BRANZ Test Report

BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND
BRANZ, Private Bag, Porirua, New Zealand
Telegrams BRANZ, Wellington. Telex NZ30256. Telephone Wellington (04) 357600

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REPORT ON THE FIRE RESISTANCE PROPERTIES OF A LOADBEARING TIMBER FRAMED WALL LINED WITH 19MM THICK "PLASTERGLASS FYRWALL"

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REPORT ON THE FIRE RESISTANCE PROPERTIES OF A LOADBEARING TIMBER FRAMED WALL LINED WITH 19MM THICK "PLASTERGLASS FYRWALL"

1 INTRODUCTION

1.1 Test Sponsors

The original purpose of the test was as a commissioning test for the BRANZ loadbearing wall testing equipment. The test specimen was constructed as an almost exact copy of a specimen which had previously been tested as a non-loadbearing wall, but with some modifications in order to comply with the test standard for a loadbearing wall test.

Subsequently a request was received from the New Zealand Fibrous Plaster Association for a report to be prepared at their expense, and therefore the test is regarded as being jointly sponsored by:

1. The Building Research Association of New Zealand,
   Private Bag,
   Porirua,
   New Zealand.

2. The New Zealand Fibrous Plaster Association Incorporated,
   P.O. Box 1087,
   Wellington,
   New Zealand.

1.2 Test Specification

The test was in accordance with ISO 834 - 1975 Fire Resistance Tests - Elements of Building Construction. This states that the fire resistance of a loadbearing test specimen shall be the time, expressed in minutes, to failure under one or more of the following criteria:

1.2.1 Loadbearing Capacity

The test specimen shall not collapse in such a way that it no longer performs the loadbearing function for which it was constructed.

1.2.2 Insulation

For elements of construction, such as walls, which have the function of separating two parts of a building:

1. The average temperature of the unexposed face of the test specimen shall not exceed the initial temperature by more than 140^{o}C.

2. The maximum temperature at any point on this face shall not exceed the initial temperature by more than 180^{o}C, and shall not exceed 220^{o}C irrespective of the initial temperature.

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1.2.3 Integrity

Initial integrity failure is deemed to occur when either:

1. Cracks, holes or other openings are formed in the test specimen such that flames or hot gases can pass so as to cause ignition of a cotton pad, or

2. Sustained flaming, having a duration of at least ten seconds, appears on the unexposed face of the test specimen.

Ultimate integrity failure is deemed to occur when the partition collapses.

2 DESCRIPTION OF THE TEST SPECIMEN

2.1 General

The test specimen consisted of a loadbearing timber framed wall, lined with one layer of nominal 19mm thick "Plasterglass Fyrwall" on either side. The lining configurations were chosen to include an example of each type of joint, both vertical and horizontal, which is likely to occur in practice. The framing was of nominal 150 x 50mm Radiata pine. Figure 9 shows details of the framing and lining configurations.

2.2 Timber Frame

All timber for the studs, dwangs, top and bottom plates was nominal 150 x 50mm dressed No. 1 framing grade Radiata pine. The measured dimensions and properties of the timber were as follows:

Depth	144 to 145mm Average 144mm
Thickness	46 to 47mm Average 46mm
Moisture content	17.6 to 22.1% Average 19.2%
Dry density	366 to 524 kg/m^3 Average 456 kg/m^3

There were five loadbearing studs, spaced at approximately 600mm centres starting 300mm from one side of the specimen holder. In addition there was a stud at either side of the specimen which was cut 100mm short at top and bottom to ensure that it did not carry any significant load.

There were three rows of dwangs spaced vertically at 1m centres, and a top and bottom plate.

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2.3 Edge Treatment

The side studs were fixed to the specimen holder with two bolts each, and the dwangs and lining sheets were nailed to the side studs. This fixing detail meant that there was a considerable degree of restraint against vertical and out of plane movement at the edges of the specimen. The top and bottom plates were fixed to the specimen holder with four bolts each.

2.4 Lining

The wall framing was lined on both sides with one layer of nominal 19mm thick "Plasterglass Fyrwall". A drawing showing the layout of the lining sheets on both the fire exposed and unexposed faces are included as Figure 9. The measured thickness of the lining was as follows:

On a formed edge	19.6 to 20.7mm Average 20.2mm
On a cut edge	19.0 to 20.0mm Average 19.6mm

All sheet joints on studs or dwangs, and the perimeter of the specimen, were caulked with "Victor Plaster Cornice Adhesive" by wiping onto the sheet edge as it was placed. The sheet edges at such positions were fixed by nailing at 150 mm centres with 50 x 2.5 mm galvanised flathead nails. In the field of the sheet the fixing was by 50 x 2.5 mm galvanised flathead nails at 300 mm centres on all studs and dwangs.

Joints between sheets which did not fall on a stud or dwang were formed by the "wadding" method. This consists of applying a mixture of plaster and glass fibres pressed into a gap between the sheets. Details of the method of application of the wads and the width of the gap between adjacent sheets are not available.

All sheet joints, and the perimeter of the specimen were taped with 36mm wide open weave fibreglass tape with about 2.5mm between strands. The tape was bedded in "Victor Plaster Cornice Adhesive", and the joint was then filled to a smooth surface using "Victor Plaster 4F" stopping compound. All nail heads were punched and stopped with the same stopping compound.

