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BRE Global Test Report

Fire resistance test in accordance with EN 1365-2:2014 on a loadbearing floor, with two layers of Gyproc Fireline on the exposed face, suspended using an Oscar Iso-mount Type 1 system.

Prepared for: **Oscar Engineering Ltd.**

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SUMMARY

A loadbearing floor, 4250mm long (clear span) x 3500mm wide, was subjected to a fire resistance test in accordance with EN 1365-2:2014, for a duration of 101 minutes on 12th December 2018 at the BRE laboratories, Garston, whilst supporting an imposed load of 1.5kN/m^2.

The floor was constructed using timber joists (190mm x 47mm) at 400mm centres, clad on the top surface using one layer of 21mm-thick chipboard.

Oscar Iso-mount fixings were attached to each joist (near the bottom of the joist) at 980mm centres, to which lengths of Gypliner GL1 steel channel were attached. Two layers of 15mm-thick Gyproc Fireline plasterboard, with staggered joints between the two layers were then attached to the steel channels. A single layer of 100mm-thick Earthwool insulation was fitted between the floor joists, within the void / floor cavity, on top of the ceiling.

The specimen was installed on a concrete lined furnace test frame with a nominal internal aperture of 3500mm x 4150mm. The unsupported span of the floor was 4250mm.

In the orientation tested, the floor was found to achieve the following fire resistance:

Loadbearing capacity:		100 minutes
Integrity:	Cotton Pad:	99 minutes
	Sustained Flaming:	99 minutes
	Gap Gauge	100 minutes (taken as the time of loadbearing failure)
Insulation:		99 minutes (taken as the time of integrity failure).

1 OBJECTIVE

To determine, at the request of Oscar Engineering Limited, the fire resistance of a loadbearing floor, clad on the exposed face with two layers of 15mm-thick Gyproc Fireline, suspended via Oscar Iso-Mounts Type 1, when tested in accordance with EN 1365-2 : 2014.

2 TEST CONSTRUCTION

2.1 General

The floor, of overall size 4540mm long x 3500mm wide, was constructed within the aperture of a reinforced concrete test frame of internal exposed dimensions nominally 4150mm long x 3500mm wide. The 4150mm opening in the test frame had a 55mm wide chamfered shoulder at either end, the joists set over this aperture, therefore had an unsupported span of 4250mm.

BRE was not involved in the selection of any of the materials used in construction of the test specimen.

The general arrangement of the specimen is shown in the Figures and Photographs.

2.2 Materials

2.2.1 Joists

Solid timber joists (stated by the supplier to be grade C24) were 190mm deep x 47mm wide x 4540mm long. The joists were spaced at nominally 400mm centres across the width of the test frame and rested on a ledge at each end of the test frame across its width. The joists had an unsupported length (span) of 4250mm.

Herringbone noggins (formed from pieces of 45mm x 45mm timber) were fitted between the ends of the joists at the supported ends, nailed to each joist with 85mm-long x 3mm-diameter nails, providing rigidity to the joists. Noggins were also fitted between joists at mid length of the floor.

2.2.2 Chipboard floorboard

The Chipboard floorboard was 21mm-thick flooring-grade chipboard supplied in sheets, 2400mm long x 600mm wide, with tongue-and-grooved edges.

2.2.3 Gyproc Fireline plasterboard

Gyproc Fireline plasterboard (manufactured by British Gypsum) was described as an aerated gypsum core, containing glass fibre and additional additives to increase the fire protection characteristics, encased in and firmly bonded to strong paper liners. It was taper edged, 15mm thick and was delivered in sheets, 2400mm long x 1200mm wide. The board was pink coloured on the exposed side and brown coloured on the unexposed side.

2.2.4 Earthwool Insulation

Knauf Earthwool insulation was described as a non-combustible Rock Mineral Wool slab, manufactured using ECOSE® technology. The insulation supplied was marked as RS45 slabs, with a stated density of 45kg/m^3. The slabs were supplied 1200mm x 600mm, being cut to size to fit between the joists.

2.2.5 GL1 channel

Gypliner GL1 channel was a galvanised steel channel, 45mm-wide x 18mm-deep, formed from 0.5mm-thick steel. The channel was supplied in 3.6m lengths. Further details of the channel are given in the Figures.

2.2.6 Oscar Iso-Mount Type 1

Oscar Iso-mount Type 1 was described as an isolating ceiling mount which significantly reduces transmission of noise from the floor above but only loses 6mm of ceiling height.

The mounts were a three-component assembly comprising a metal 'L' bracket, a nitrile compound rubber block (30mm x 30mm x 13.5mm) and a saddle.

The metal 'L' bracket screws to the sides of the joists and incorporates the rubber block which sits in position on the 'L' bracket and breaks the path of vibration to the 3rd component, a metal saddle that is held in position on the rubber block. The GL1 ceiling channels are suspended from the metal saddle. Further details of the ISO-Mount Type 1 assembly are given in the Figures.

2.3 Construction

Ten joists were placed spanning the length of the test frame at nominally 400mm centres (the last pair nominally 100mm apart) with the ends of the joists resting on the ledges across the width of the test frame. This resulted in an un-supported clear span of 4250mm. Herringbone noggins were then fitted across the ends of the joists (between the joists) at both ends, and at mid-span of the floor.

The 21mm-thick chipboard floorboard planks were laid perpendicular across the top of the joists and secured with 38mm-long parallel-shank wood screws, with two screws per joist location. The ends of the floorboards coincided with the joists.

Oscar Iso-Mount Type 1 brackets were fitted to each joist at 980mm centres, with the brackets at each end of the floor nominally 100mm from the edge of the floor. The brackets were screwed to the floor using two 4mm x 40mm-long wood screws per bracket.

Lengths of GL1 channel were then suspended from the Oscar Iso-Mount brackets, to which two layers of 15mm-thick Fireline plasterboard were attached using 35mm-long screws for the first layer and 45mm-long screws for the second layer. Screws were at 230mm centres in the fields of the boards and 150mm centres along board edges. The screws were located nominally 13mm from cut board edges and 10mm from bound board edges.

The two layers of plasterboard were staggered / offset from each other to prevent co-incidental board joint locations.

The butt joints formed between plasterboard sheets on the exposed face layer were sealed using paper jointing tape and Gyproc joint filler.

Further details of the floor and Oscar Iso-Mount Type 1 brackets are given in the Figures and Photographs.

3 CONDITIONING

Representative samples of the chipboard floorboard, Gyproc Fireline and Earthwool Insulation were taken during construction and placed into ovens, to determine their free moisture content by weight loss technique.

The free moisture content of the samples expressed as a percentage of the dried weights were found to be as given in the following table:

Material	Oven drying temperature	Moisture content by dry weight (%)
Gyproc Fireline Plasterboard	50ºC	0.4
Chipboard floorboard	105ºC	1.2
Earthwool Insulation	105ºC	0.5

Additionally, the moisture content of the timber joists was measured using a Timbermaster Protimeter (Scale A) and found to have a mean moisture content of 12.1%.

4 TEST PROCEDURE

4.1 General

The test was carried out on the 12th December 2018 at the BRE Garston laboratories and was witnessed by Mr. J. Hancock and Mr. B. Hancock representing the sponsor. The ambient temperature at the start of the test was 15°C.

4.2 Loading

The total imposed load applied to the floor (as requested by the sponsor) was 1.5kN/m^2. The load was achieved using cast-iron weights distributed evenly over the area of the floor, as detailed below.

Total imposed load required = 1.5kN/m^2

Area of floor : 4.25m x 3.50m = 14.875m^2

Therefore, applied load required = 14.875m^2 x 1.5kN/m^2

= 22.31kN

= 2275kg

The cast-iron weights and chains were laid on the floor uniformly in a grid giving a total actual weight of 2303kg. Therefore, the actual load applied exceeded the load required by 1.2%.

4.3 Furnace temperature & pressure

The furnace temperature was measured by means of ten plate thermometers arranged symmetrically in the furnace, suspended through the floor assembly (with the holes sealed) such that the measuring junctions were set 100mm below the soffit of the floor. The furnace was controlled so that the mean temperature recorded followed the time/temperature relationship specified in EN 1363-1:2012.

The furnace pressure was controlled to be 16Pa ±3Pa at a height of 350mm below the floor. This resulted in a pressure of 18Pa 100mm below the floor, as required by the standard.

