

# test report

**Title:**

The fire resistance performance of a specimen of a loadbearing timber floor assembly protected by a plasterboard ceiling, when tested in accordance with BS 476: Part 21: 1987, Clause 7

**Report No:**

155359

**Prepared for:**

**EWS (Manufacturing) Ltd**  
Headway Road,  
Wolverhampton,  
WV10 6PZ

**Date:** 3<sup>rd</sup> January 2007

**Notified Body No:**

**0833**



0249

# Summary

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**Objective** To determine the fire resistance performance of a loadbearing timber floor assembly, protected by a plasterboard ceiling incorporating an EWS support system, when tested in accordance with Clause 7 of BS 476: Part 21: 1987.

**Sponsor** EWS (Manufacturing) Ltd, Headway Road, Wolverhampton, WV10 6PZ.

**Summary of Tested Assembly** The timber floor had overall nominal dimensions of 4200 mm long by 3000 mm wide and incorporated softwood timber joists at 600 mm centres. The upper surface of the floor comprised boarding of nominally 18 mm thick tongue and grooved chipboard. The ceiling assembly comprised an EWS steel ceiling system clad with two layers of 12.5 mm thick plasterboard ceiling panels referenced 'Fireline'.

The floor supported an evenly distributed load of 0.962 kN/m<sup>2</sup>.

## Test Results:

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**Loadbearing Capacity** 98 minutes

**Integrity** 104 minutes\*

**Insulation** 102 minutes


\* The test duration. The test was discontinued after a period of 104 minutes.

**Date of Test** 10<sup>th</sup> October 2006

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## Signatories

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Responsible Officer <b>N. Howard*</b> Testing Officer


Approved <b>D. Hankinson*</b> Technical Consultant

\* For and on behalf of **warringtonfire**.

Report Issued  Date : 3 <sup>rd</sup> January 2007
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# Test Procedure

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## Introduction

The specimen tested was of a loadbearing construction. The test was conducted in accordance with Clause 7 of BS 476: Part 21: 1987, 'Methods for determination of the fire resistance of loadbearing elements of construction'. This test report should be read in conjunction with that Standard and with BS 476: Part 20: 1987, 'Method for determination of the fire resistance of elements of construction (general principles)'.

The purpose of the test was to evaluate the performance of a timber floor construction when protected by a ceiling incorporating the EWS support system.

The specimen was judged on its ability to comply with the performance criteria for loadbearing capacity, integrity and insulation, as required by BS 476: Part 21: 1987, Clause 7.

## Fire Test Study Group/EGOLF

Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group and EGOLF have identified a number of such areas and have agreed Resolutions which define common agreement of interpretations between fire test laboratories which are members of the Groups. Where such Resolutions are applicable to this test they have been followed.

## Instruction To Test

The test was conducted on the 10<sup>th</sup> October 2006 at the request of EWS (Manufacturing) Ltd, the test sponsor.

Mr. C. Stephenson, a representative of the test sponsor witnessed the test.

## Test Assembly Construction

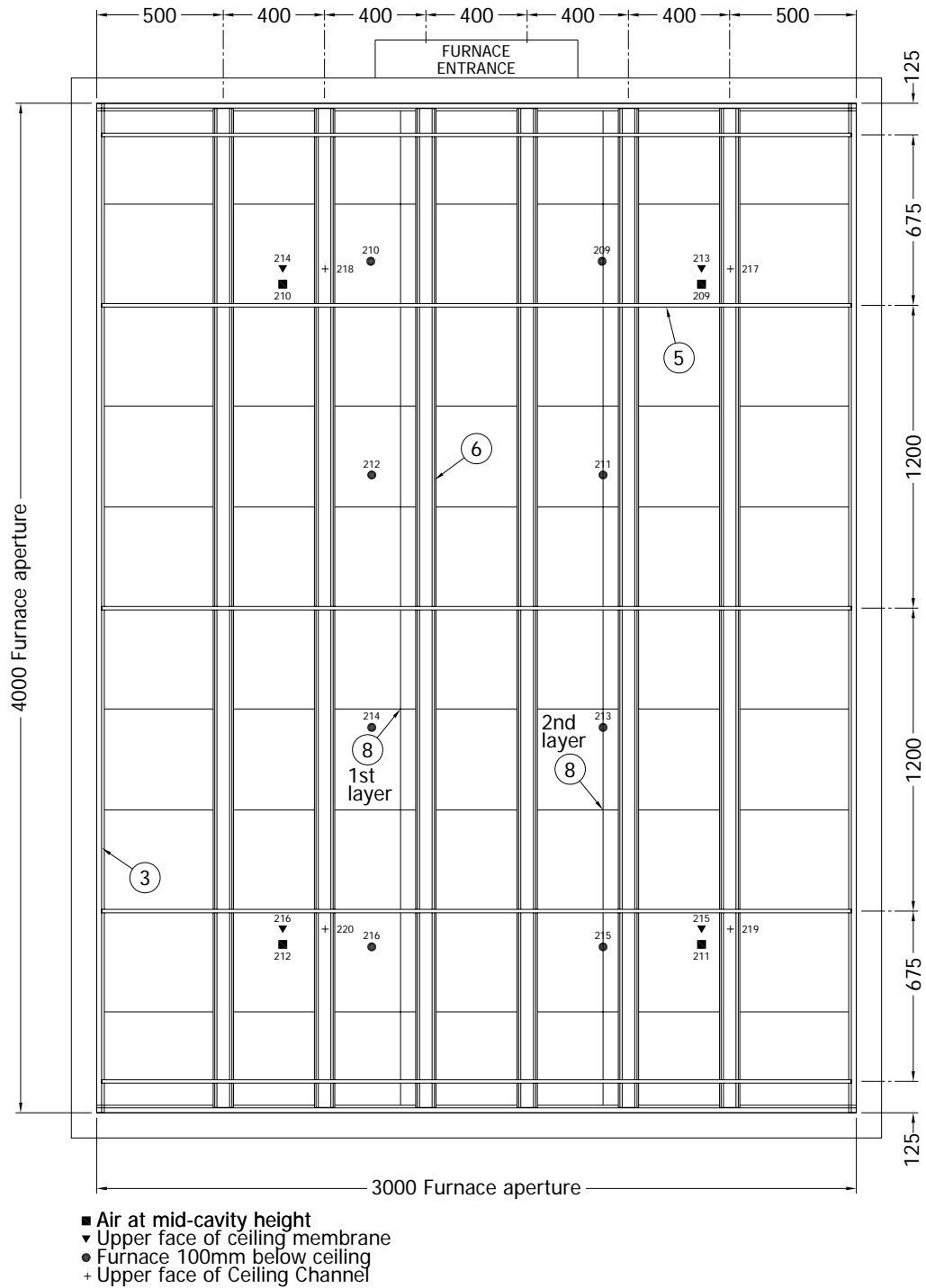
A comprehensive description of the test construction is given in the Schedule of Components. The description is based on a detailed survey of the specimen and information supplied by the sponsor of the test.