3 TEST PROCEDURE

3.1 General

The test was conducted on the 3rd of September 1981 at the BRANZ laboratories at Judgeford, New Zealand, in the presence of representatives of the New Zealand Fibrous Plaster Association.

The frame containing the test specimen was sealed to the furnace, and the temperature and pressure conditions controlled as nearly as possible to those specified in ISO 834 - 1975.

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3.2 Furnace Temperature Measurement

The temperature of the atmosphere within the furnace was measured using twelve chromel - alumel thermocouples distributed evenly on a vertical plane approximately 100mm from the exposed face of the specimen.

3.3 Specimen Temperature Measurement

The temperature on the unexposed face of the test specimen was measured using chromel - alumel thermocouples in accordance with ISO 834 - 1975, Section 4.1.4. Five thermocouples were placed on the wall, one at the approximate mid-point of the specimen, and one at the approximate centre of each of the quarters. These thermocouples were located such that they did not fall on any stud or dwang.

In addition to the five standard thermocouples, 27 extra 1mm diameter sheathed thermocouples were placed within the studs to gather information concerning the charring of the timber. Of these 27, 15 were set into the timber studs 5mm back from the exposed side, and four each at 10, 15 and 20mm back. The positions of all the thermocouples are shown on Figure 8.

3.4 Temperature Recording

All the thermocouples described in sections 3.2 and 3.3 were connected to potentiometric recorders.

3.5 Pressure Measurements

The pressure difference between the furnace and laboratory atmospheres was adjusted such that it was 10 $\pm$ 2 Pa at a point 3.0m above the bottom of the specimen. The pressure was monitored using a micromanometer connected to a continuously reading recorder.

3.6 Load Application

A load of 32.8kN per loadbearing stud was applied to the specimen, giving a total load of 164kN. The load was applied by means of three hydraulic jacks, and was monitored using load cells connected to a continuously reading recorder.

3.7 Deflection Measurements

The out of plane deflection of the specimen was measured using a theodolite and rule. Measurements were taken at approximately ten minute intervals, on points A to E, as shown on Figure 9.

The vertical movement of the platen was monitored by dial gauges which were read as appropriate to the amount of movement. A dial gauge was located under the platen at each side of the specimen holder.

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4 OBSERVATIONS

4.1 Duration

The test was terminated after the specimen had been exposed to the standard fire resistance test for 1 hour and 35 minutes.

4.2 Severity

A measurement of the severity of a fire resistance test can be established by a comparison of the area beneath the time - temperature curve for the test with the area beneath the standard time - temperature curve for the same period. Figure 1 shows the standard time - temperature curve for ISO 834 - 1975 in relation to the actual temperatures for the test. The fire severity of this test as calculated by the above comparison for the duration of the test was 100%.

4.3 Loadbearing Capacity

The specimen carried the applied load until 1 hour and 35 minutes, at which time the right hand loadbearing stud (as shown on Figure 9, Unexposed Face) collapsed at a point about 700mm up from the bottom of the specimen. This constituted a failure of the loadbearing capacity, and after this time the load was removed.

4.4 Insulation

4.4.1 Average Specimen Temperature Rise

The average specimen temperature rise as measured by the five standard thermocouples did not reach the failure criterion of 140^{o}C. The maximum value recorded for the average specimen temperature rise was 51^{o}C, and occurred at 1 hour and 35 minutes.

4.4.2 Maximum Specimen Temperature Rise

The maximum specimen temperature rise as measured by the five standard thermocouples did not reach the failure criterion of 180^{o}C. The maximum value recorded for the maximum specimen temperature rise was 57^{o}C, and occurred at 1 hour and 35 minutes.

Graphs of the temperature rises measured by these five thermocouples are included as Figure 2.

4.5 Integrity

No cracks or fissures formed through which hot gases could escape. At 1 hour and 35 minutes the right hand loadbearing stud (see Figure 9, Unexposed Face) collapsed and bowed away from the furnace such that a gap appeared between the specimen and the concrete frame through which the interior of the furnace was clearly visible. This constituted a failure of ultimate integrity.

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4.6 Deflections

4.6.1 Out Of Plane Deflections

The maximum out of plane deflection measured was 48mm away from the furnace, and occurred at 92 minutes on the midpoint of the specimen. The out of plane deflections are shown on Figure 7A.

4.6.2 Vertical Deflection Of Platen

The maximum vertical movement measured was 15mm upwards and ocurred on the right hand side (from unexposed face) at 95 minutes. The vertical movement of the platen is shown on Figure 7B.

4.7 Charring Of Studs

The time to onset of char is taken as being the time for a sheathed thermocouple 5mm back from the fire exposed side of the timber to reach a temperature of 300^{o}C. All of the 15 thermocouples at such locations reached this temperature, and the average time taken was 76 minutes.

Graphs of the temperatures measured on the 27 thermocouples included to examine the charring behaviour are included as Figures 3 to 6.

