FR 3524

FIRE RESISTANCE OF A LIGHT WEIGHT CONCRETE PANEL LOAD BEARING WALL

Author: **M. W. McLarin**
Fire Engineer

Reviewer: **M. E. Godkin**
Senior Fire Testing Engineer
IANZ Approved Signatory

Contact:
BRANZ Limited
Moonshine Road
Judgeford
Private Bag 50908
Porirua City
New Zealand
Tel: +64 4 237 1170
Fax: +64 4 237 1171
www.branz.co.nz

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FIRE RESISTANCE OF A LIGHT WEIGHT CONCRETE PANEL LOAD BEARING WALL

1. CLIENT

Litecrete (NZ) Ltd
66 Boundary Road
Papakura
Auckland 1703
New Zealand

2. TEST STANDARD

2.1 Test Specification

The test was conducted in accordance with AS 1530.4-1997 Methods for fire tests on building materials, components and structures, Part 4: Fire-resistance tests of elements of building construction, Section 3 Walls and Partitions. This standard states that the fire resistance of a load bearing test specimen is the time, expressed in minutes, to failure under one or more of the following criteria:

2.2 Structural Adequacy

Failure in relation to structural adequacy shall be deemed to have occurred upon collapse.

2.3 Integrity

For an element intended to separate spaces and resist the passage of flame from one space to another, failure in relation to integrity shall be deemed to have occurred upon collapse, or the development of cracks, fissures, or other openings through which flames or hot gases can pass.

2.4 Insulation

Failure in relation to insulation shall be deemed to have occurred when either:

(a) The average temperature of the relevant thermocouples attached to the unexposed face of the test specimen rises by more than 140K above the initial temperature; or

(b) The temperature of any of the relevant thermocouples attached to the unexposed face of the test specimen rises by more than 180K above the initial temperature.

3. DESCRIPTION OF THE TEST SPECIMEN

3.1 General

The test specimen consisted of a load bearing, 150 mm thick precast panel, light weight concrete wall 3.0 m high by 3.0 m wide.

3.2 Wall Construction

The wall specimen was formed from two precast panels nominally 1500 mm wide x 3000 mm high x 150 mm thick connected at mid width by a tongue and groove joint sealed with Sika Flamex PU sealant. The tongue and groove were nominally 50 mm deep and were tapered from nominally 40 mm to 80 mm. Each panel was reinforced with HD12 steel reinforcing mesh of 230 mm square grid and provided with a cast-in top edge lifter fitting comprising two 1000 mm long steel rods.

The wall was sealed top and bottom in the specimen loading frame by ceramic fibre strips and located top and bottom by bolting through steel angles onto the unexposed face. Both vertical edges were unrestrained with expansion gaps nominally 10 mm wide lightly packed with ceramic fibre.

The measured mean bulk density and moisture content by weight of representative samples of the concrete at the time of testing were as follows:

Bulk density	1018 kg/m^3
Moisture content	10.6 %

4. TEST PROCEDURE

4.1 General

The test was conducted on 12 January 2006, at the BRANZ laboratories at Judgeford.

The frame containing the test specimen was sealed to the 3 m wide x 4 m high furnace, and the temperature and pressure conditions were controlled as specified in AS 1530.4-1997.

The ambient temperature at the beginning of the test was 19 °C.

4.2 Furnace Temperature Measurement

Temperature measurement within the furnace was made using twelve mineral insulated metal sheathed (MIMS) chromel-alumel thermocouples uniformly distributed in a vertical plane approximately 100 mm from the exposed face of the specimen.

4.3 Specimen Temperature Measurement

The temperature on the unexposed face of the test specimen was measured using chromel-alumel thermocouples mounted on copper discs and covered with insulating pads, in accordance with clause 2.2.3 of the test standard. Six thermocouples for determining the average temperature were placed on the unexposed face of the wall, one either side of the panel joint adjacent to the

wall centre point, and one at the centre of each quarter of the wall. An additional three thermocouples were placed at potential hot spots; one in the top right corner of the left panel and one each at the top centre edge and right side edge of the right hand panel. The locations of the thermocouples are shown in Figure 5.

A roving thermocouple was available for measuring temperatures elsewhere on the specimen.