4.4 Unexposed face temperatures

The temperature of the unexposed face of the floor was recorded using ten thermocouples, located as given in the table below.

Thermocouple	Location
1*	Near the centre of the top left quarter area of the floor.
2*	Near the centre of the top right quarter area of the floor.
3	Adjacent to a corner joint in the chipboard floor.
4	Adjacent to a linear joint in the chipboard floor, away from any joists.
5	Adjacent to a linear joint in the chipboard floor, over a joist location.
6	Adjacent to a joint in the floor and over the location of a joint in the first layer of plasterboard.
7*	Near the centre of the floor.
8	Adjacent to a joint in the floor and over the location of a joint in the second layer of plasterboard.
9*	Near the centre of the bottom left quarter area of the floor.
10*	Near the centre of the bottom right quarter area of the floor.

* These thermocouples were used to determine the mean surface temperature on the unexposed face of the floor, with all thermocouples used to determine the maximum temperature.

4.5 Deflection

The vertical deflection at the centre of the floor was continuously measured during the test by a linear deflection transducer attached via a taut fine steel wire to the centre of the floor.

5 RESULTS

5.1 Observations

Observations made during the test are given in the following table and unless stated refer to the exposed face.

Time minutes	Observation
0	Start test.
13	The jointing between sheets of plasterboard has fallen out.
21	Gaps of approximately 2mm to 3mm have formed at joints between sheets of plasterboard. Slight sagging of the boards between screw locations has occurred.
63	All boards are intact. Gaps at board joints are up to a maximum of approximately 10mm.
75	One piece of plasterboard is starting to bend down towards the furnace at one corner.
77	A piece of plasterboard approximately 0.5m x 0.5m has fallen from the first (exposed) layer of boards.
78	Several pieces of plasterboard on the exposed face layer are starting to sag and bend away from the ceiling. An occasional crackle, characteristic of burning timer can be heard. Flaming is coming from the exposed joints in the second layer of plasterboard.
84	The second layer of plasterboard is now sagging considerably towards the furnace in several locations.
87	Pieces of plasterboard from the second layer are now falling from the ceiling.
92	Approximately half of the second layer of plasterboard has now fallen from the ceiling.
94	Vast flaming inside the furnace prevents further observation of the exposed face of the floor.
99	Flaming from the unexposed face. Failure of integrity.
101	The floor collapsed. Test stopped.

5.2 Furnace control

The mean furnace temperature together with the specified curve for comparison is given in the Graphs. Furnace pressure recorded 350mm below the ceiling is also given in the Graphs.

5.3 Unexposed face temperatures.

The mean, maximum and individual temperatures recorded on the unexposed face of the floor are given in the attached Graphs. The mean temperature rise limit for insulation (140^{O}C) was not exceeded during the test. The maximum temperature rise limit for insulation (180^{O}C) was exceeded after 101 minutes (at the end of the test).

5.4 Deflection

The deflection at the centre of the floor recorded by the transducer is plotted against time in the Graphs. The maximum deflection measured during the course of the test was 48.5mm towards the furnace, recorded at the end of the test.

The maximum rate of deflection was 26mm/min, recorded at the end of the test. The rate of deflection exceeded the limit of 10.6mm/minute after 100 minutes of the test, when a value of 11.2mm/minute was recorded.

6 PERFORMANCE CRITERIA

The standards state the fire resistance of a loadbearing floor shall be expressed in terms of the elapsed time (in completed minutes) between the commencement of heating and the termination of heating, or until failure to meet the loadbearing capacity, integrity (sustained flaming, gap gauges and cotton pad) and insulation criteria occurs, whichever is the sooner.

Loadbearing capacity: Failure arises when the specimen is no longer able to support the test load. This is deemed to occur when one of the following are exceeded:

a) a limiting deflection D = L2/400d

b) a limiting rate of deflection dD/dt = L2/9000d

where

L is the clear span of specimen (in mm);

d is the full depth of the structural section (in mm).

Integrity : Failure is deemed to occur when:

a) ignition of a cotton test pad applied to the specimen occurs;

b) a 6mm-diameter gap gauge can penetrate through a gap into the furnace and be moved in the gap for a distance of at least 150mm;

c) a 25mm-diameter gap gauge can penetrate through a gap into the furnace;

d) sustained flaming for not less than 10s on the unexposed face occurs;

e) loadbearing capacity failure occurs.

Insulation : Failure is deemed to occur when:

a) the mean unexposed face temperature increases by more than 140°C above its initial value;

b) the temperature recorded at any position on the unexposed face is in excess of 180°C above the initial mean unexposed face temperature;

c) integrity failure occurs.

7 CONCLUSION

A loadbearing floor, comprising timber joists,190mm deep x 47mm wide spaced at 400mm centres, protected with two layers of 15mm-thick Gyproc Fireline plasterboard, the boards suspended via Oscar Iso-Mount Type 1 brackets, and clad on the unexposed face with 21mm thick chipboard, was subjected to a fire resistance test in accordance with EN 1365-2 : 2014 on 12th December 2018 while supporting a load of 1.5kN/m^2..

The floor, as described, achieved the following fire resistance:

Loadbearing capacity:		100 minutes.
Integrity:	Sustained flaming:	99 minutes.
	Gap gauge:	100 minutes (taken as time of loadbearing failure).
	Cotton Pad:	99 minutes.
	Insulation:	99 minutes (taken as time of integrity failure).

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 of the result.

This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in EN 1363-1 and where appropriate EN 1363-2. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

8 FIELD OF DIRECT APPLICATION OF TEST RESULTS

The test results are directly applicable to a similar untested floor or roof construction provided the following is true:

a) With respect to the structural building member:

The maximum moments and shear forces, which when calculated on the same basis as the test load, shall not be greater than those tested.

b) With respect to the ceiling system:

The size of the panels of the ceiling lining may be increased by a maximum of 5% but limited to a maximum of 50mm. The length of the grid members can be increased accordingly.

c) With respect to the cavity:

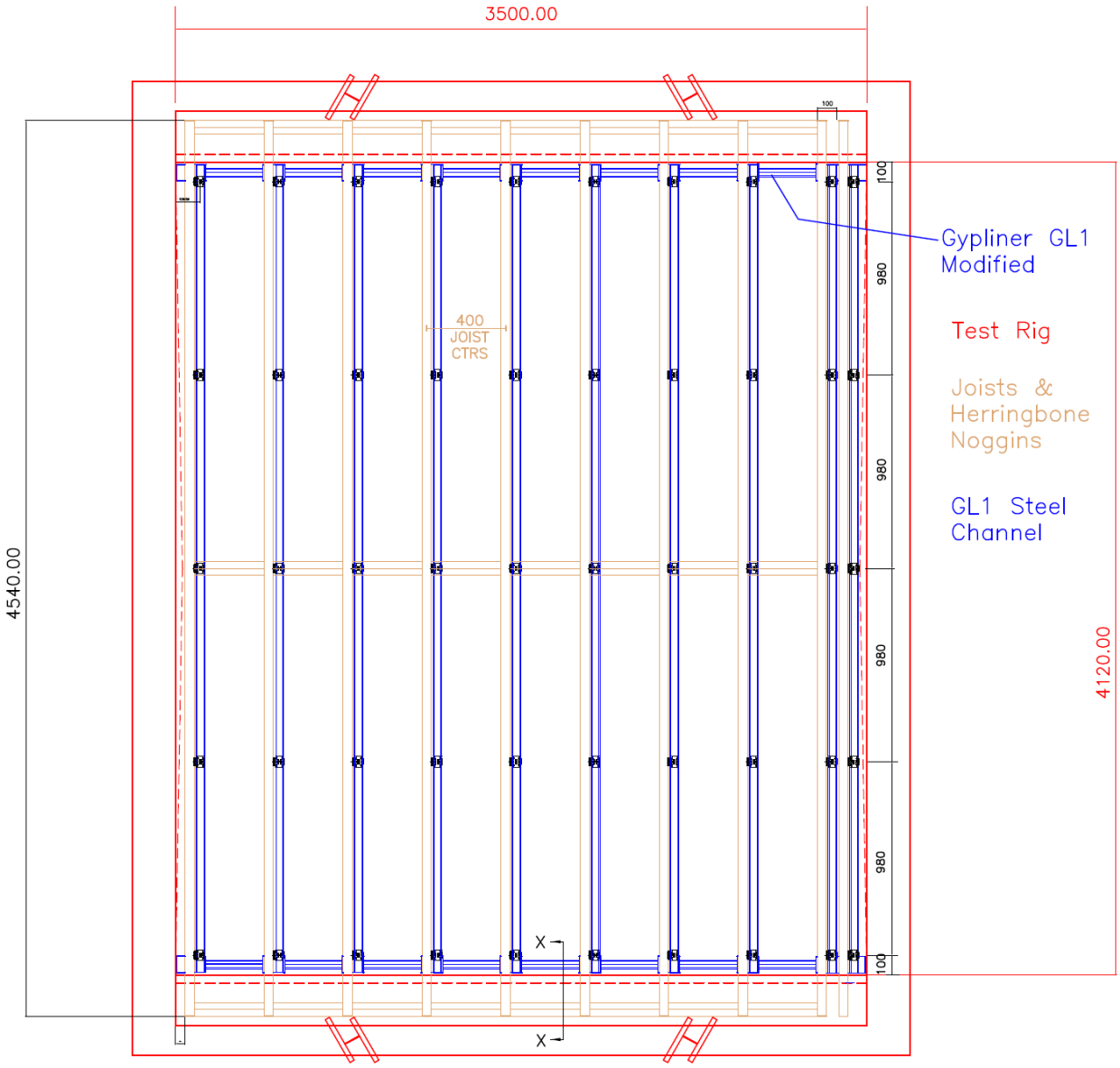
The height of the cavity h and the minimum distance d between the ceiling and the structural members (See Figure 1 in the standard) are equal to or greater than those tested.