5 SUMMARY

The fire resistance of the specimen was as follows:

Loadbearing Capacity:	1 hour 35 minutes
Insulation:	1 hour 35 minutes (no failure)
Integrity:	1 hour 35 minutes

6 ATTACHMENTS

Figure 1	Furnace Temperature
Figure 2	Unexposed Face Temperatures
Figure 3	5mm Thermocouple Temperatures
Figure 4	10mm Thermocouple Temperatures
Figure 5	15mm Thermocouple Temperatures
Figure 6	20mm Thermocouple Temperatures
Figure 7A	Out of Plane Deflections
Figure 7B	Vertical Deflection of Platen
Figure 8	Thermocouple Positions
Figure 9	Sheet Layout and Deflection Points

J.J. King
FIRE RESEARCH ENGINEER

K. Trotter
FOR THE ASSOCIATION

Figure 1 Furnace Temperature

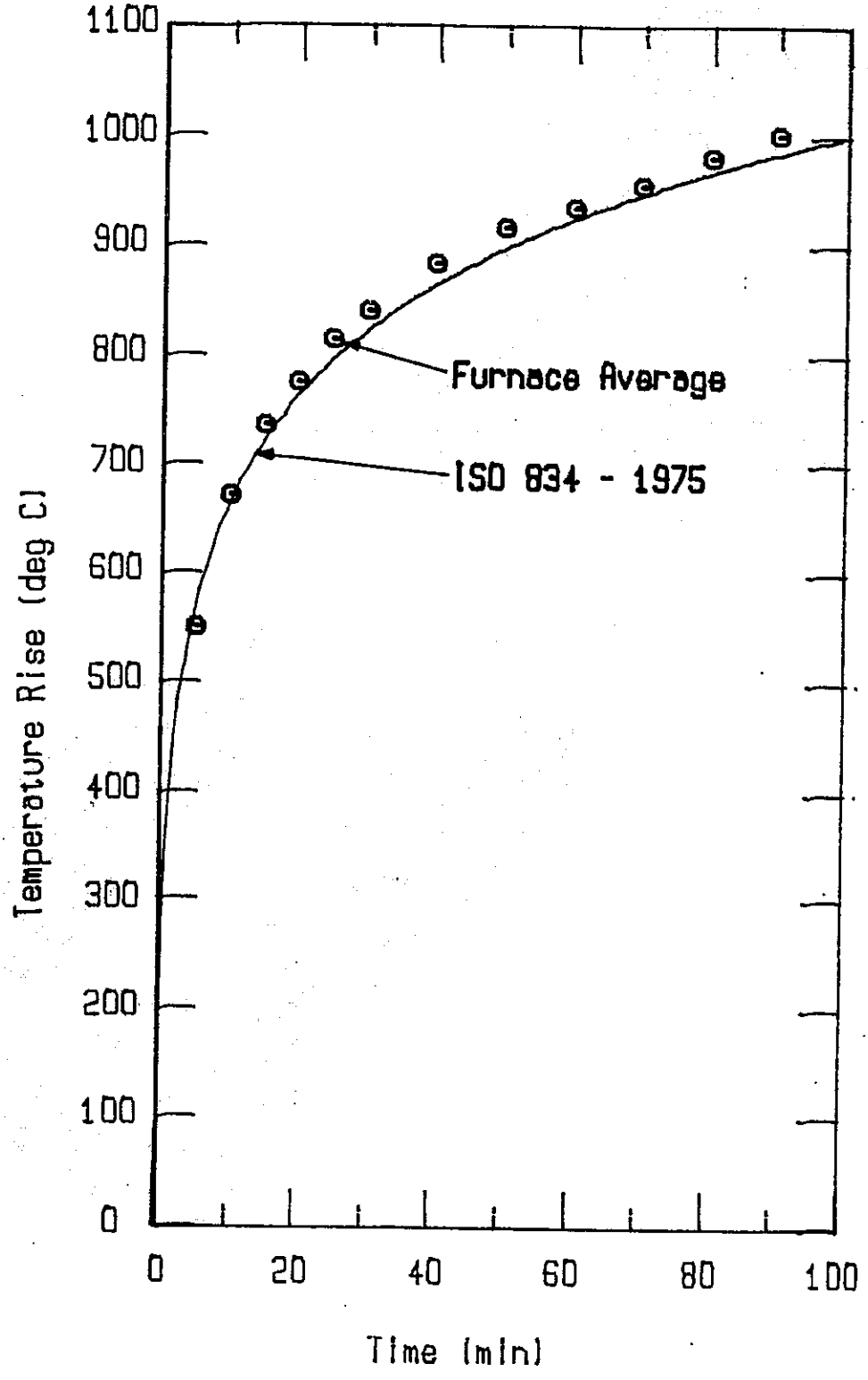


Figure 2 Unexposed Face