4.4 Temperature Recording

All the thermocouples described in sections 4.2 and 4.3 were connected to a computer controlled data logging system which recorded the temperatures at 15 second intervals.

4.5 Pressure Measurements

The pressure difference between the furnace and laboratory atmosphere was controlled to be neutral at 500 mm above the notional floor level. The differential pressure was monitored using a micromanometer connected to a computer controlled data logging system which recorded the pressure at 15 second intervals.

4.6 Deflection Measurements

The deflection of the unexposed face of the specimen was measured using a theodolite and rule at the deflection points shown in Figure 5. Measurements were taken at 15 minute intervals up to 60 minutes then at 30 minute intervals for the remainder of the test.

The deflection of each end of the movable loading platen was measured by linear transducers connected to a computer controlled data logging system which recorded the vertical deflections of the wall at 15 second intervals.

4.7 Loading

At the request of the client a vertical load of 15 kN/m was applied to the wall. The load was applied to the specimen at least 30 minutes before the commencement of the test and was maintained for the duration of the test. The load was monitored using a load cell, placed between each of the two hydraulic jacks and the moveable platen, and connected to a computer controlled data logging system which recorded the load at 15 second intervals.

5. RESULTS

5.1 Duration

The test was stopped after 250 minutes.

5.2 Furnace Temperature

Figure 1 shows the standard curve in relation to the actual mean furnace temperature.

In accordance with the test standard the accuracy of control of the furnace was as follows:

	Variation of area under time-temperature curve (%)	
	Standard	**Actual**
End of first 10 minutes	± 15.0	1.4
End of first 30 minutes	± 10.0	0.3
After 30 minutes (max)	± 5.0	0.0 to 0.3
At end of test	± 5.0	0.0
	Variation of the mean furnace temperature (°C)	
	Standard	**Actual**
After 10 minutes	± 100	-15 to 15
	Variation of individual furnace temperatures (°C)	
	Standard	**Maximum Actual**
After first 10 minutes	± 100	-71 to 91

The furnace conditions complied with the test standard.

5.3 Structural Adequacy

The specimen maintained structural adequacy for the duration of the test.

5.4 Integrity

The specimen maintained integrity for the duration of the test.

5.5 Insulation

The average temperature rise measured by the relevant thermocouples on the unexposed face of the specimen did not exceed the failure criterion of 140K for the duration of the test. The average temperature rise measured at the end of the test was 39K.

The maximum temperature rise measured by the thermocouples on the unexposed face of the specimen did not exceed the failure criterion of 180K for the duration of the test. The maximum temperature rise measured at the end of the test was 67K adjacent to the panel joint at the top right hand corner of the left hand panel.

A graph of the average and maximum temperature rise measured by the relevant thermocouples is shown in Figure 2.

5.6 Observations

Observations related to the integrity performance of the wall were as follows at the times stated in minutes and seconds. References to left and right hand side are as observed from the unexposed face.

Mins:secs

10:00 There were shallow surface cavities approximately 10 to 20 mm in diameter on the exposed face and spaced at about one per square metre.

22:30 Random hairline cracks approximately 100 mm apart in all directions were visible on the exposed face.

83:00 Hairline cracks on the exposed face had increased slightly but were still less than 1 mm in width.

100:00 There was some moisture on the unexposed face adjacent to the lower half of the joint between the two panels.

124:00 On the exposed face the visible cracks were well defined but not greater than approximately 1 mm wide.

147:00 A hairline crack had developed across the full width at approximately mid height of the unexposed face of the left hand panel.

238:00 The hairline cracks visible on the exposed face were still no more than approximately 1 mm in width and the crack on the unexposed face of the left hand panel was approximately 1 mm wide. On the unexposed face there was some moisture showing at this crack and also at the joint between the two panels.

The test was stopped after 250 minutes.

After the furnace was opened it was apparent that the crazing in the surface of the exposed face was fairly uniform with the cracks mostly approximately 2-3 mm wide but where they radiated out from the vertical joint between the two panels the cracks were approximately 4 mm wide.

The seal in the joint was mainly still in place on the exposed face with only some sections fallen out and on the unexposed face there was no sign of degradation in the seal.

