

Title:

The Fire Resistance Performance of a Specimen of a Loadbearing Timber Floor Assembly Protected by a Plasterboard Ceiling Designed to Provide 90 minutes Fire Resistance, Incorporating Sixteen Downlight Light Fittings, Tested in Accordance with BS 476: Part 21: 1987, Clause 7

WF Report No:

388542A Issue 2



Prepared for:

Integral LED
Unit 6, Iron Bridge Close, Iron
Bridge Business Park,
London, NW10 0UF, UK

Date:

26th January 2018

Notified Body No:

0833



0249

This test report is additional to that issued as WF Test report No. 388542 and dated 15th December 2017. The original test report remains valid and is not replaced by this additional test report.

Summary

Objective To determine the fire resistance performance of a loadbearing timber floor assembly protected by a plasterboard ceiling designed to provide 90 minutes fire resistance, incorporating sixteen downlight light fittings, when tested in accordance with Clause 7 of BS 476: Part 21: 1987.

Sponsor **Integral LED**
Unit 6, Iron Bridge Close, Iron Bridge Business Park, London, NW10 0UF,

Summary of Tested Assembly Briefly, the timber floor had overall nominal dimensions of 4400 mm long by 3000 mm wide and comprised softwood timber joists at 600 mm centres. The upper surface of the floor comprised nominally 22 mm thick tongue and grooved chipboard flooring.

The floor assembly was protected on its underside by a direct fixed ceiling, formed from two layers of 15 mm thick British Gypsum Fireline plasterboard, the ceiling was screw fixed to the underside of the floor joists.

The floor supported an evenly distributed load of 0.822 kN/m².

The ceiling incorporated sixteen downlight light fittings, two of which are subject to this test report and were referenced as follows:

Test Ref.	Model Ref.	Description
K	ILDIFR92CXXX	Round LED recessed down light, 92 mm diameter cut-out
M	ILDIFR70AXXX	Round LED recessed down light, 70 mm diameter cut-out
A – J, L and N - P	Items reported separately	

Test Results:

Loadbearing Capacity	93 minutes*
Integrity	93 minutes*
Insulation	93 minutes*

*The test was discontinued after a period of 93 minutes

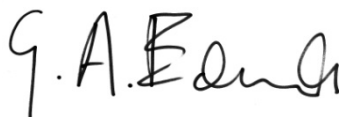
Date of Test 16th September 2017

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Signatories



Responsible Officer
W. Drazkiewicz*
Technical Officer



Approved
G. Edmonds*
Senior Technical Officer

* For and on behalf of **Warringtonfire**.

Report Issued
Date: 26th January 2018

This test report is additional to that issued as WF Test report No. 388542 and dated 15th December 2017. The original test report remains valid and is not replaced by this additional test report.

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Revision History

Issue No: 2	Re-issue Date: 16 th December 2019
Revised By: D. Whittle	Approved By: W. Drazkiewicz
Reason for Revision: Rebranding of report and amendment to details of Specimen M	

Issue No :	Re-issue Date:
Revised By:	Approved By:
Reason for Revision:	