No material is added to the cavity unless the same amount (in terms of both weight and fire load) of material was included in the test specimen

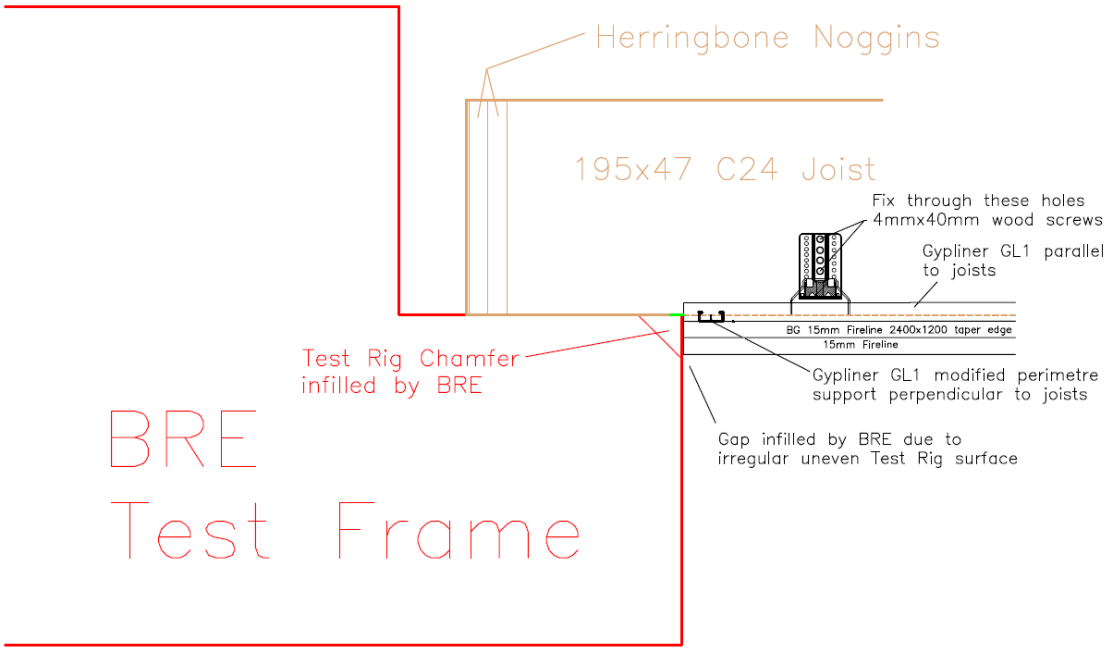
9 REFERENCES

- Fire resistance tests for loadbearing elements. Part 2. Floors and roofs. EN 1365-2 : 2014. British Standards Institution, London, 2014.
- Fire resistance tests. Part 1. General requirements. EN 1363-1 : 2012. British Standards Institution, London, 2012.

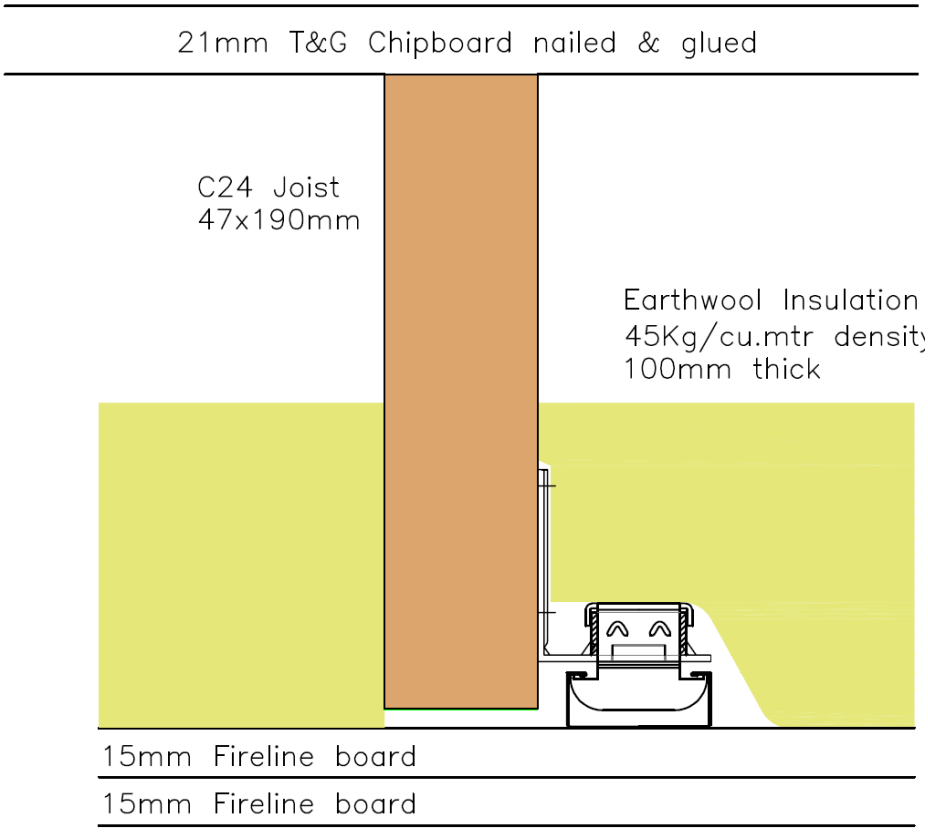
10 FIGURES (supplied by the client)



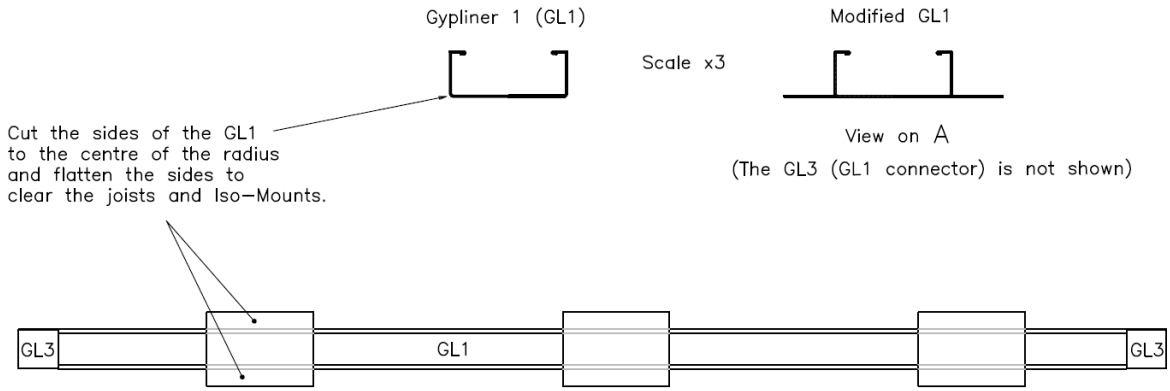
General arrangement of floor construction.