## Installation

Representatives of the sponsor assembled the ceiling construction on the 10<sup>th</sup> October 2006.

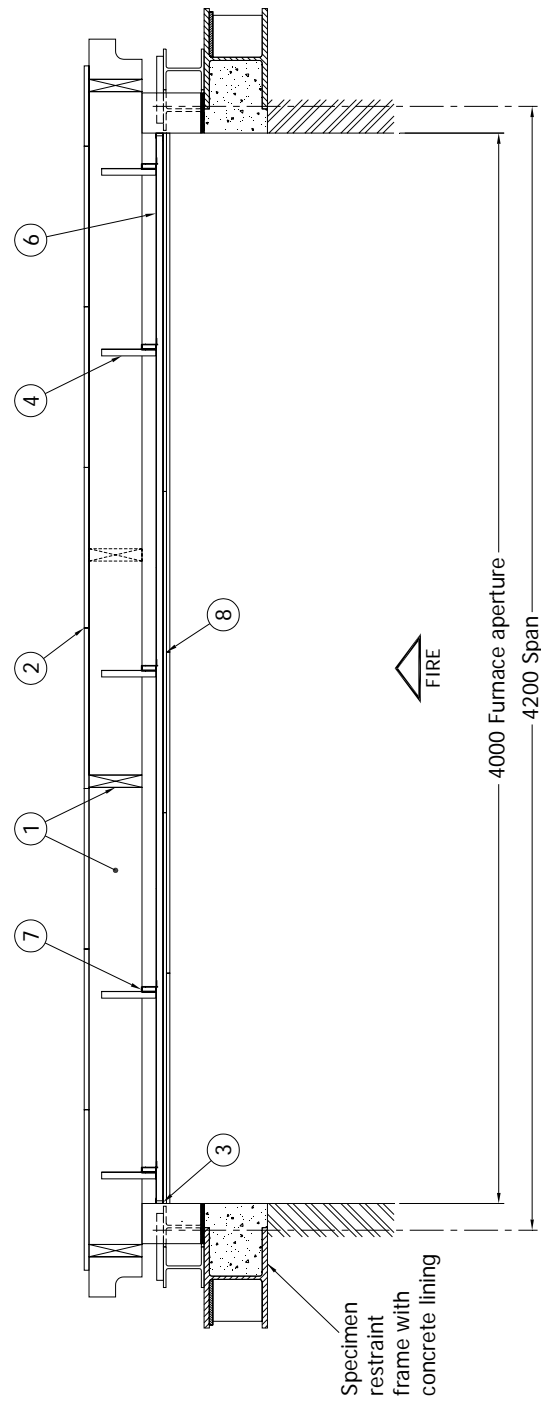


**Figure 2 – Details of Test Assembly**



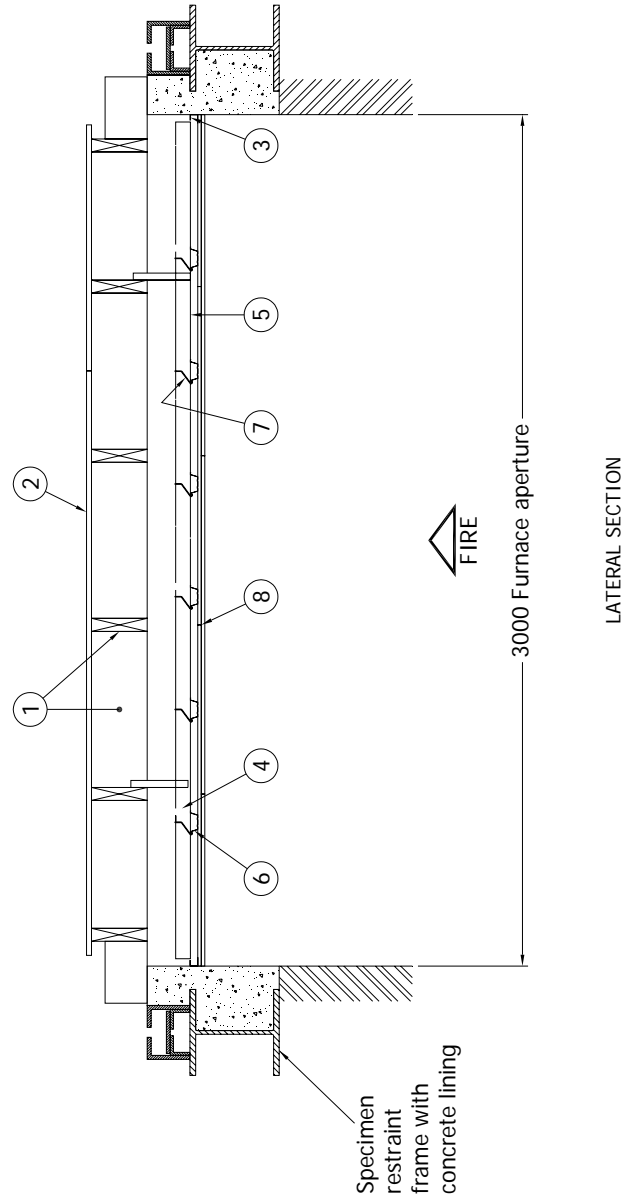
Do not scale. All dimensions are in mm

**Figure 3 – Longitudinal Section Through Test Assembly**



Do not scale. All dimensions are in mm

Figure 4 – Lateral Section Through Test Assembly



Do not scale. All dimensions are in mm

# Schedule of Components

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(Refer to Figures 1 to 4)