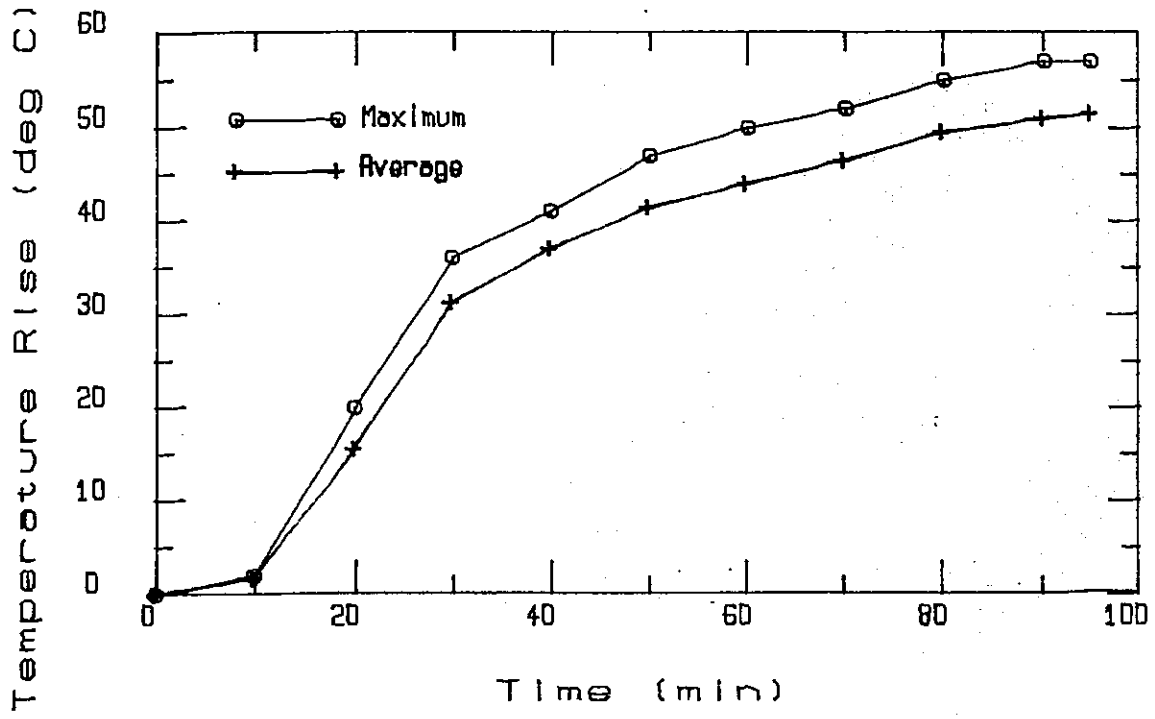


Figure 3 5mm Thermocouples

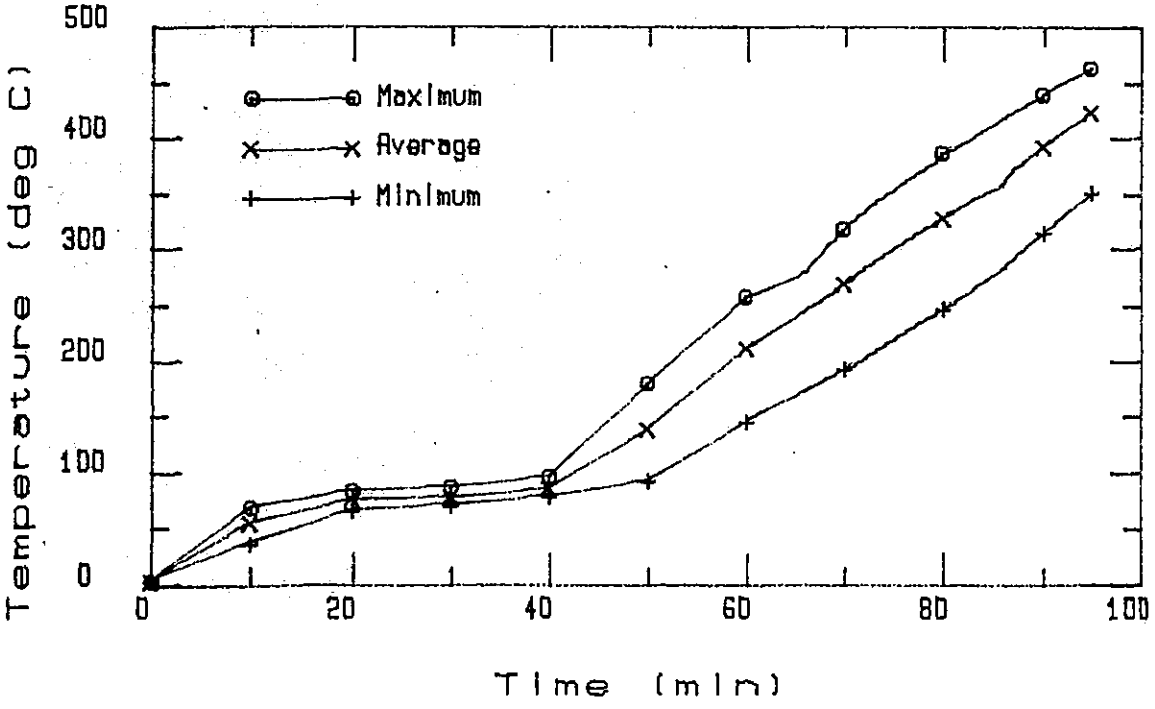


Figure 4 10mm Thermocouples

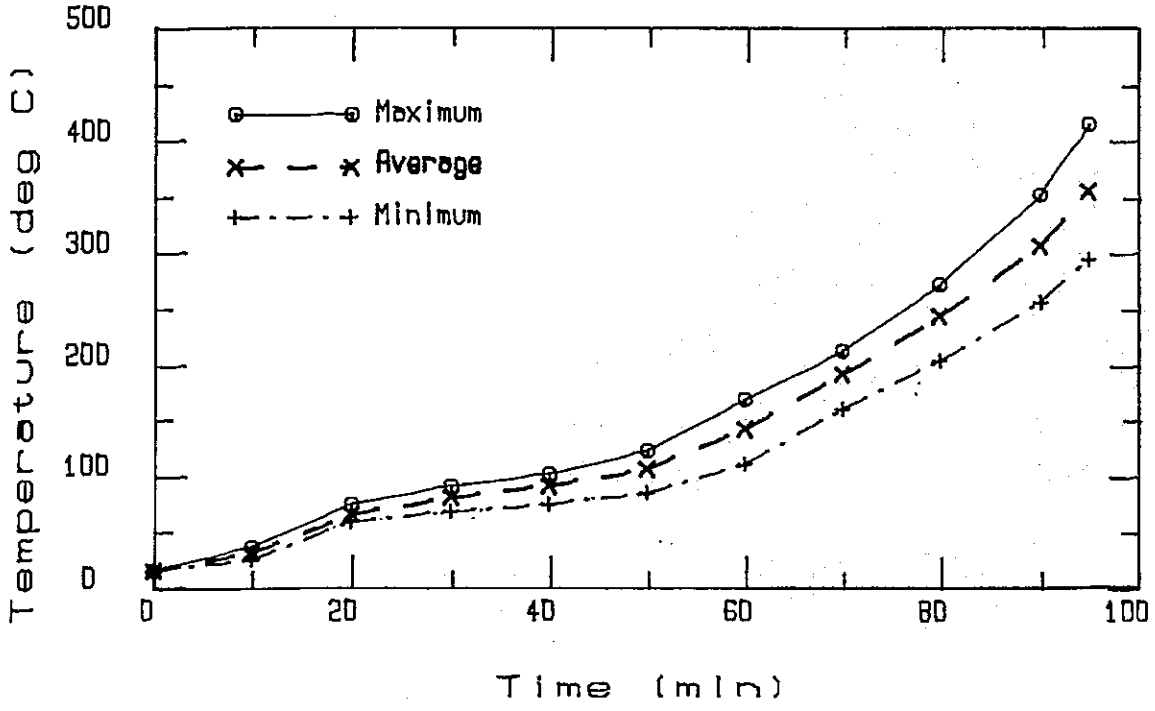


Figure 5 15mm Thermocouples

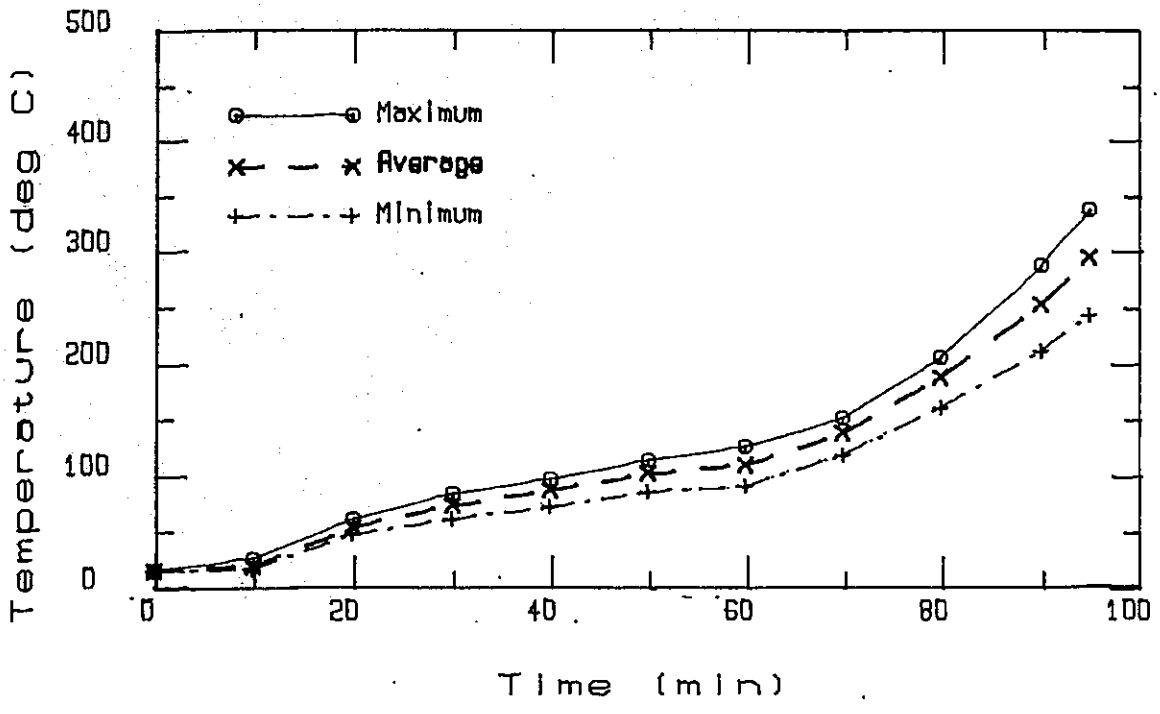