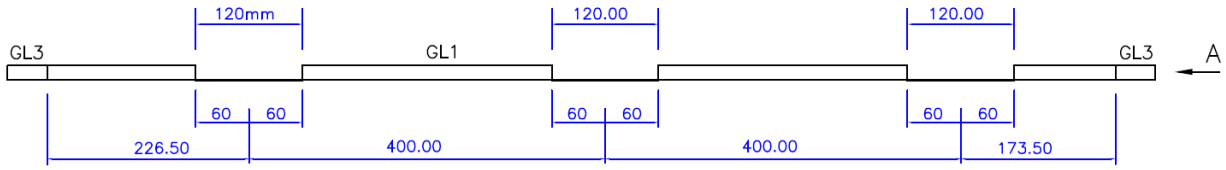
Section X-X showing typical detail at floor perimeter.



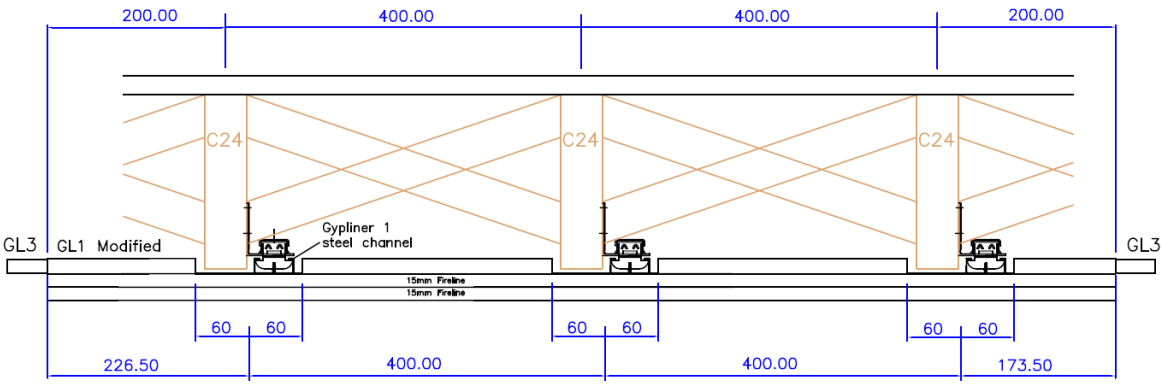
Section view showing general construction of floor.



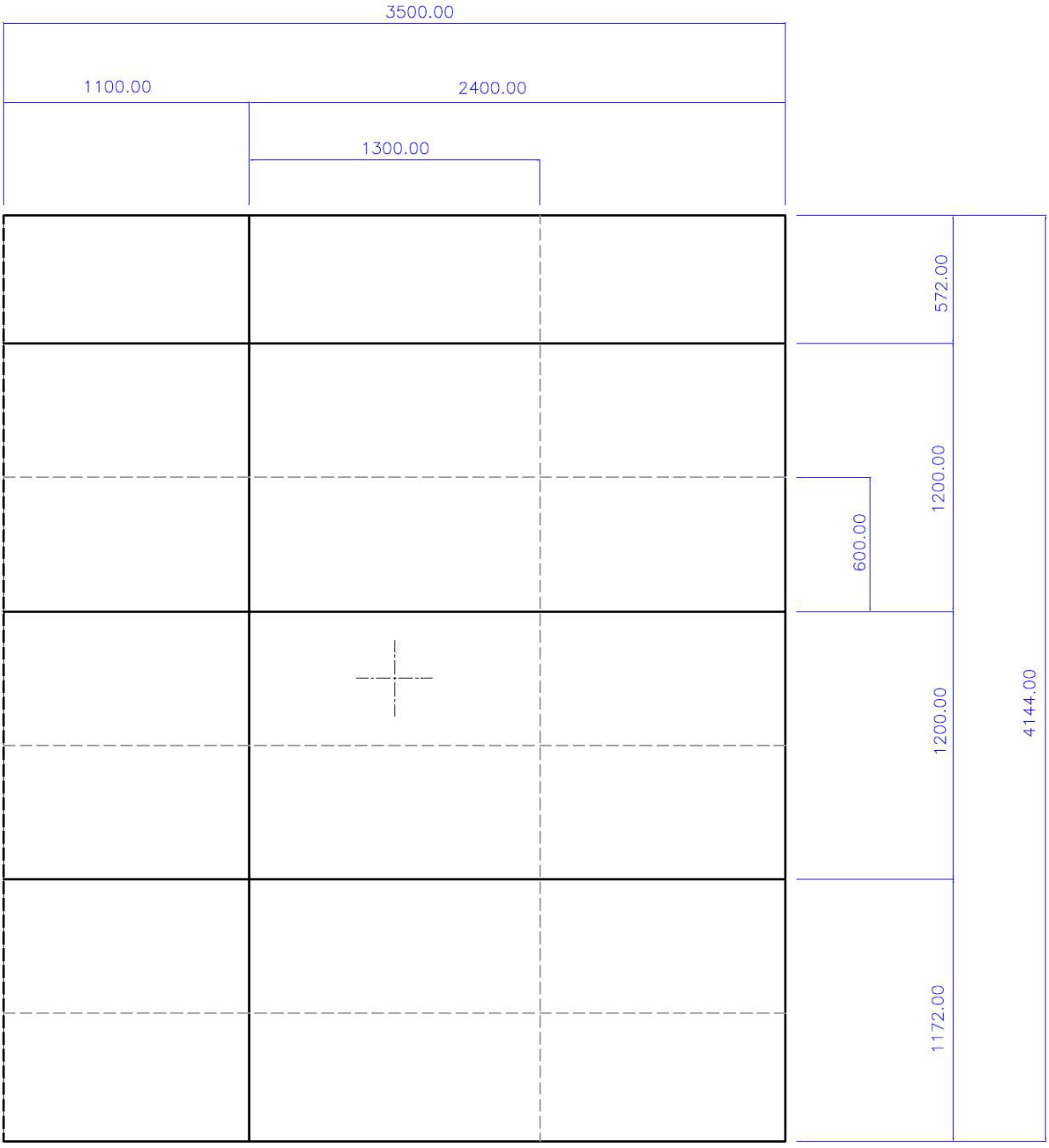
Cut outs in the GL1 channel are necessary when the Type1 Iso-Mounts are fitted high for minimum ceiling height loss.