(All values are nominal unless stated otherwise)

(All other details are as stated by the sponsor)

<b><u>Item</u></b>	<b><u>Description</u></b>
<b>1. Timber Floor</b>	
Material	: Class SC3 grade softwood
Density	: 35.1 kg/m <sup>3</sup> , measured
Overall size	: 198 mm x 46 mm
Lengths	:
i. longitudinal joists	: 4600 mm
ii. lateral end joists	: 2754 mm
iii. noggins	: 354mm
Centres	: 600 mm
<b>2. Flooring</b>	
Material	: Tongue & Groove chipboard
Density	: 76.1 kg/m <sup>3</sup> , measured
Thickness	: 18 mm
Overall size	: Cut from 2400 mm long x 600 mm wide sheets
Fixing method	: Through fixed to each joist nominally 50 mm from the edge
Fixings	
i. type	: Fired nails
ii. material	: Steel
iii. overall size	: 65 mm long x 4 mm diameter
<b>3. Perimeter Channel</b>	
Manufacturer	: EWS (Manufacturing) Ltd
Reference	: T4290
Material	: Galvanised mild steel channel
Thickness	: 0.55 mm
Overall size	: 18.5 mm x 27.5 mm x 30.5 mm
Expansion allowance	: None
Fixings	
i. material	: Plastics plugs (Red) with steel screws
ii. overall size	: 33 mm long 6 mm diameter plugs complete with 38 mm long x 3.4 mm diameter screws
iii. centres	: 300 mm nominal

**Item****Description****4. Hanger Bracket**

Manufacturer	:	EWS (Manufacturing) Ltd
Reference	:	T4285
Material	:	Galvanised mild steel angle
Thickness	:	0.55 mm
Overall size	:	25 mm x 25 mm x 0.55 mm thick x 203 mm long
Fixing methods	:	Through screwed to timber joists using 38 mm long x 3.4 mm diameter screws

**5. Primary Support Channel**

Manufacturer	:	EWS (Manufacturing) Ltd
Reference	:	T4289
Material	:	Galvanised mild steel channel
Thickness	:	0.55 mm
Overall size	:	45 mm x 13.5 mm x 3600 mm long
Fixing method	:	Through screwed from hanger bracket, item 4, using 13 mm long x 4.8 mm diameter self drilling self tapping pan head screws

**6. Ceiling Channel**

Manufacturer	:	EWS (Manufacturing) Ltd
Reference	:	T4291
Material	:	Profiled galvanised mild steel
Thickness	:	0.55 mm
Overall size	:	79 mm wide x 26.5 mm deep x 3600 mm long cut to size
Expansion allowance	:	5 mm nominally at each end
Fixing method	:	Hung from support channel via connection clips, item 8

**7. Connecting Clip**

Manufacturer	:	EWS (Manufacturing) Ltd
Reference	:	T4383
Material	:	Rolled galvanised mild steel wire
Diameter	:	2.6 mm
Fixing method	:	Fitted over primary support channel, item 5, and snap fitted under flanges of ceiling channel, item 6 at every crossing point

**Item****Description****8. Cladding Boards**

Manufacturer	:	British Gypsum
Reference	:	Fireline board
Material	:	Class A plasterboard complete with paper faces
Thickness	:	12.5 mm
Overall size	:	1200 mm wide x 2700 mm long
Fixing method	:	Through screwed in 2 off layers to soffit of ceiling channel, item 6
Fixings to first layer		
i. type	:	Drywall screws
ii. material	:	Steel
iii. overall size	:	25 mm long 3.4 mm diameter
Fixings to second layer		
i. type	:	Drywall screws
ii. material	:	Steel
iii. overall size	:	34 mm long 3.4 mm diameter