Figure 6 20mm Thermocouples

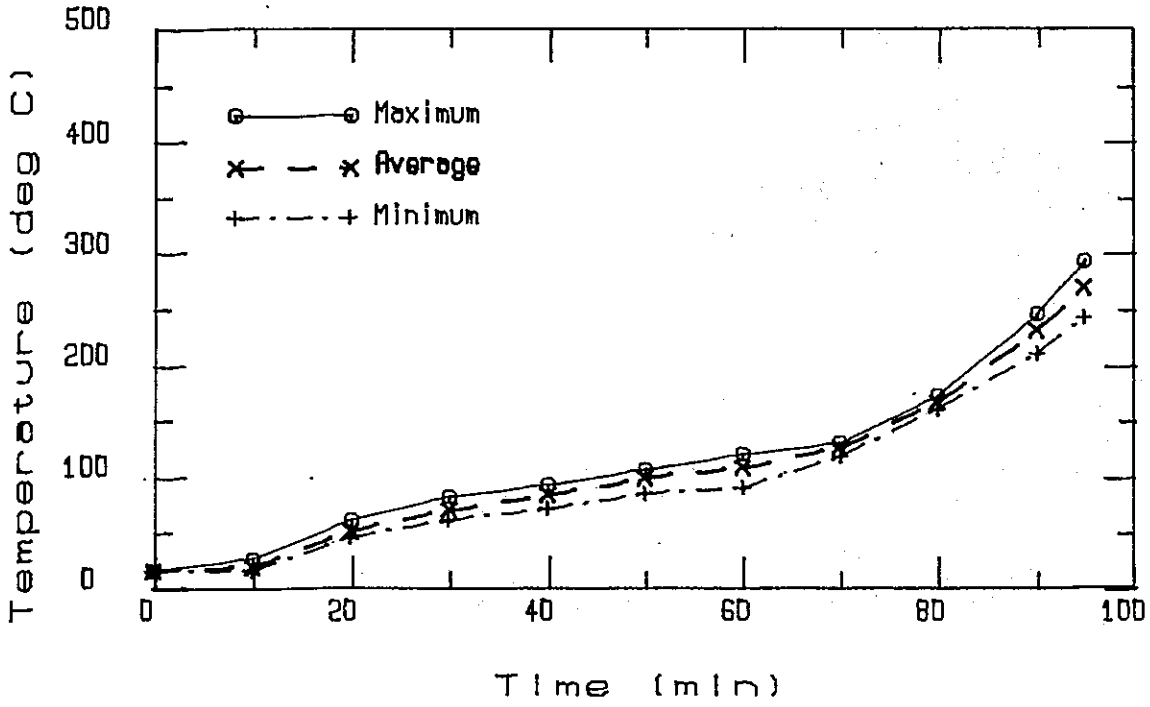


Figure 7A Out of Plane Deflection

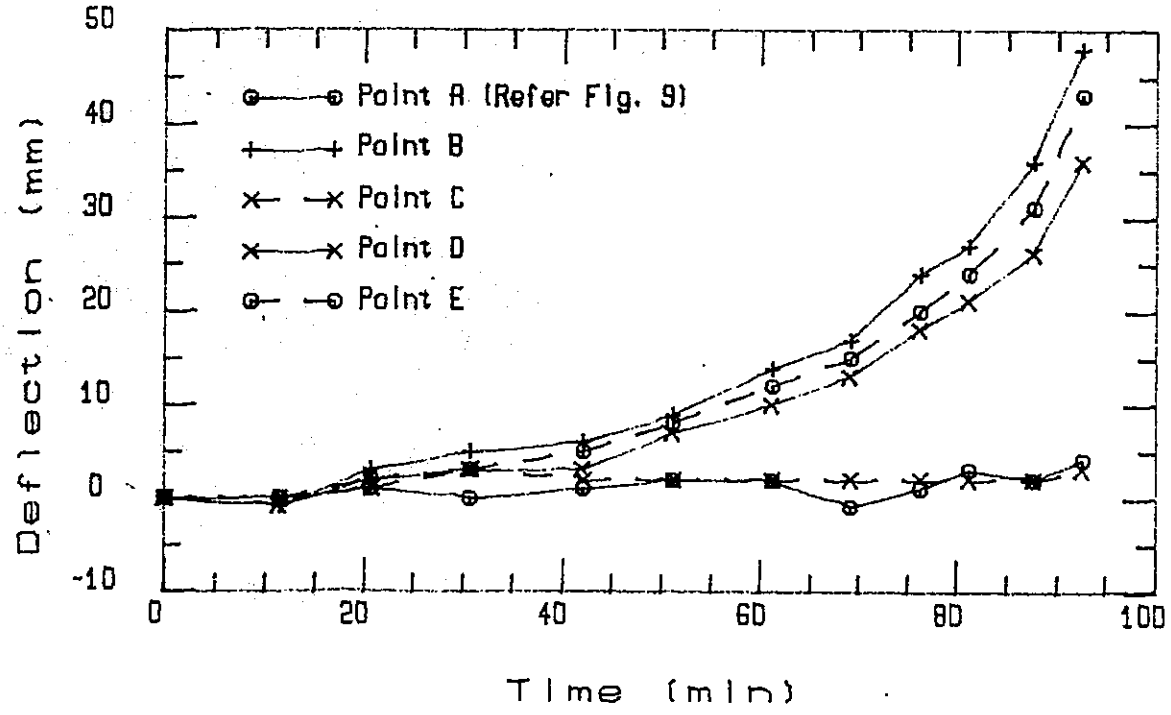
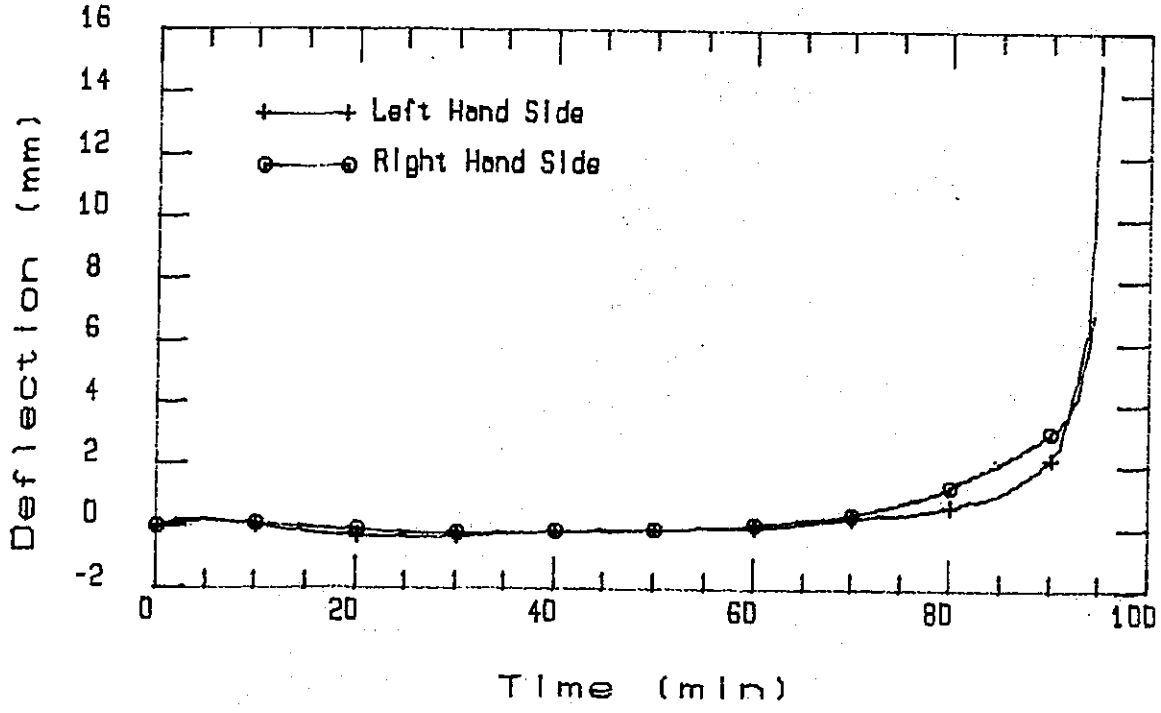
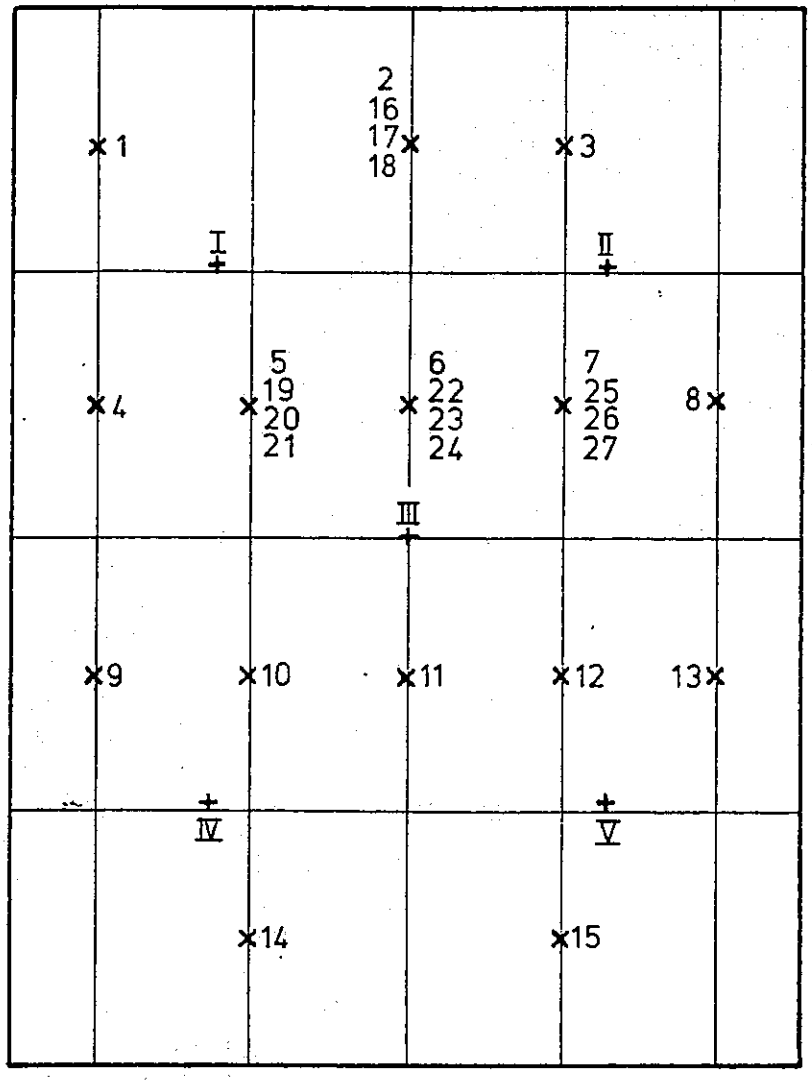