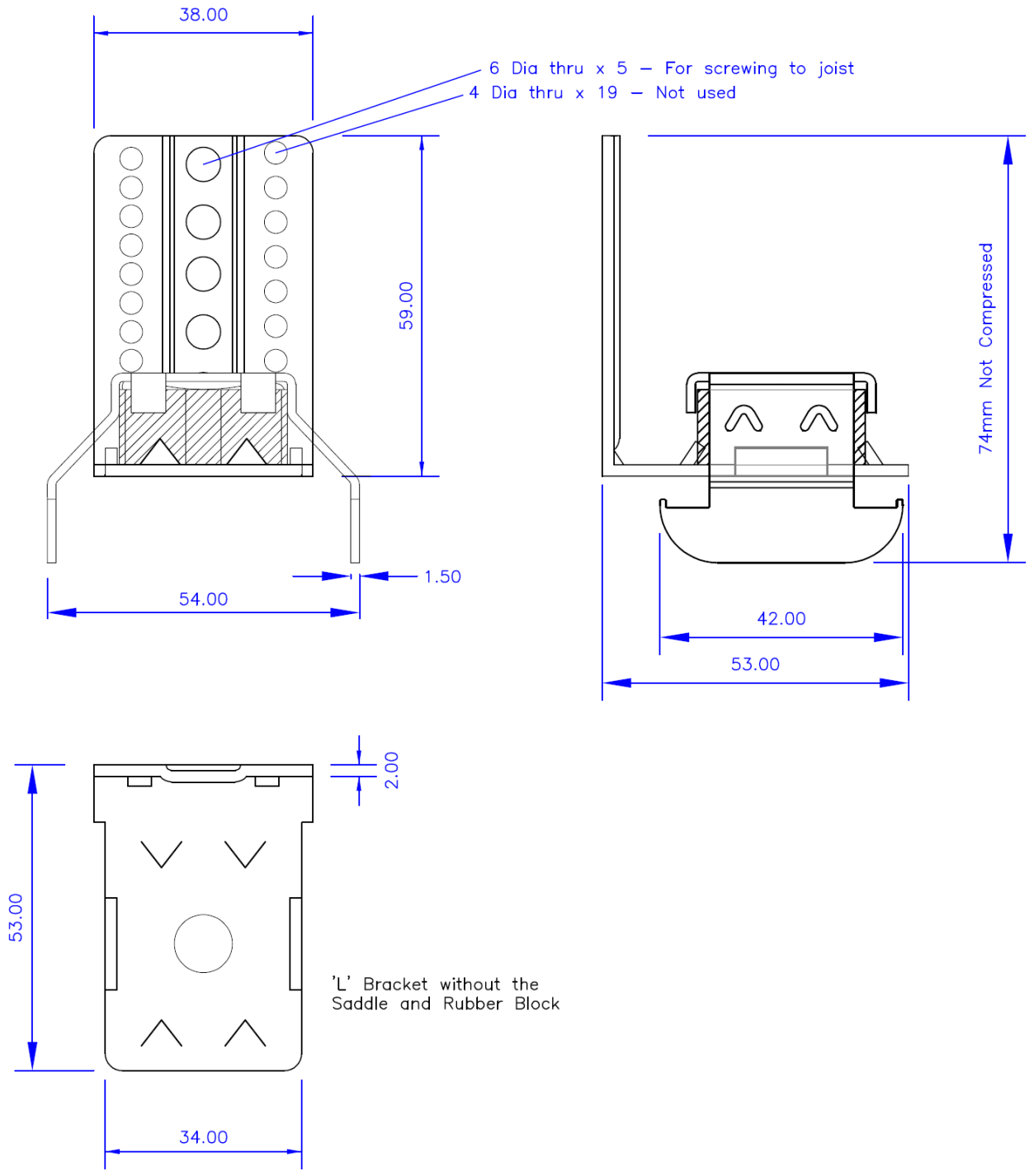
GL1 Modifications: for 50mm wide joists @ 400mm centres.



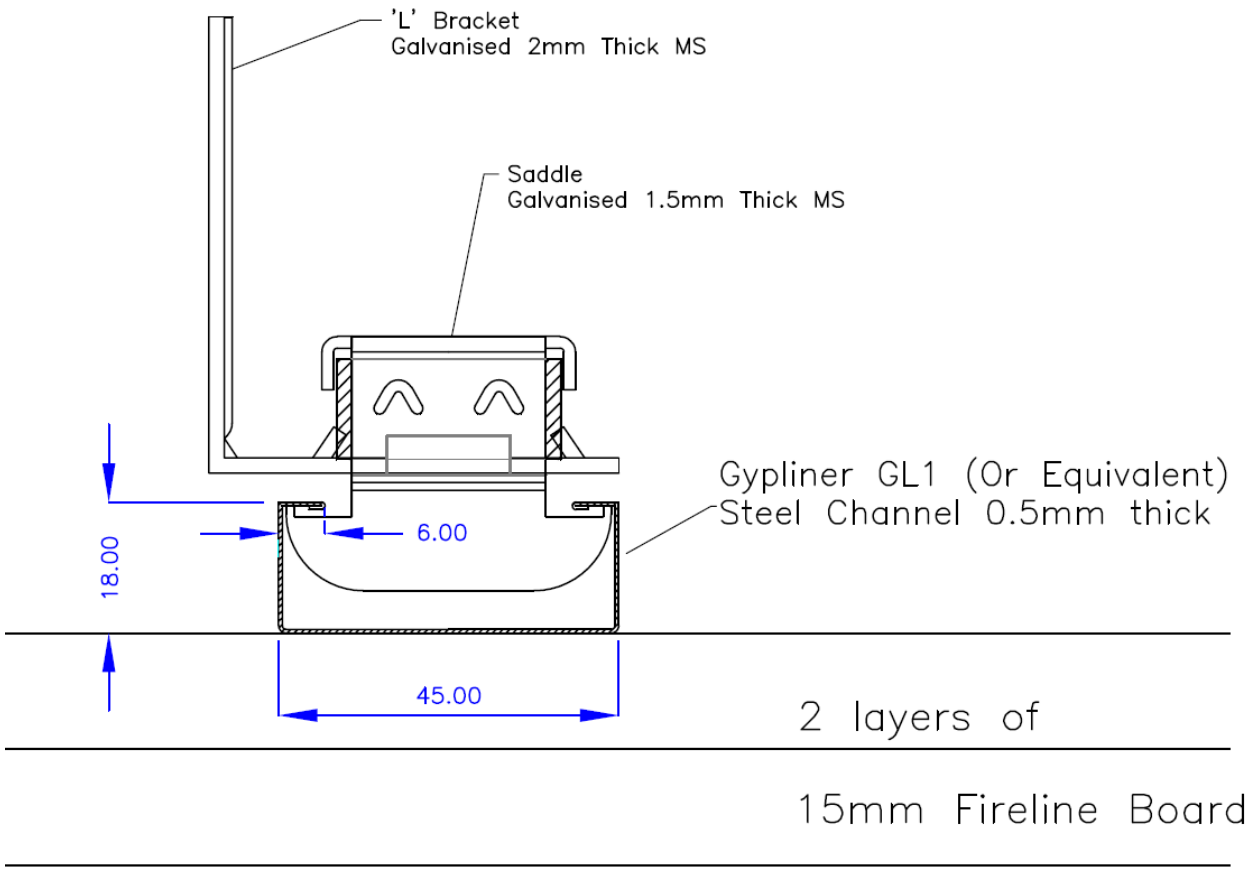
Cross-section of floor, showing the perimeter detail, perpendicular to the direction of the joists.



Arrangement of boards on the exposed face.

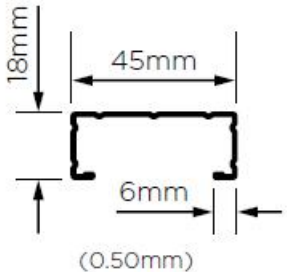


Details of Oscar Iso-Mount Type 1 brackets.