# Instrumentation

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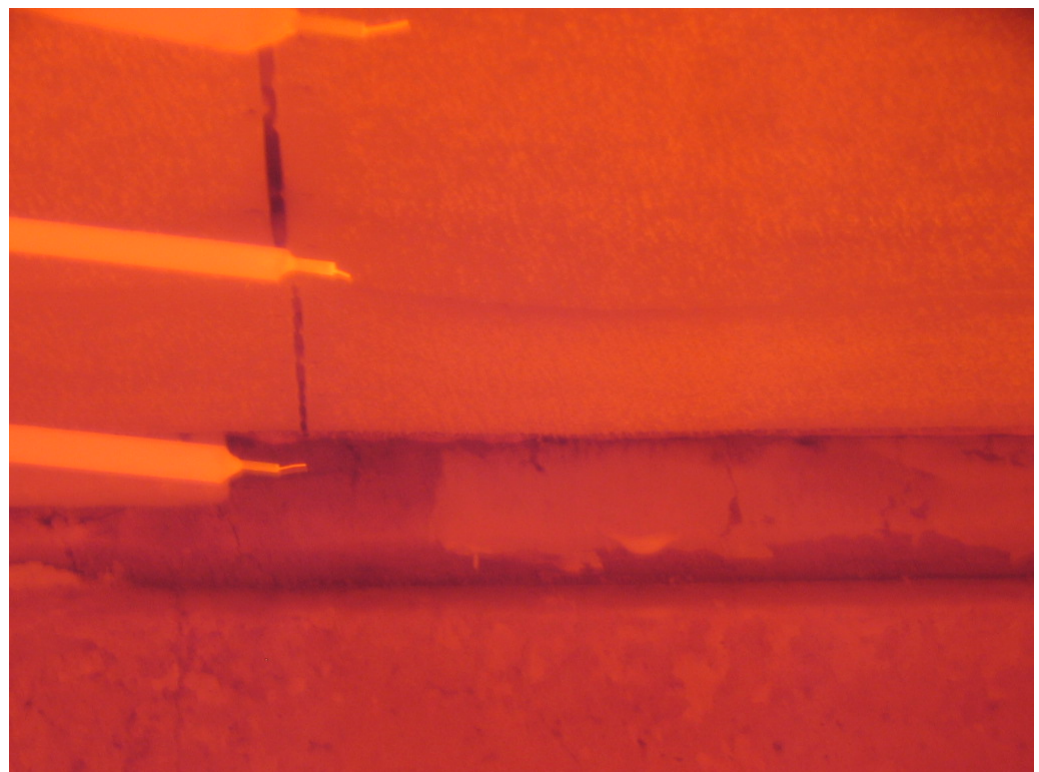
<b>General</b>	The instrumentation was provided in accordance with the requirements of the Standard.
<b>Furnace</b>	The furnace was controlled so that its mean temperature complied with the requirements of BS 476: Part 20: 1987, Clause 3.1. using eight mineral insulated thermocouples distributed over a plane 100 mm from the underside of the test construction.
<b>Thermocouple Allocation</b>	Thermocouples were provided to monitor the unexposed surface of the floor assembly and the output of all instrumentation was recorded at no less than one minute intervals as follows:
<b>Thermocouples 202 to 206</b>	At five positions on the unexposed surface of the floor assembly, one approximately at the centre and one at approximately the centre of each quarter section.
<b>Thermocouples 207 &amp; 208</b>	At two positions on the unexposed surface of the assembly, adjacent to two of the floorboard joints.  Additional thermocouples were included for information purposes only. These additional thermocouples were installed within the assembly during its construction as follows:
<b>Thermocouples 209 to 212</b>	At four positions, mid-height of the air cavity within the assembly, one in each quarter section.
<b>Thermocouples 213 to 216</b>	At four positions within the cavity of the assembly, positioned on the back of the ceiling panels, one in each quarter section.
<b>Thermocouples 217 to 220</b>	At four positions, placed on the ceiling panel steel support system, one approximately at the centre of each quarter section  The locations and reference numbers of the various unexposed surface and internal thermocouples are shown in Figure 1.
<b>Roving Thermocouple</b>	A roving thermocouple was available to measure temperatures on the unexposed surface of the specimen at any position, which might appear to be hotter than the temperatures indicated by the fixed thermocouples.
<b>Integrity criteria</b>	Cotton pads and gap gauges were available to evaluate the impermeability of the specimen to hot gases.
<b>Furnace Pressure</b>	After the first five minutes of testing and for the remainder of the test, the furnace atmospheric pressure was controlled so that it complied with the requirements of BS 476: Part 20: 1987, Clause 3.2.2. The calculated pressure differential relative to the laboratory atmosphere at a position 100 mm below the underside of the assembly was 18 ( $\pm 2$ ) Pa.

## Test Photographs

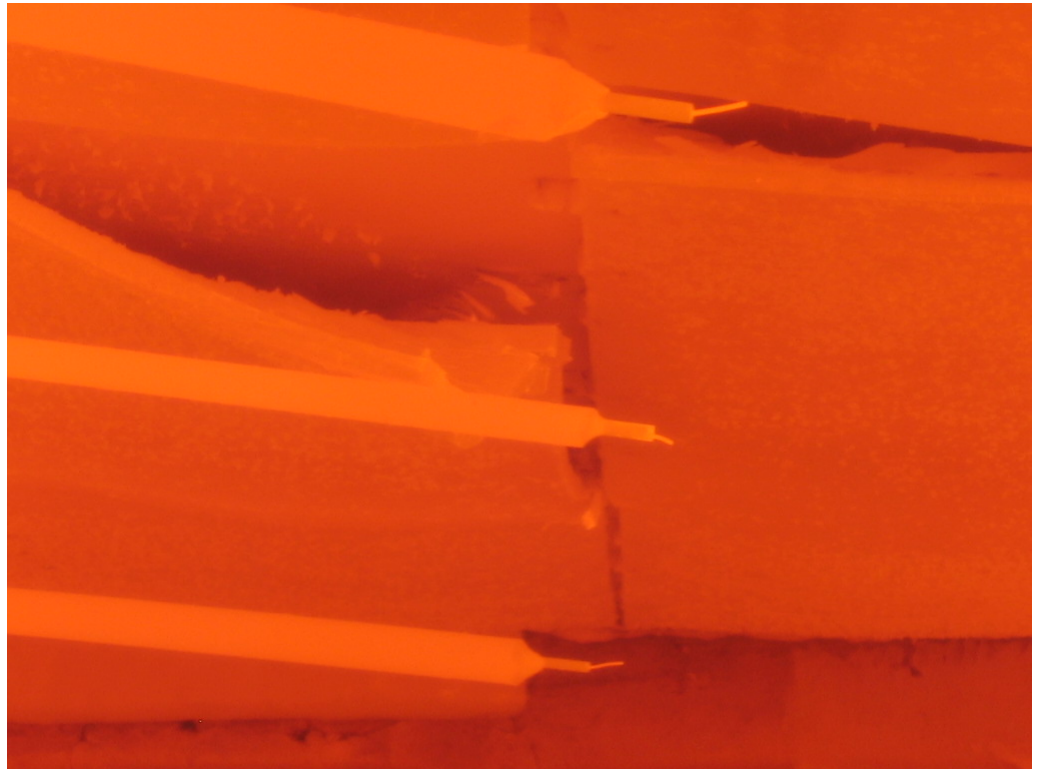
The exposed face of the ceiling assembly prior to testing