5.7 Deflections

The position of the unexposed face deflection measurement points are shown in Figure 5 and the deflections measured at these points are shown in Figure 3. Positive deflections are towards the furnace. The wall generally deflected convex towards the furnace. The maximum deflection measured during the test was 21 mm towards the furnace at mid height of the right hand panel adjacent to the panel joint at 240 minutes. Measured differential movement at the panel joint was not greater than 4 mm throughout the test.

The vertical movement of the loading platen is shown in Figure 4. Negative deflections are downward movement of the platen in response to thermal expansion of the wall. The wall continued to expand throughout the test and the maximum downward movement of the platen was 7 mm measured on the left hand side at 250 minutes.

6. SUMMARY

The fire resistance, in accordance with AS 1530.4-1997, of the 150 mm thick light weight concrete panel load bearing wall under an imposed vertical load of 15 kN/m was as follows:

Structural Adequacy	250 minutes No Failure
Integrity:	250 minutes No Failure
Insulation:	250 minutes No Failure

The test standard requires the following statement to be included: “The results of this test may be used to directly assess fire hazard, but it should be recognized that a single test method will not provide a full assessment of fire hazard under all fire conditions.”

7. ATTACHMENTS

Figure 1 Furnace Temperature

Figure 2 Specimen Temperatures

Figure 3 Specimen Face Deflections

Figure 4 Deflections of the Loading Platen

Figure 5 Thermocouples and Deflection Points

MWM MG

Figure 1 Furnace Temperature

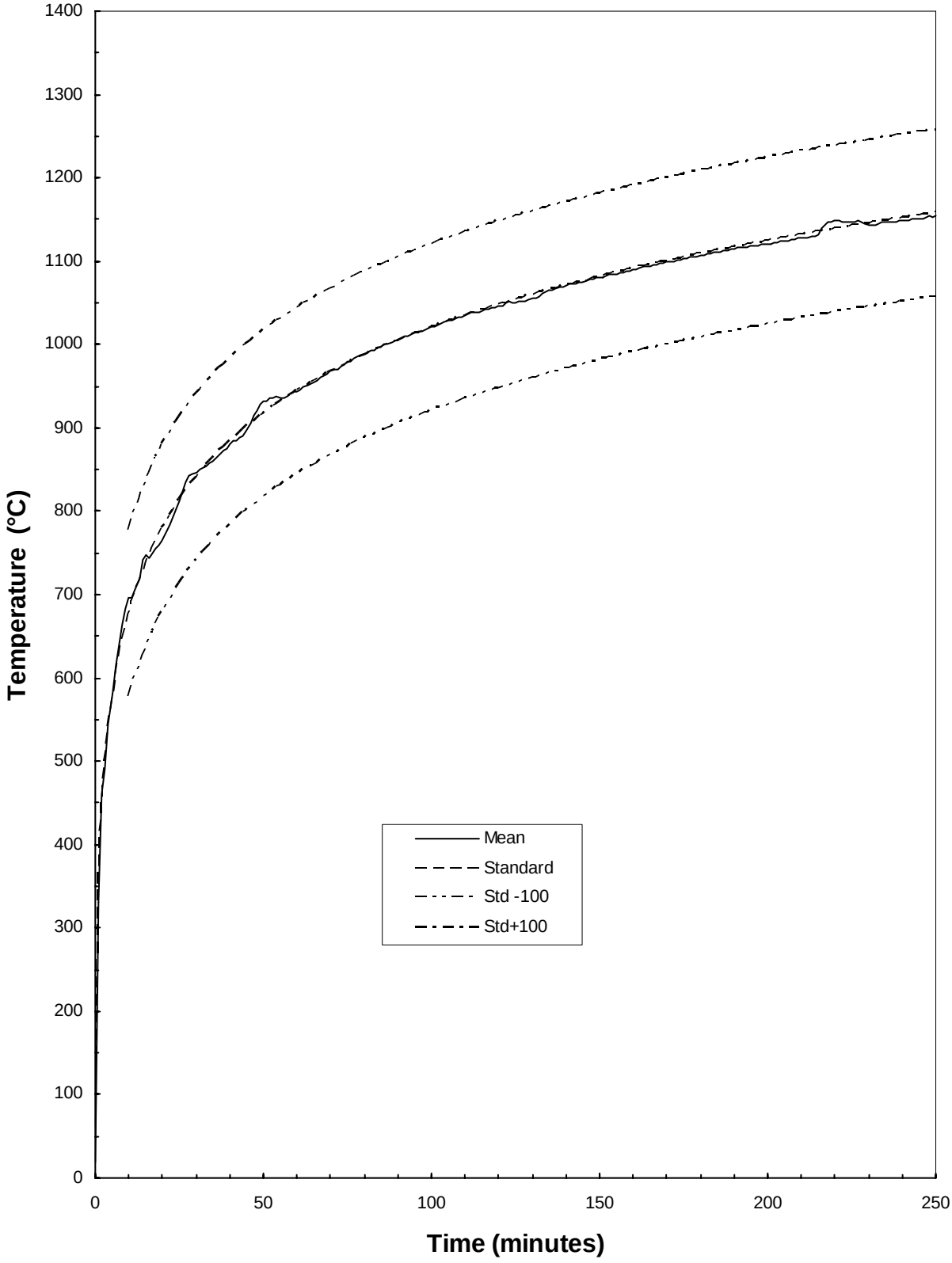

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Figure 2 Specimen Temperatures