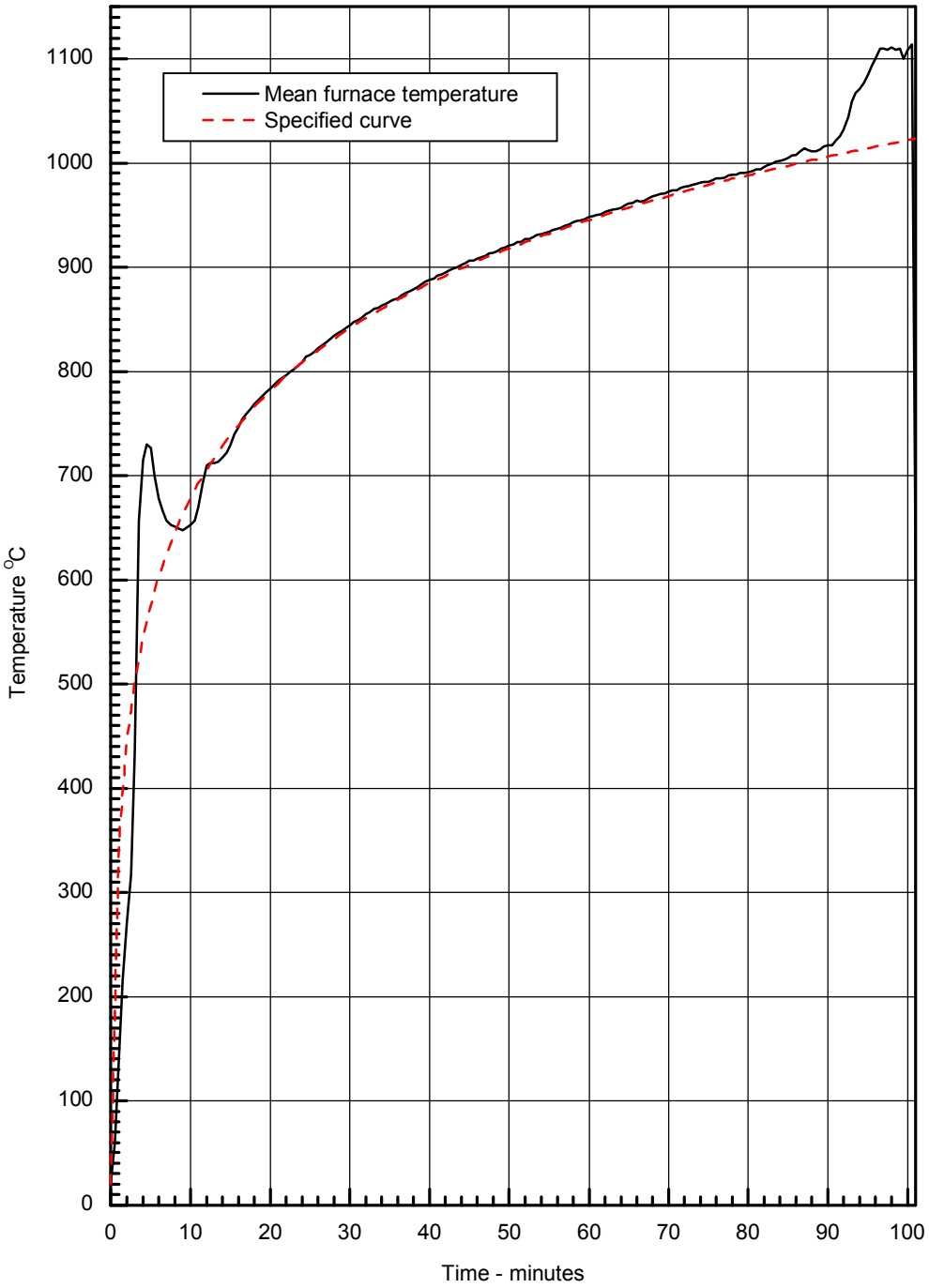


Further details of Oscar Iso-Mount Type 1 brackets.

