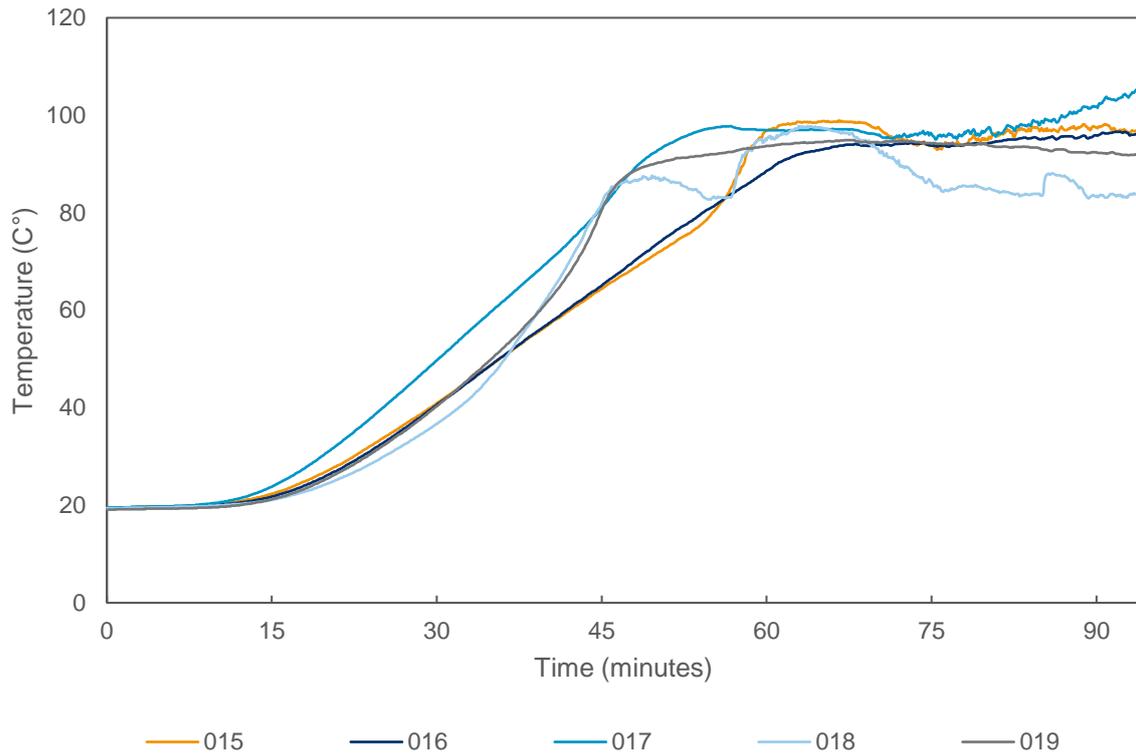


Figure 13 Quarter points and centre -unexposed (non-rendered section) – temperature vs time