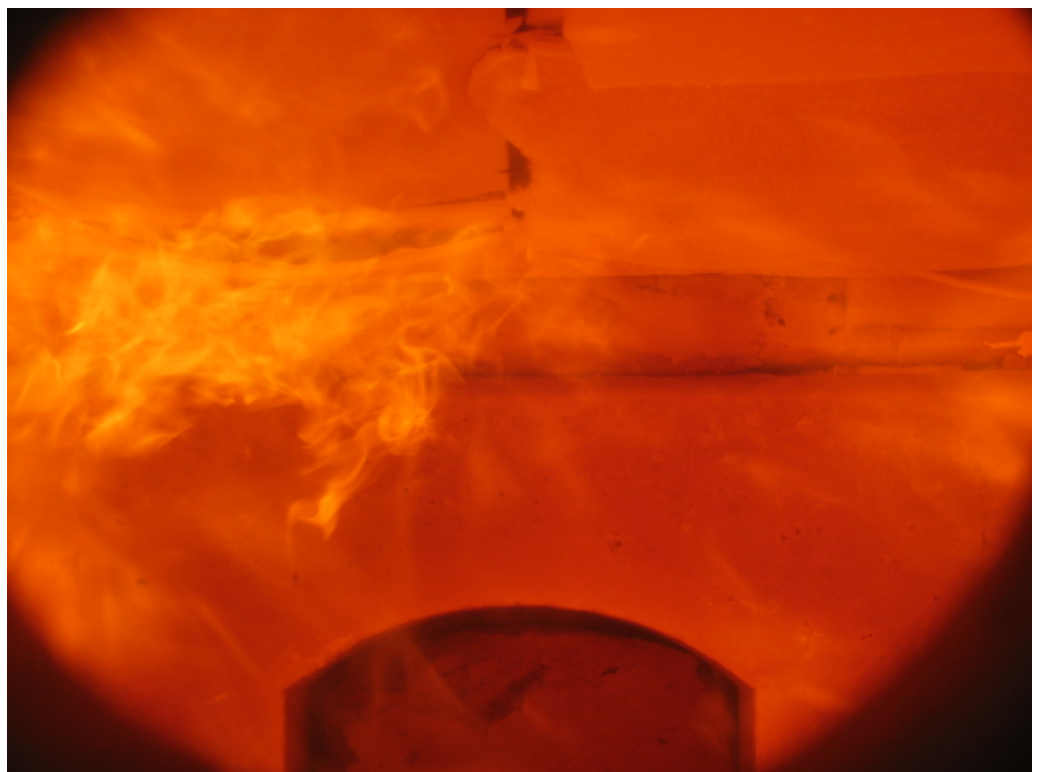
The exposed surface of the ceiling assembly after a duration of 20 minutes of testing



The exposed surface of the ceiling assembly after a duration of 68 minutes of testing



The exposed surface of the ceiling assembly after a duration of 90 minutes of testing



The unexposed surface of the ceiling assembly after a test duration of 98 minutes showing distortion of the floor.



The unexposed face of the ceiling assembly showing integrity failure at 104 minutes



## Temperature & Deflection Data

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Mean furnace temperature, together with the temperature/time relationship specified in the Standard

Time Mins	Specified Furnace Temperature Deg. C	Actual Furnace Temperature Deg. C
0	20	34
5	576	579
10	678	675
15	739	734
20	781	781
25	815	818
30	842	842
35	865	868
40	885	884
45	902	901
50	918	920
55	932	941
60	945	949
65	957	965
70	968	974
75	979	982
80	988	989
85	998	993
90	1006	1019
95	1014	1034
100	1022	1043
104	1028	1037

**Individual and mean temperatures recorded on the unexposed surface of the floor assembly**

Time Mins	T/C Number 2 Deg. C	T/C Number 3 Deg. C	T/C Number 4 Deg. C	T/C Number 5 Deg. C	T/C Number 6 Deg. C	Mean Temp Deg. C
0	21	20	21	23	24	22
5	21	21	21	23	24	22
10	21	*	21	24	24	23
15	23		22	25	25	24
20	27		25	28	29	27
25	31		28	32	32	31
30	35		31	35	35	34
35	39		35	39	39	38
40	42		38	43	43	42
45	45		41	46	46	45
50	48		44	48	48	47
55	50		46	50	50	49
60	54		48	54	53	52
65	65		51	64	62	61
70	78		55	75	74	71
75	82		63	81	81	77
80	83		72	83	84	81
85	83		79	84	87	83
90	84		83	86	90	86
95	85		88	88	90	88
100	86		86	91	91	89
104	88		93	90	107	95

\* Thermocouple Malfunction

**Individual temperatures recorded adjacent to two of the joints in the flooring**

Time Mins	T/C Number 7 Deg. C	T/C Number 8 Deg. C
0	22	23
5	22	23
10	22	23
15	24	23
20	28	24
25	33	24
30	37	24
35	42	25
40	46	25
45	49	25
50	52	25
55	54	26
60	58	26
65	63	27
70	72	28
75	78	29
80	80	31
85	80	32
90	80	32
95	83	34
100	106	35
104	441	42

**Individual temperatures recorded mid-height of the air cavity**

Time Mins	T/C Number 9 Deg. C	T/C Number 10 Deg. C	T/C Number 11 Deg. C	T/C Number 12 Deg. C
0	25	27	28	29
5	26	30	31	31
10	35	46	50	47
15	57	62	64	61
20	68	71	72	69
25	71	78	82	79
30	78	87	91	88
35	83	94	98	95
40	86	100	103	100
45	88	106	110	107
50	90	115	132	122
55	94	140	174	154
60	102	173	207	185
65	118	201	233	208
70	137	224	254	227
75	154	242	274	249
80	172	264	294	275
85	188	293	314	309
90	202	333	332	336
95	214	370	361	387
100	226	517	462	557
104	234	702	632	738