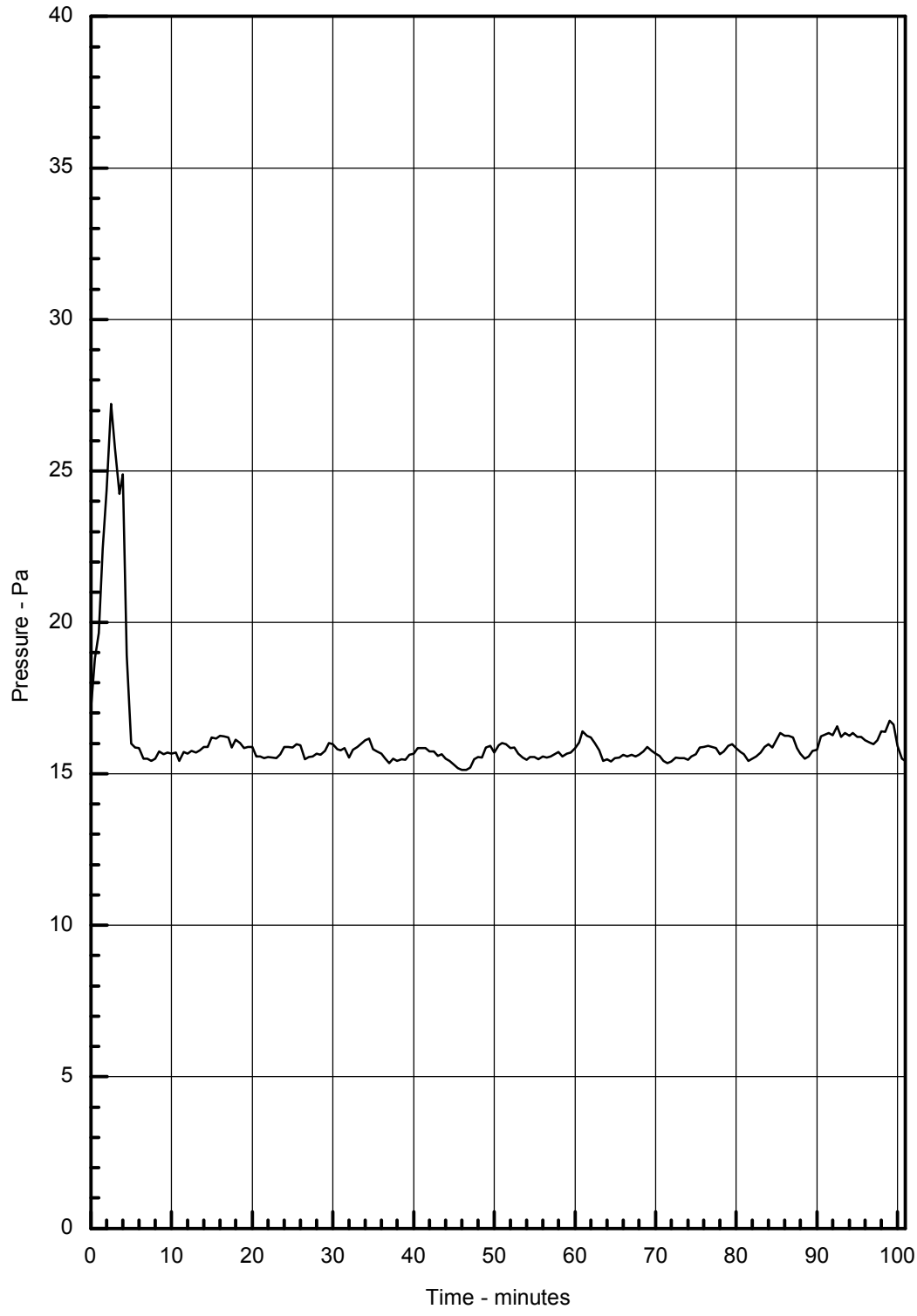
Gypframe GL1 Channel



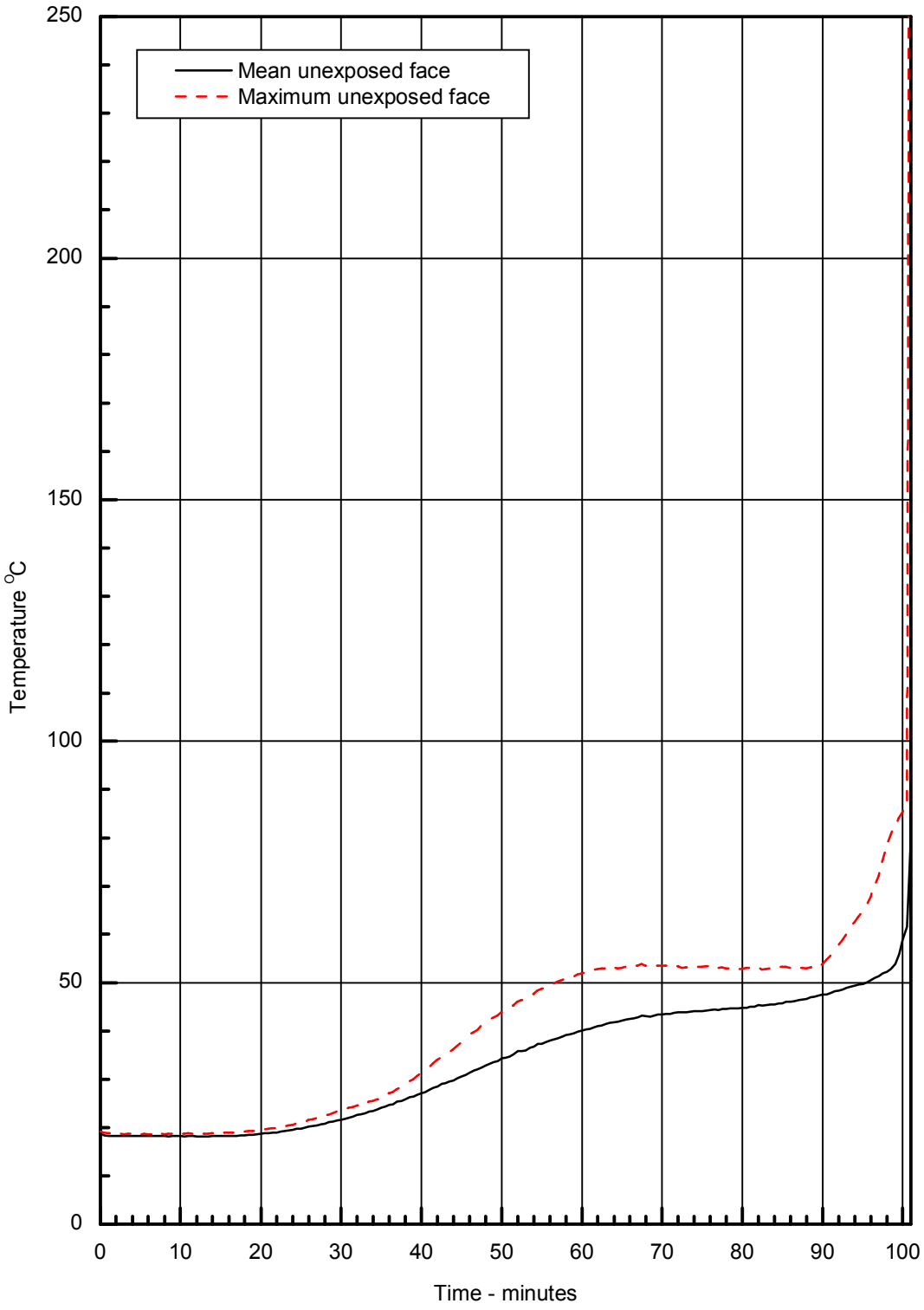
11 GRAPHS



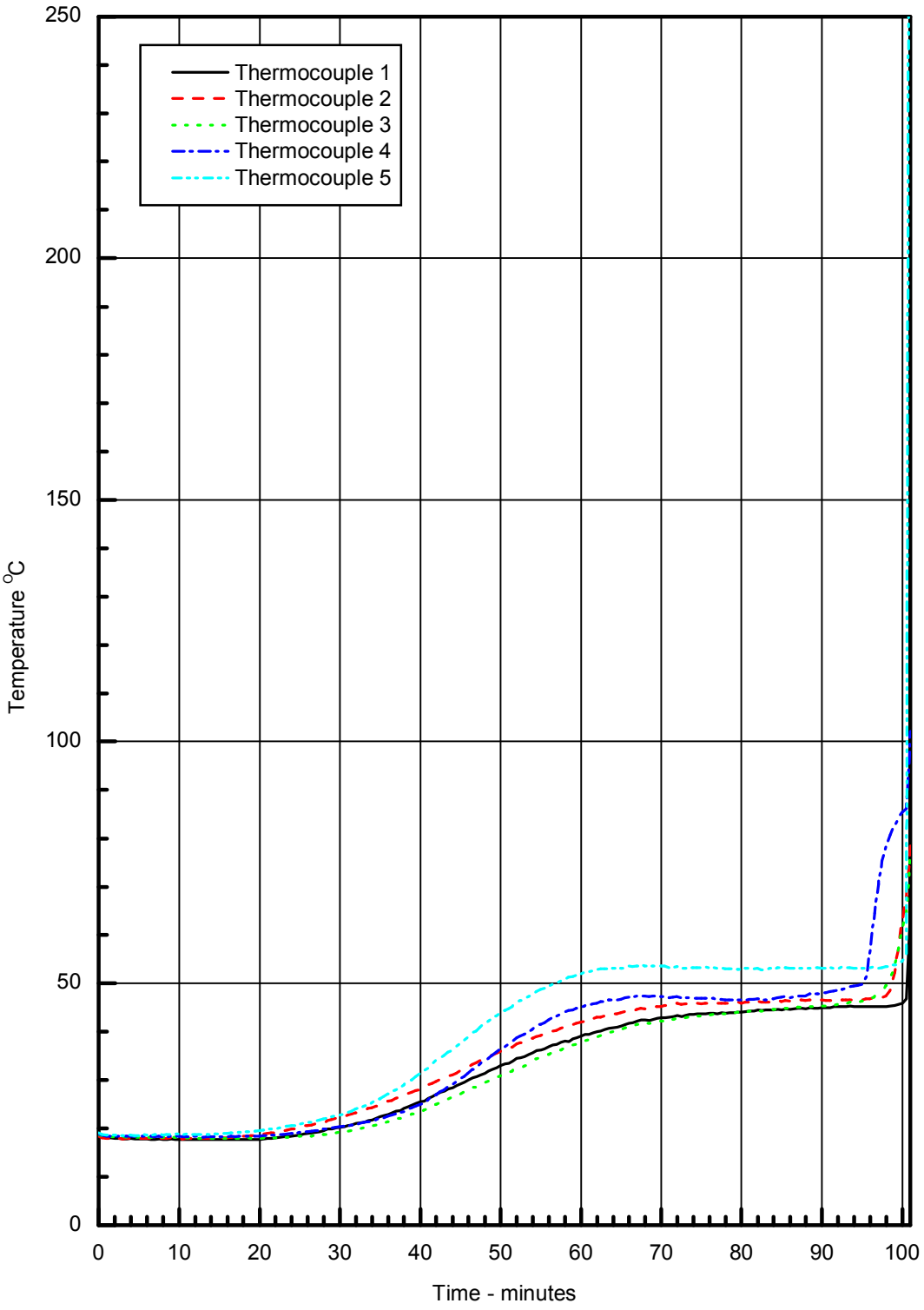
Mean furnace temperature with specified curve for comparison.



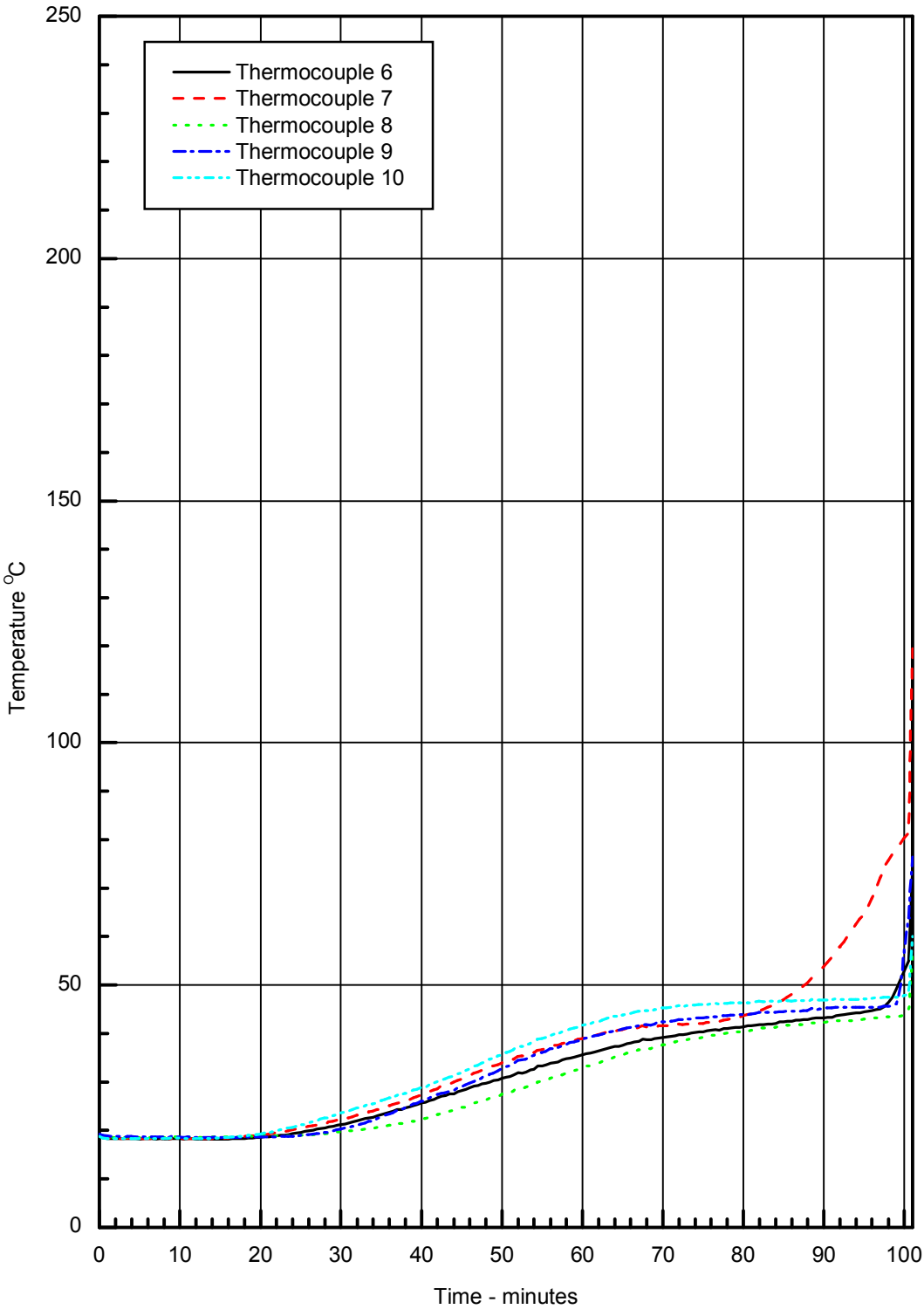
Furnace pressure recorded 350mm below the floor.