Figure 7B Vertical Deflection





+ ISO Thermocouples.

× Internal Thermocouples.

Figure 8. Thermocouple Positions.

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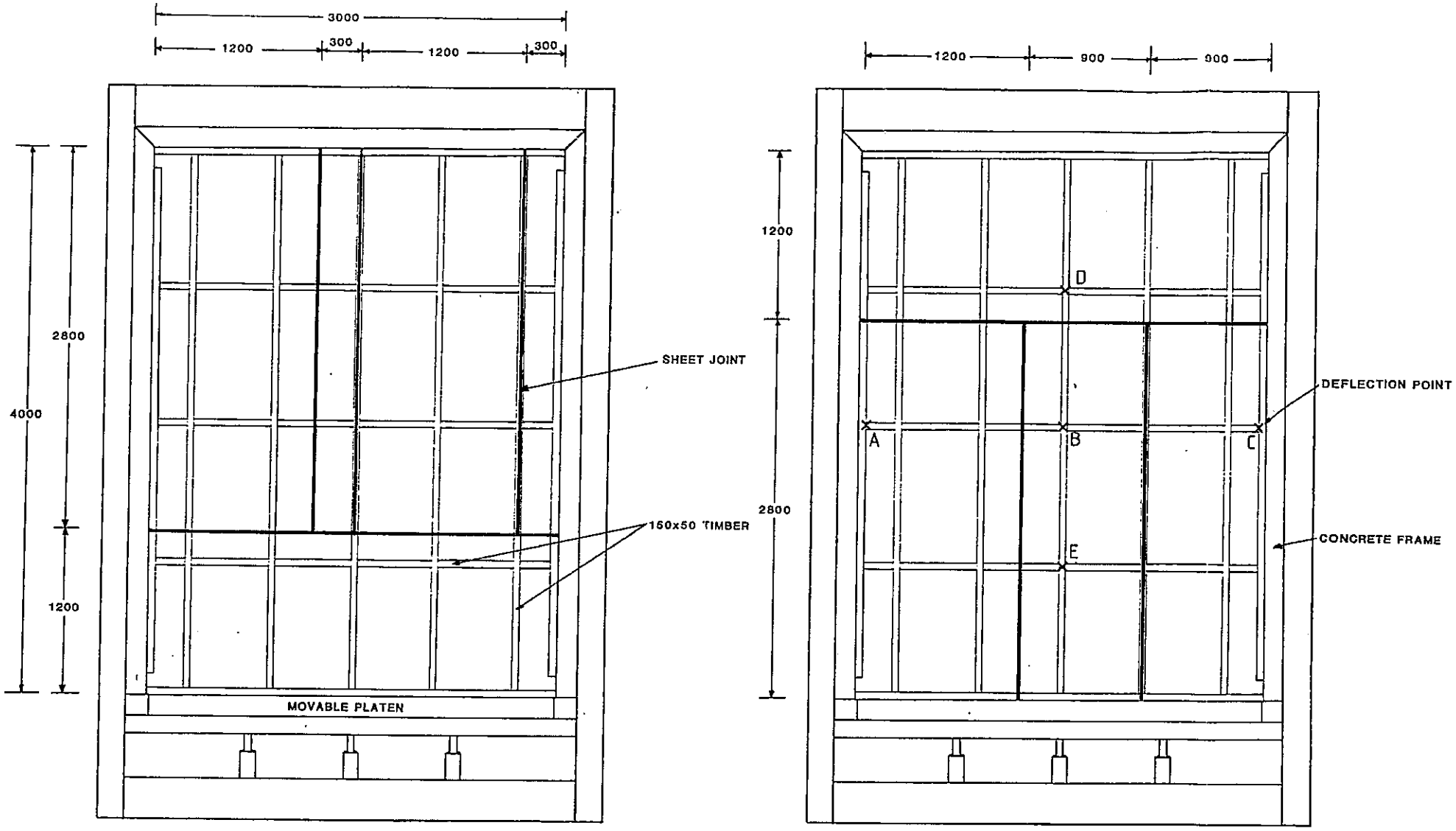

EXPOSED FACE

FIGURE 9

UNEXPOSED FACE

SHEET LAYOUT

LOADBEARING TIMBER WALL

19mm FYRWALL PLASTERGLASS