**Individual Temperatures Recorded On  
The Back Of The Ceiling Panels**

Time Mins	T/C Number Deg. C	T/C Number Deg. C	T/C Number Deg. C	T/C Number Deg. C
0	25	29	27	28
5	26	34	32	34
10	43	65	62	66
15	64	83	80	79
20	73	88	85	83
25	77	94	91	90
30	84	98	95	96
35	91	102	98	106
40	95	107	105	112
45	98	116	113	119
50	102	129	128	138
55	110	173	183	225
60	135	258	272	293
65	163	303	315	328
70	183	327	340	352
75	200	346	359	373
80	216	362	375	393
85	231	386	391	424
90	244	415	407	457
95	257	446	424	500
100	274	528	449	650
104	287	725	530	993

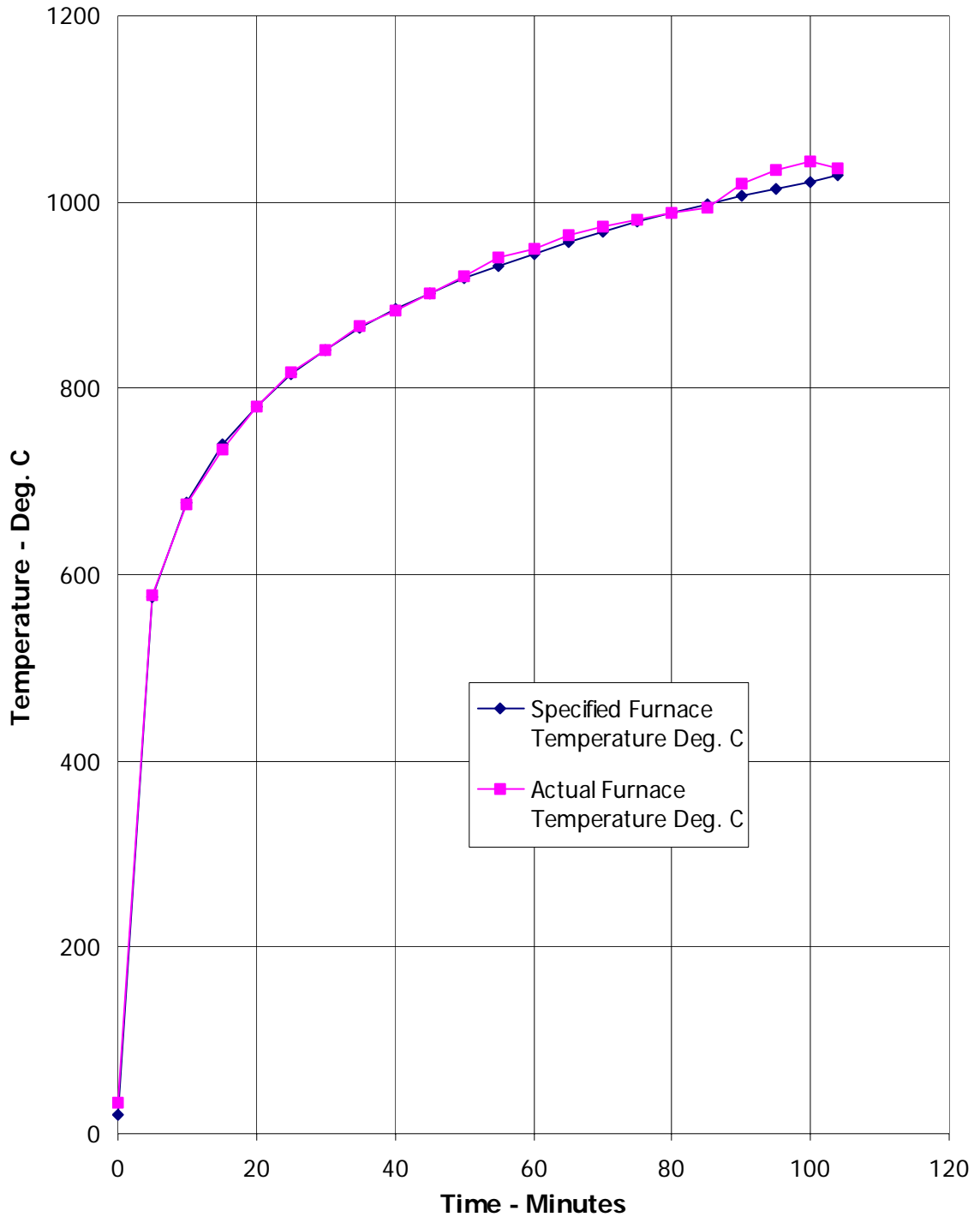
**Individual Temperatures Recorded On  
The Ceiling Panels Steel Support System**

Time Mins	T/C Number Deg. C	T/C Number Deg. C	T/C Number Deg. C	T/C Number Deg. C
0	26	25	25	26
5	29	26	26	27
10	59	42	39	41
15	79	55	55	55
20	85	62	64	63
25	90	70	72	72
30	94	79	81	81
35	101	85	89	89
40	105	90	94	94
45	114	93	98	99
50	124	98	104	110
55	162	112	129	141
60	240	141	172	183
65	284	168	202	213
70	308	188	224	237
75	325	207	244	264
80	340	224	263	290
85	353	253	282	327
90	361	291	300	361
95	371	328	319	403
100	388	450	352	569
104	389	566	419	816