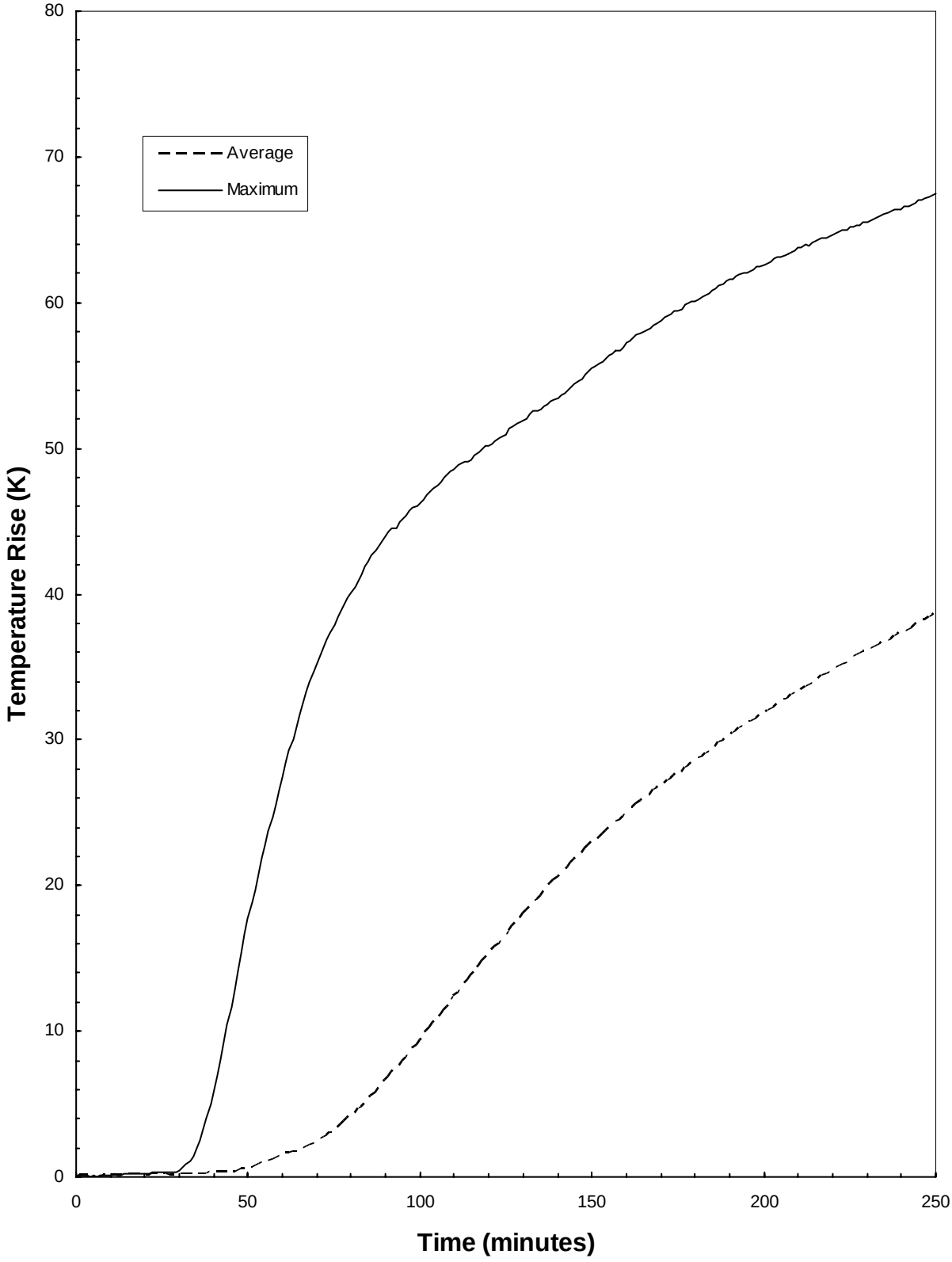

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Figure 3 Specimen Face Deflections