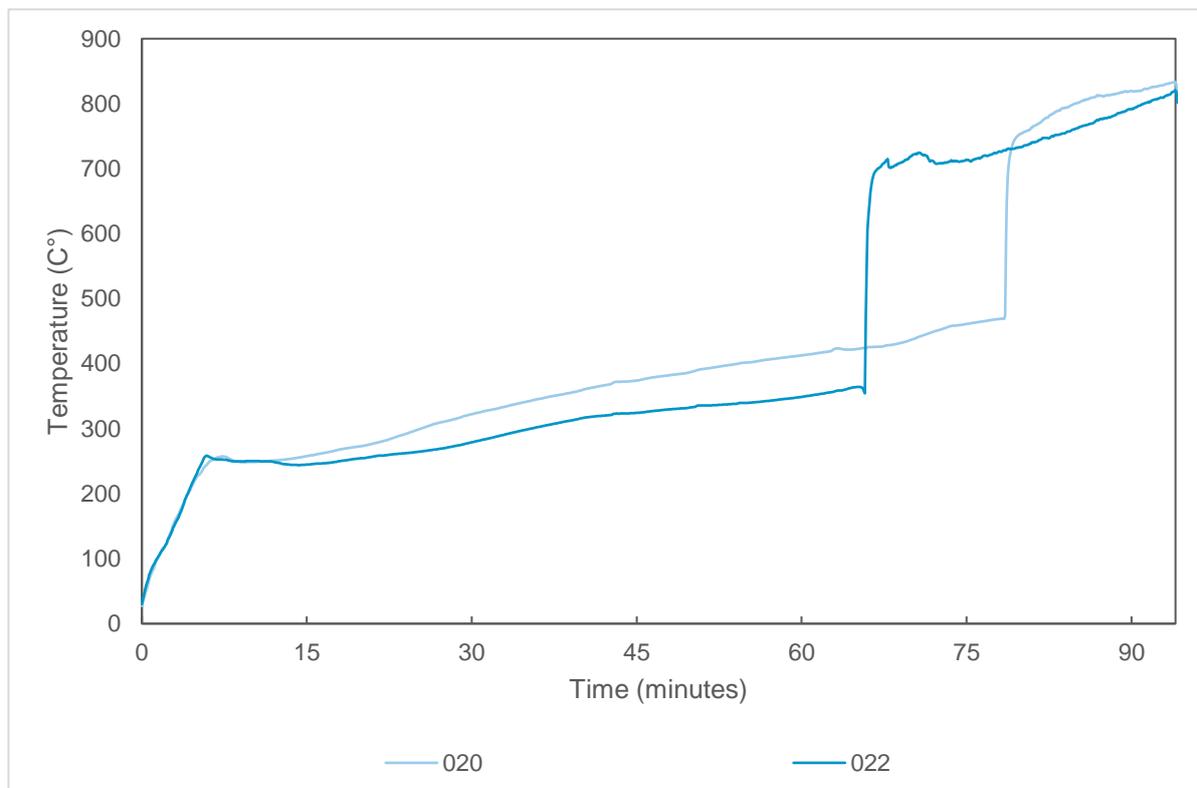


Figure 14 Underside of the arch, non-rendered section – temperature vs time (TC 021 was faulty throughout the whole test period)