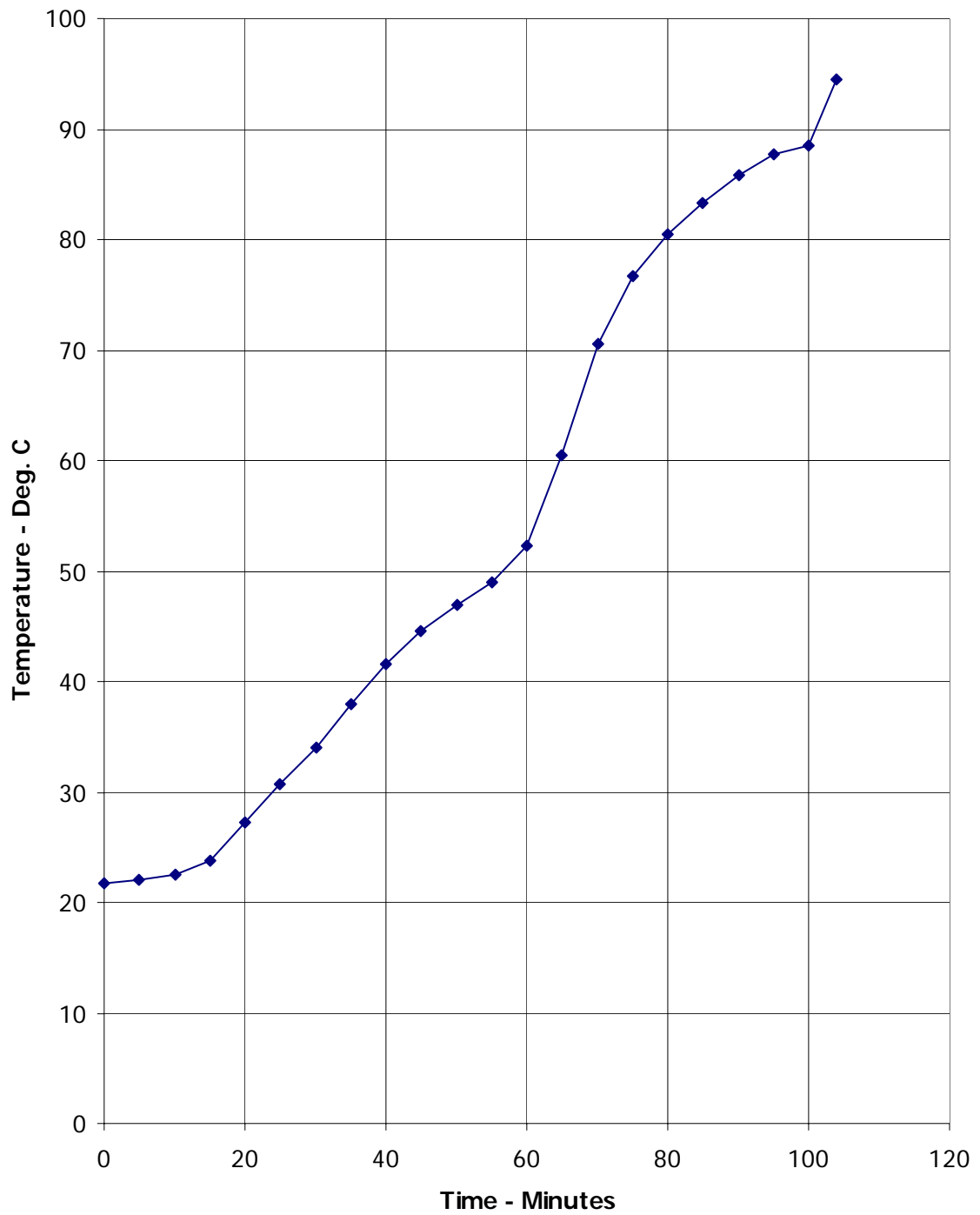
**Deflection and rate of deflection of the floor assembly during the test**

Time Minutes	Vertical Deflection In mm	Deflection Rate mm/min
0	0	0
5	0	0
10	0	0
15	0	0
20	0	0
25	0	0
30	1	1
35	4	1
40	6	1
45	11	1
50	15	1
55	17	1
60	22	1
65	29	1
70	36	2
75	45	2
80	55	2
85	76	4
90	94	4
95	125	7
98	153	13

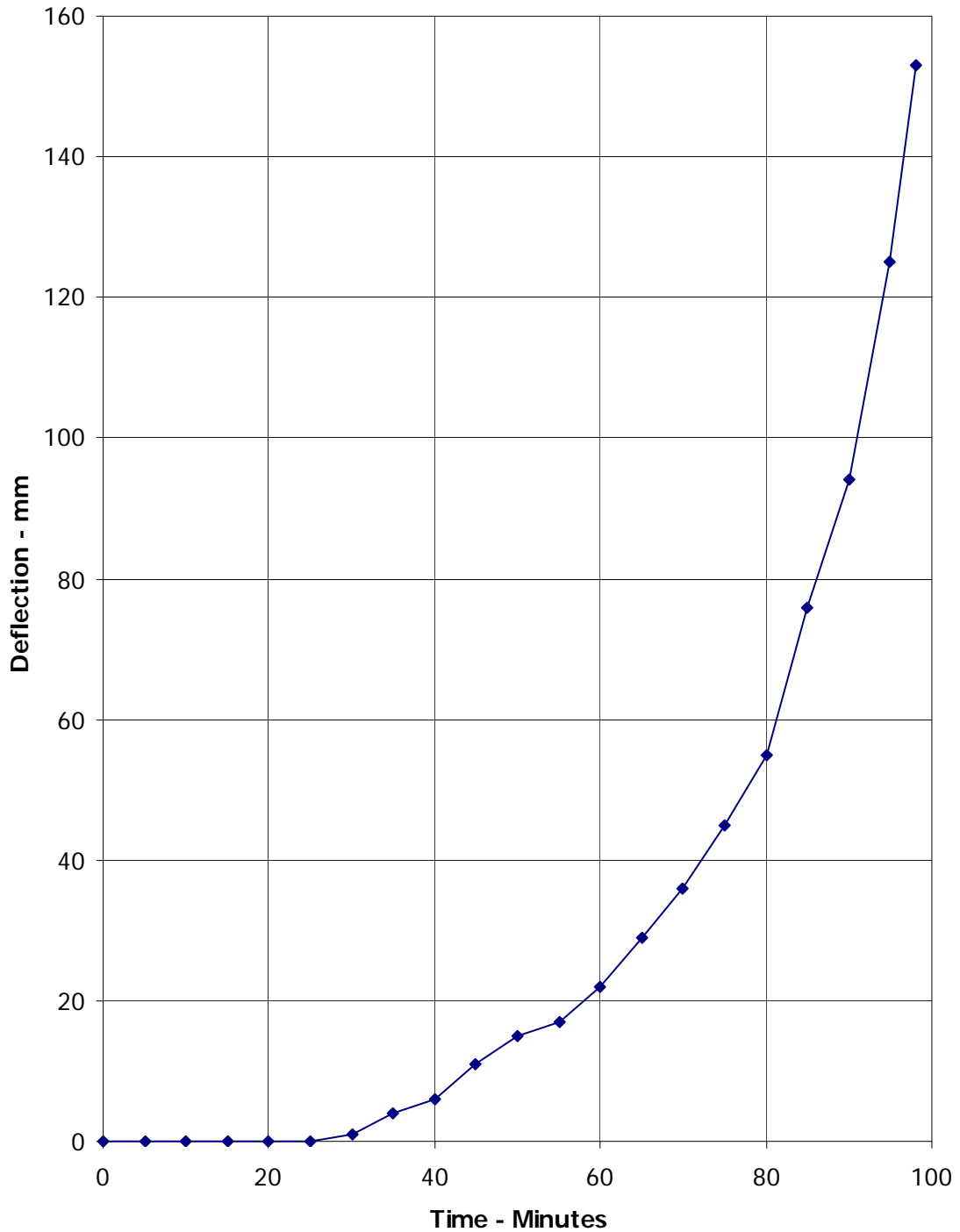
Graph showing specified and Actual Furnace Temperatures