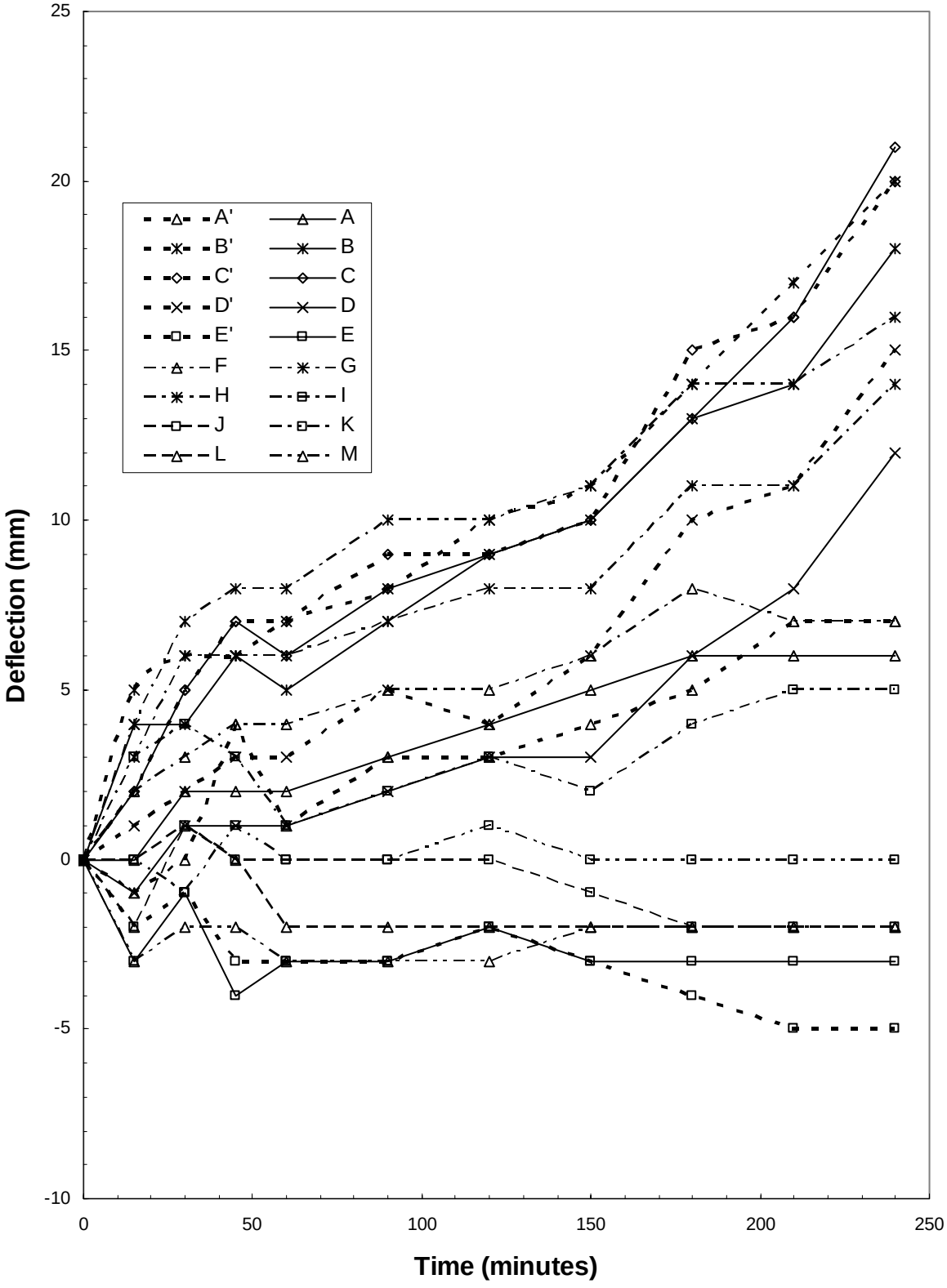

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Figure 4 Deflections of the Loading Platen