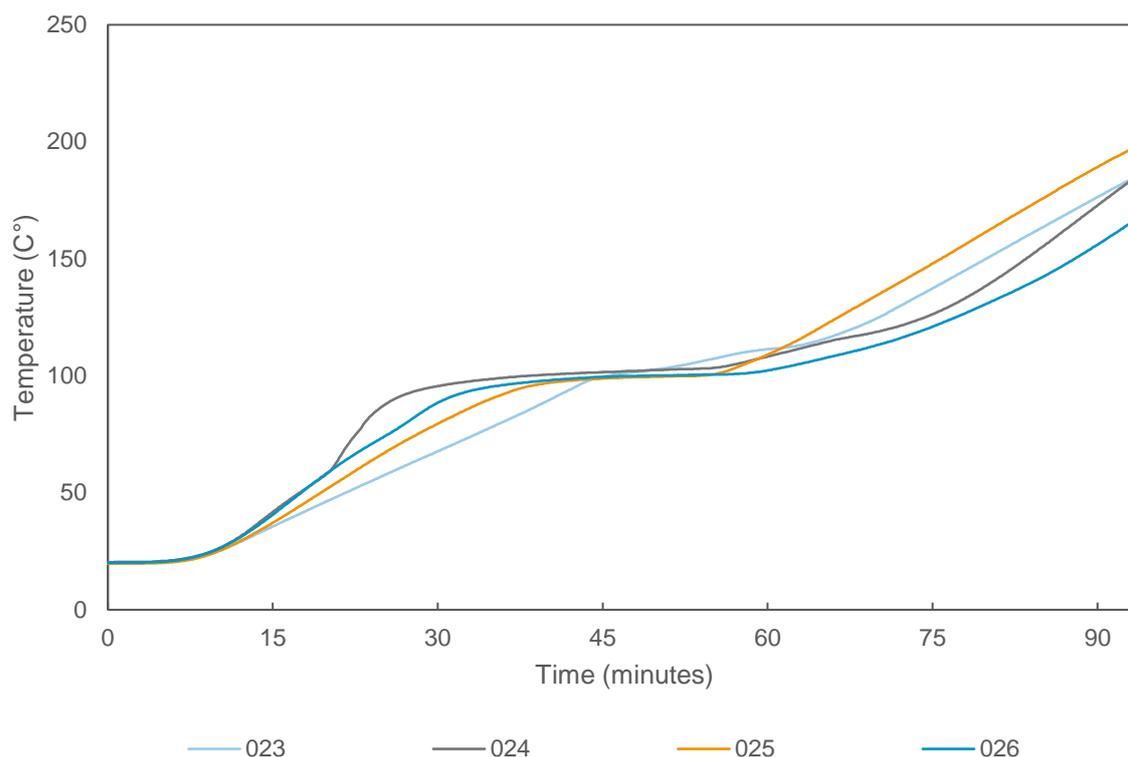


Figure 15 Embedded TCs, at mid-depth of the arch – temperature vs time

Table 13 Test specimen temperatures

Location	T/C #	Description ¹	Temp (°C) at t (minutes)					Limit ² (minutes)
			t=0	t=30	t=60	t=90	t=94	
On the south 360UB51 beam	001	At mid-length of the south steel beam, 6 mm deep from the top side of the inside bottom flange.	20	130	248	413*	424*	N/A
	002	At mid-length of the south steel beam, 6 mm deep on the interface fillet between the web and the bottom flange, on the inside of the beam.	20	92	168	281*	292*	N/A
	003	At mid-length of the south steel beam, 4 mm deep at 55 mm high from the inside bottom flange.	20	64	117	185*	193*	N/A
On the north 360UB51 beam	004	At 325 mm away from the east end of the arch, 6 mm deep from the top side of the inside bottom flange.	20	150	362	606*	627*	N/A
	005	At 325 mm away from the east end of the arch, 6 mm deep on the interface fillet between the web and the bottom flange, on the inside of the beam.	20	111	239	416*	436*	N/A
	006	At 325 mm away from the east end of the arch, 4 mm deep at	20	72	142	245*	261*	N/A

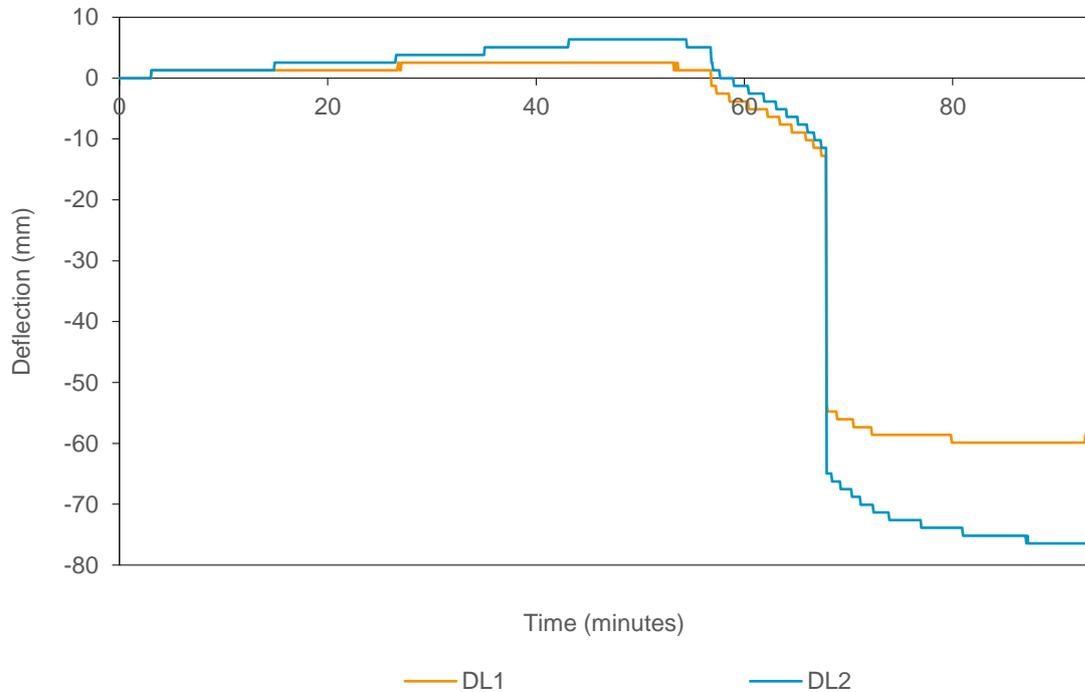
Location	T/C #	Description ¹	Temp (°C) at t (minutes)					Limit ² (minutes)
			t=0	t=30	t=60	t=90	t=94	
		55 mm high from the inside bottom flange.						
	007	At 325 mm away from the west end of the arch, 6 mm deep from the top side of the inside bottom flange.	20	150	352	567*	594*	N/A
	008	At 325 mm away from the west end of the arch, 6 mm deep on the interface fillet between the web and the bottom flange, on the inside of the beam.	20	118	234	391*	412*	N/A
	009	At 325 mm away from the west end of the arch, 4 mm deep at 55 mm high from the inside bottom flange.	19	73	133	220*	234*	N/A
Quarter points and centre - unexposed (rendered section)	010	North-west quarter point	19	38	96	97*	98*	-
	011	Northeast quarter point	20	41	96	98*	101*	-
	012	Centre of section	20	55	91	104*	111*	-
	013	South-west quarter point	19	44	95	93*	92*	-
	014	South-east quarter point	20	39	91	98*	100*	-
Quarter points and centre - unexposed (non-rendered section)	015	North-west quarter point	20	41	97	97*	97*	-
	016	Northeast quarter point	20	41	89	96*	97*	-
	017	Centre of section	20	50	97	102*	105*	-
	018	South-west quarter point	19	37	95	83*	84*	-
	019	South-east quarter point	19	41	94	92*	92*	-
Underside of the arch, non-rendered section	020	At the south corner	27	323	413	819*	830*	N/A
	021	At the middle of the section.	#	#	#	#	#	N/A
	022	At the north corner	30	279	349	792*	819*	N/A
Embedded TCs, at mid-depth of the arch	023	North-west quarter of the specimen	20	68	111	177*	187*	N/A
	024	North-east corner of the specimen	20	96	108	173*	187*	N/A
	025	South-west quarter of the specimen	20	80	109	189*	199*	N/A
	026	South-east quarter of the specimen	20	89	102	156*	169*	N/A