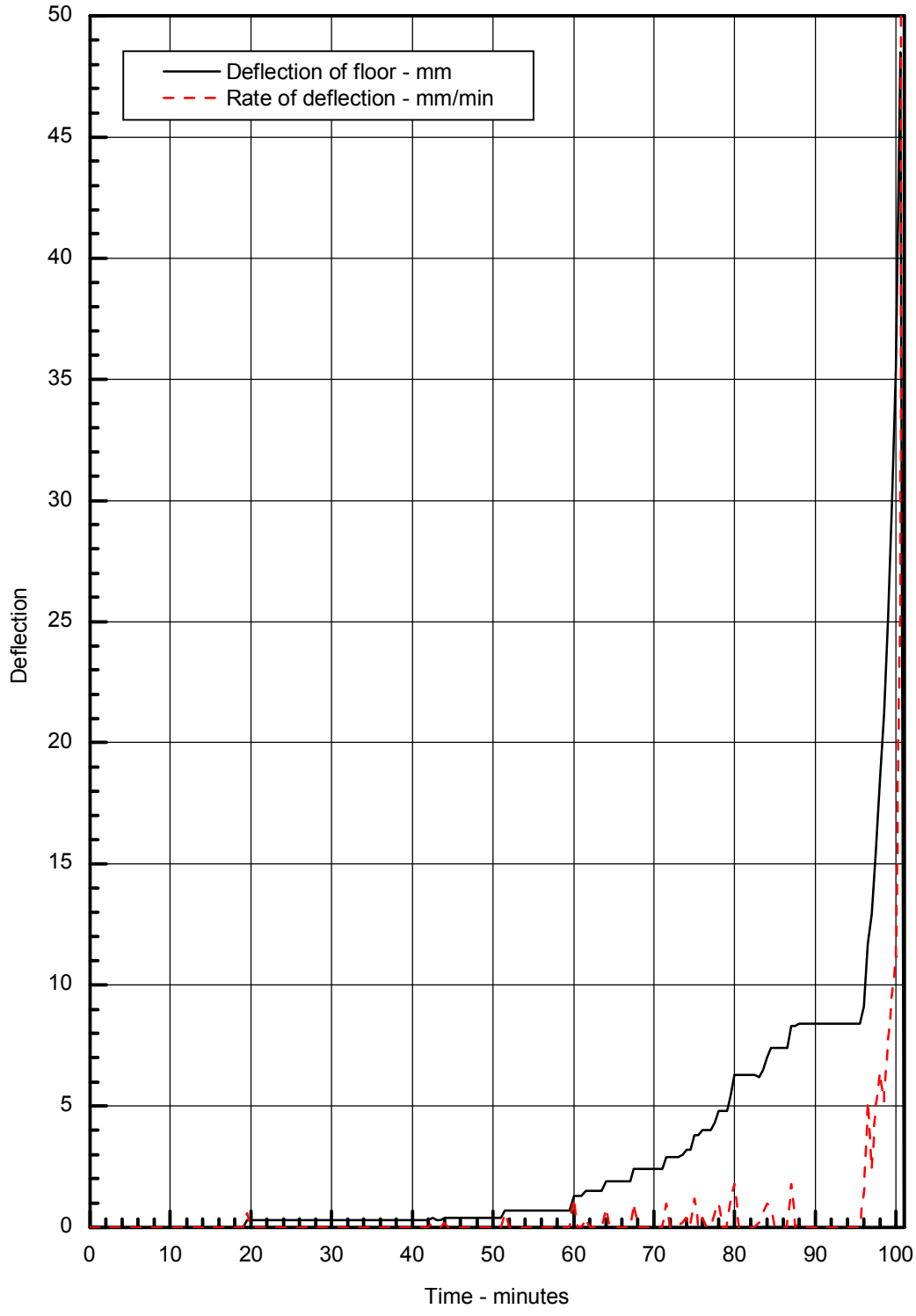
Mean and maximum temperatures recorded on the unexposed face.



Temperatures recorded on the unexposed face by thermocouples 1 to 5.



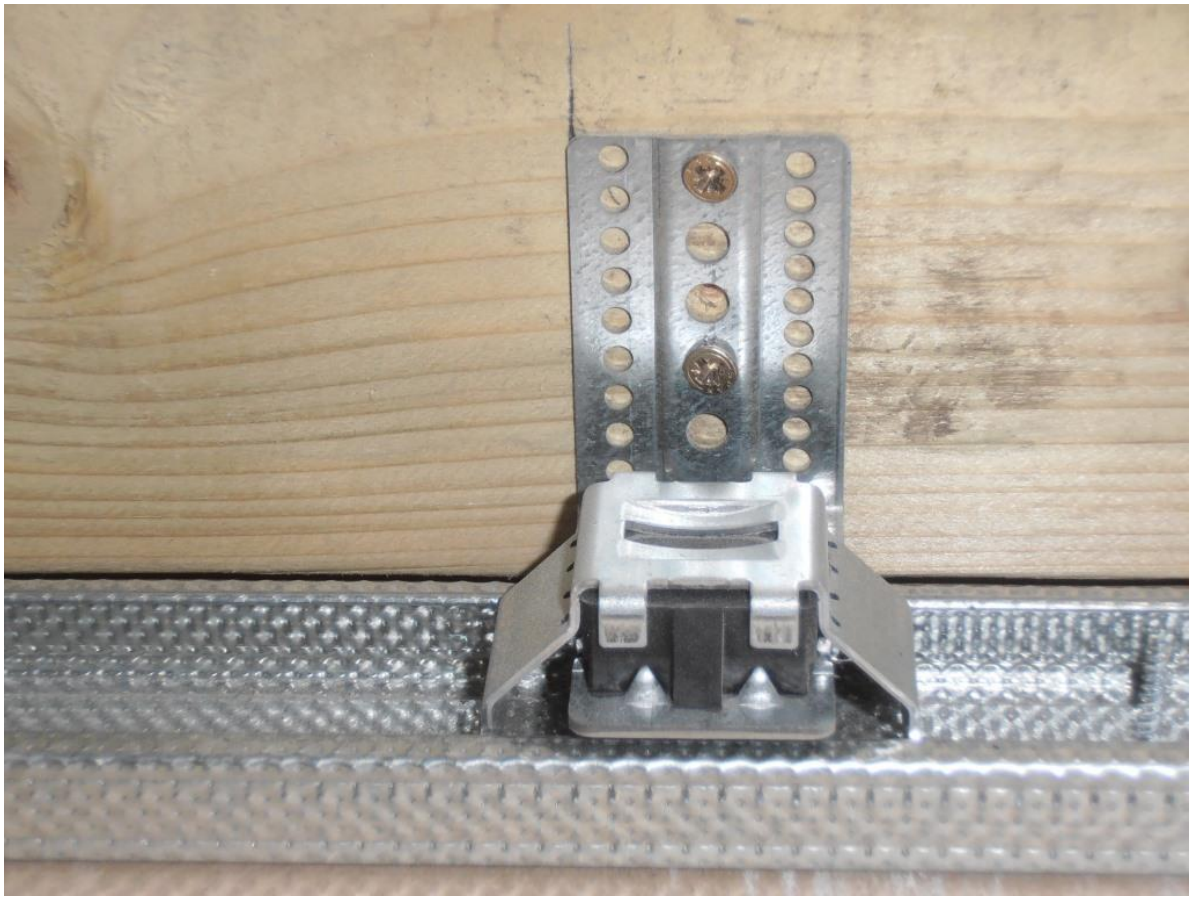
Temperatures recorded on the unexposed face by thermocouples 6 to 10.



Deflection and rate of deflection recorded at the centre of the floor.

12 PHOTOGRAPHS

Floor during construction.



View of a typical Oscar Iso-Mount Type 1 fitted in the floor.

Unexposed face before test.

Exposed face of floor before test.

Report ends.