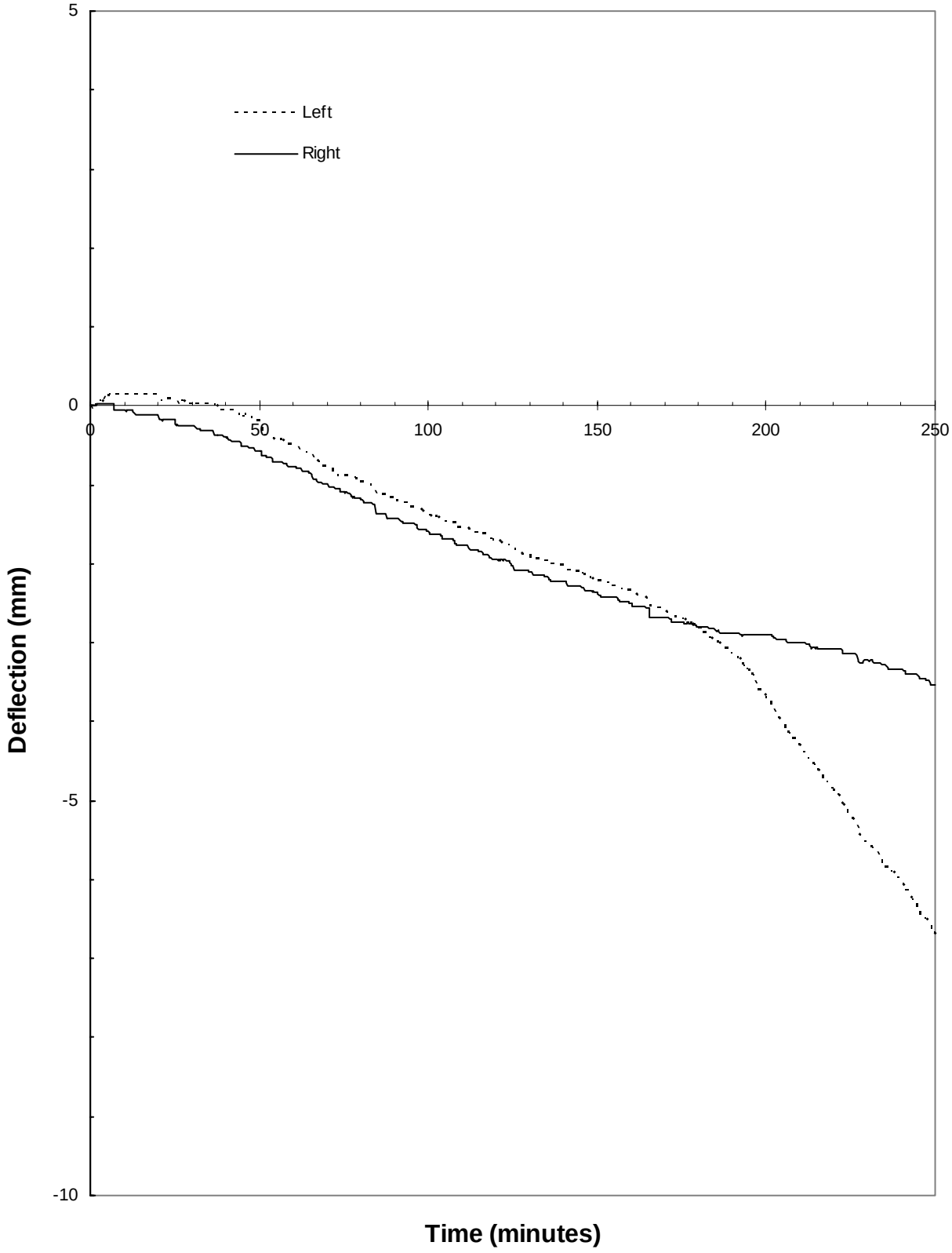

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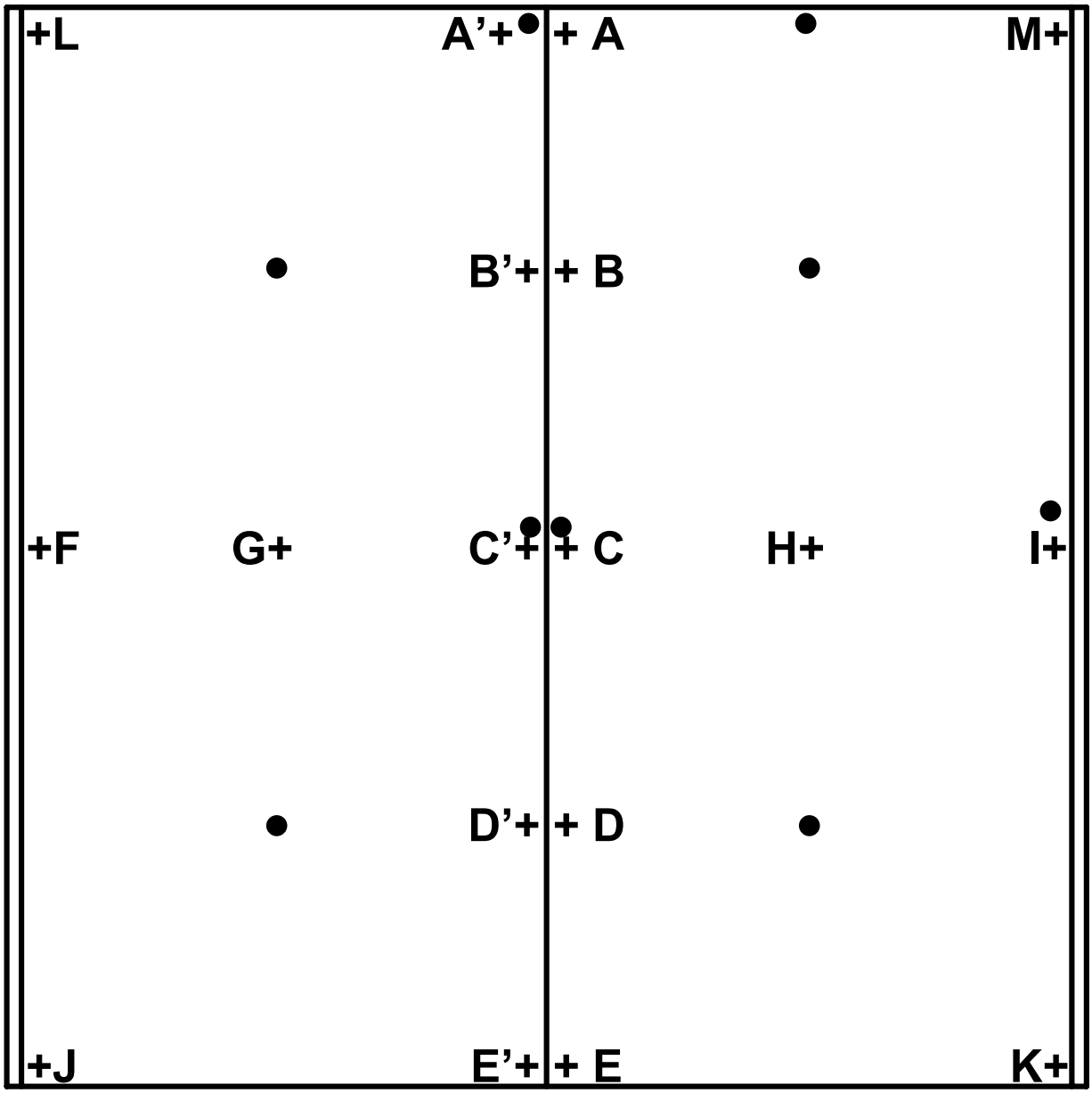
Figure 5 Thermocouples and Deflection Points



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