- Note:**
- 1 Refer to Table 10 for the locations of thermocouples as only a generic description is included in the table.
 - 2 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 180 K above the initial temperature.
- * Integrity failure of the non-loadbearing floor system.

⊔ 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.

Thermocouple malfunction.

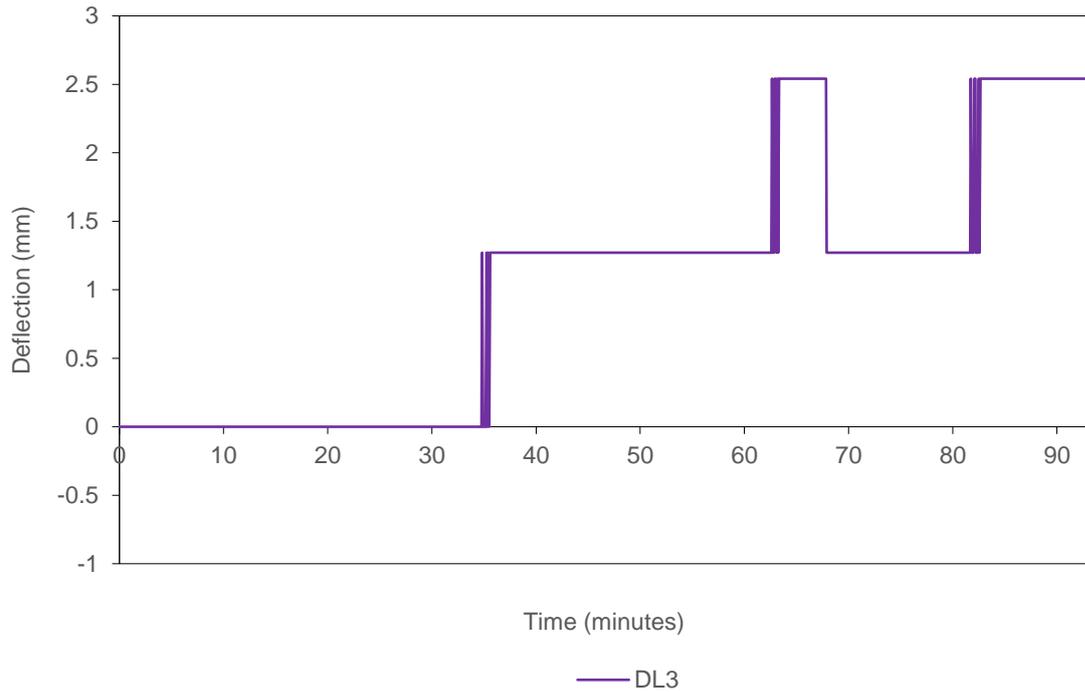
D.4 Specimen deflections



Note:

- Positive measurements show movement of the test specimen towards the furnace.
- Negative measurements show movement of the test specimen away from the furnace.

Figure 16 Deflection of test specimen vs time – vertical deflection



Note:

- Positive measurements show the 360UB 51 steel beams had flared out.
- Negative measurements show the 360UB 51 steel beams had flared in.

Figure 17 Deflection of the test specimen vs time – horizontal deflection

Appendix E Photographs



Figure 18 Unexposed face of the specimen before the start of the test



Figure 19 Exposed face of the specimen before the start of the test

West



East

Figure 20 Unexposed face of the specimen at the end of the test

East



West

Figure 21 Exposed face of the specimen at the end of the test

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