Graph showing mean unexposed surface temperature of the floor assembly



Graph showing the central vertical deflection of the floor assembly during the test



# Load Calculations

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## 1. Physical Parameters of Timber Joists

Measured Joist dimensions (d x b)	: 195 mm deep by 48 mm thick
Mean spacing (M)	: 600 mm
Effective span (L)	: 4200 mm
Timber grade of joists	: C16

## 2. Parameters - BS 5268: Part 2: 1996

Basic dry stress in bending	: 5.3 N/mm <sup>2</sup> (Table 7)
Modification factor for loading	: 1.1 (Table 2.9 (a))
Therefore working stress (F)	: 5.83 N/mm <sup>2</sup>
Nominal density	: 370 kg/m <sup>3</sup>

## 3. Total Loading Required Per Joist

Moment of Inertia(I)	: $bd^3/12$ : $(48 \times 195^3)/12$ : 29659500 mm <sup>4</sup>
Distance from neutral axis to base of joist (y)	: 98 mm
Maximum bending stress	: $FI/y$ : $(5.83 \times 29659500)/98$ : 1764438 N/mm <sup>2</sup>
Also maximum bending stress	: $wL^2/8$ : 1764438 N/mm <sup>2</sup>
Where w	= Load per unit length
∴ w	= $(1764438 \times 8) / (4200 \times 4200)$ = 0.8 N/mm = 800 N/m
∴ Total loading (W)	: 3360 N : 343 kg

## 4. Dead Weight

Combined weight of overall specimen:

Actual density of joist	: 435 kg/m <sup>3</sup>
Actual density of floor boarding	: 666 kg/m <sup>3</sup>
Actual density of ceiling tiles	: 820 kg/m <sup>3</sup>

Effective width of floor supported per joist (m): 0.6 m

weight joist	: 17 kg
weight floorboard	: 30 kg
weight ceiling	: 49 kg

Total dead weight per joist : 96 kg

**5. Imposed Load**

Imposed load per joist required : total load per joist - dead weight per joist  
: 343 - 96  
: 247 kg

Assuming even distribution of loading

Maximum imposed load per metre square :  $(284 \times 9.81) / (4.2 \times 0.6)$   
: 962 N/m<sup>2</sup>  
: **.962 kN/m<sup>2</sup>**  
: 98 kg/m<sup>2</sup>

**Calculation made by**

**Checked by**

**N Howard**  
Testing Officer  
Technical Department  
**warringtonfire**

**A. Kearns**  
Technical Consultant  
For and on behalf of  
**warringtonfire**

## Performance Criteria and Test Results

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### Loadbearing Capacity

The maximum allowable deflection and the maximum rate of deflection for the specimen, as specified by the Standard, are calculated as 210 mm and 10 mm per minute respectively. The allowable rate of deflection is not applicable until the deflection exceeds  $\frac{1}{30}$  of the span (i.e. 140 mm). The specimen satisfied this requirement for **98 minutes**.

### Integrity

It is required that there is no collapse of the specimen, no sustained flaming on the unexposed surface and no loss of impermeability. These requirements were satisfied for the **104 minutes** duration of the test.

### Insulation

It is required that the mean temperature rise of the unexposed surface shall not be greater than 140°C and that the maximum temperature rise shall not be greater than 180°C. Insulation failure also occurs simultaneously with integrity failure. These requirements were satisfied for **102 minutes**.

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## Ongoing Implications

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### Limitations

The results relate only to the behaviour of the specimen of the element of construction under the particular conditions of test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, nor do they reflect the actual behaviour in fires.

The test results relate only to the specimen tested. Appendix A of BS 476: Part 20: 1987 provides guidance information on the application of fire resistance tests and the interpretation of test data. Application of the result to assemblies of different dimensions or supported in other manners or incorporating different components should be the subject of a design appraisal.

### Review

The specification and interpretation of fire test methods are the subject of ongoing development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over five years old should be considered by the user. The laboratory that issued the report will be able to offer, on behalf of the legal owner, a review of the procedures adopted for a particular test to ensure that they are consistent with current practices, and if required may endorse the test report.

## Conclusions

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**Evaluation  
against  
objective**

A specimen of a loadbearing timber floor assembly, protected by a plasterboard ceiling has been subjected to a fire resistance test in accordance with BS 476: Part 21: 1987, Clause 7.

The evaluation of the assembly against the requirements of BS 476: Part 21: 1987, Clause 7 showed that it satisfied the requirements the periods stated below:

**Test Results:**

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**Loadbearing  
Capacity**

98 minutes

**Integrity**

104 minutes\*

**Insulation**

102 minutes

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\* The test duration. The test was discontinued after a period of 104 minutes.



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