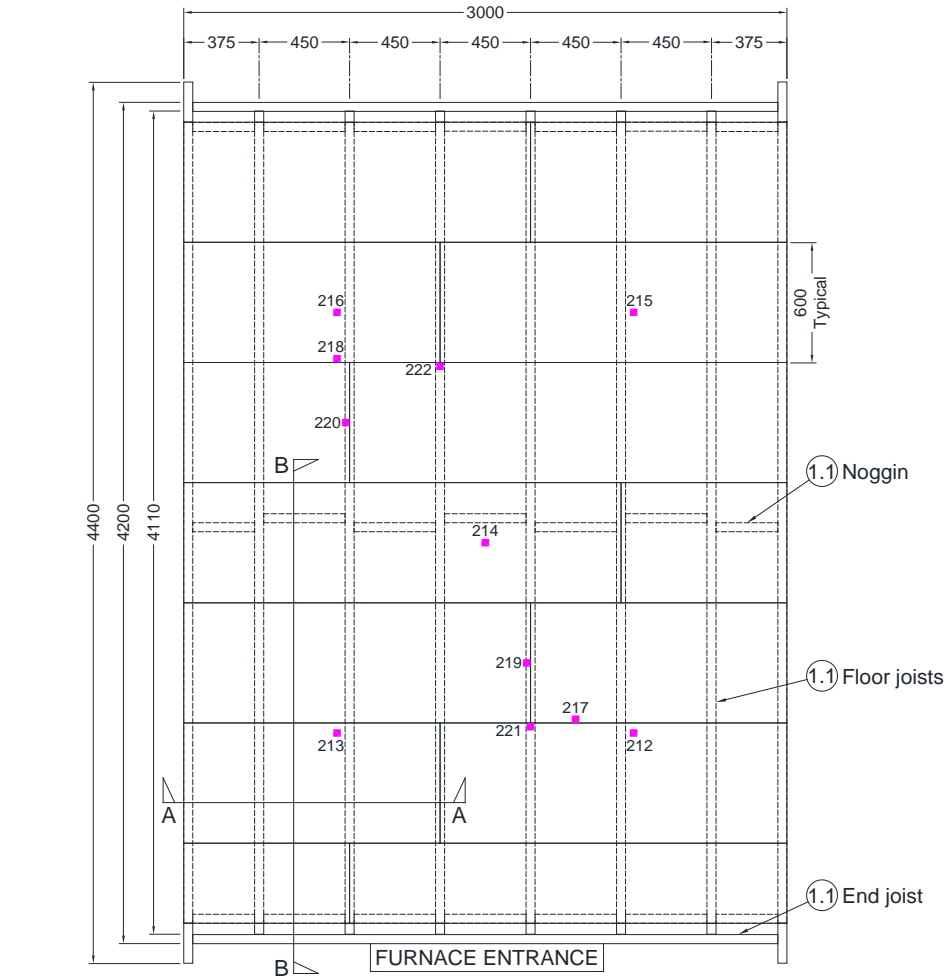
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Test Procedure

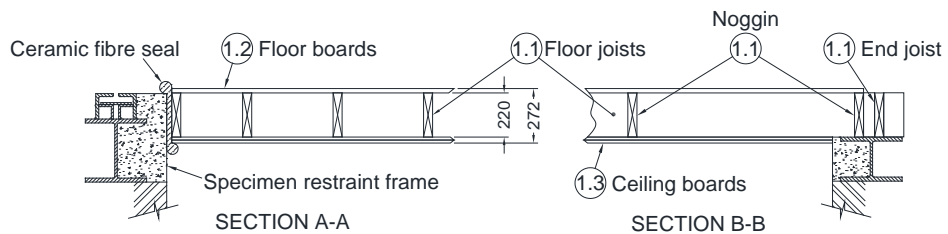
Introduction	<p>The specimen tested was of a loadbearing construction. The test was conducted in accordance with Clause 7 of BS 476: Part 21: 1987, 'Methods for determination of the fire resistance of loadbearing elements of construction'. This test report should be read in conjunction with that Standard and with BS 476: Part 20: 1987, 'Method for determination of the fire resistance of elements of construction (general principles)'.</p> <p>The purpose of the test was to evaluate the performance of a timber floor construction protected by a ceiling of previously proven fire resistance, when incorporating down lighter fitting assemblies.</p> <p>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.</p>
Fire Test Study Group/EGOLF	<p>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.</p>
Instruction To Test	<p>The test was conducted on the 16th September 2017 at the request of Integral LED, the test sponsor.</p>
Test Assembly Construction	<p>A comprehensive description of the test construction is given in the Schedule of Components. The description is based on a detailed survey of the specimens and information supplied by the sponsor of the test.</p>
Installation	<p>Representatives of Warringtonfire assembled the floor construction and installed the down lighters on the 14th September 2017</p>
Conditioning	<p>The floor construction and downlighters specimens' storage, construction, and test preparation took place in the test laboratory over a total combined time of 5 days. Throughout this period of time both the temperature and the humidity of the laboratory were measured and recorded as being within a range of from 9°C to 13°C and 50% to 62% respectively.</p>

Test Construction

Figure 1- General Elevation of Test Construction

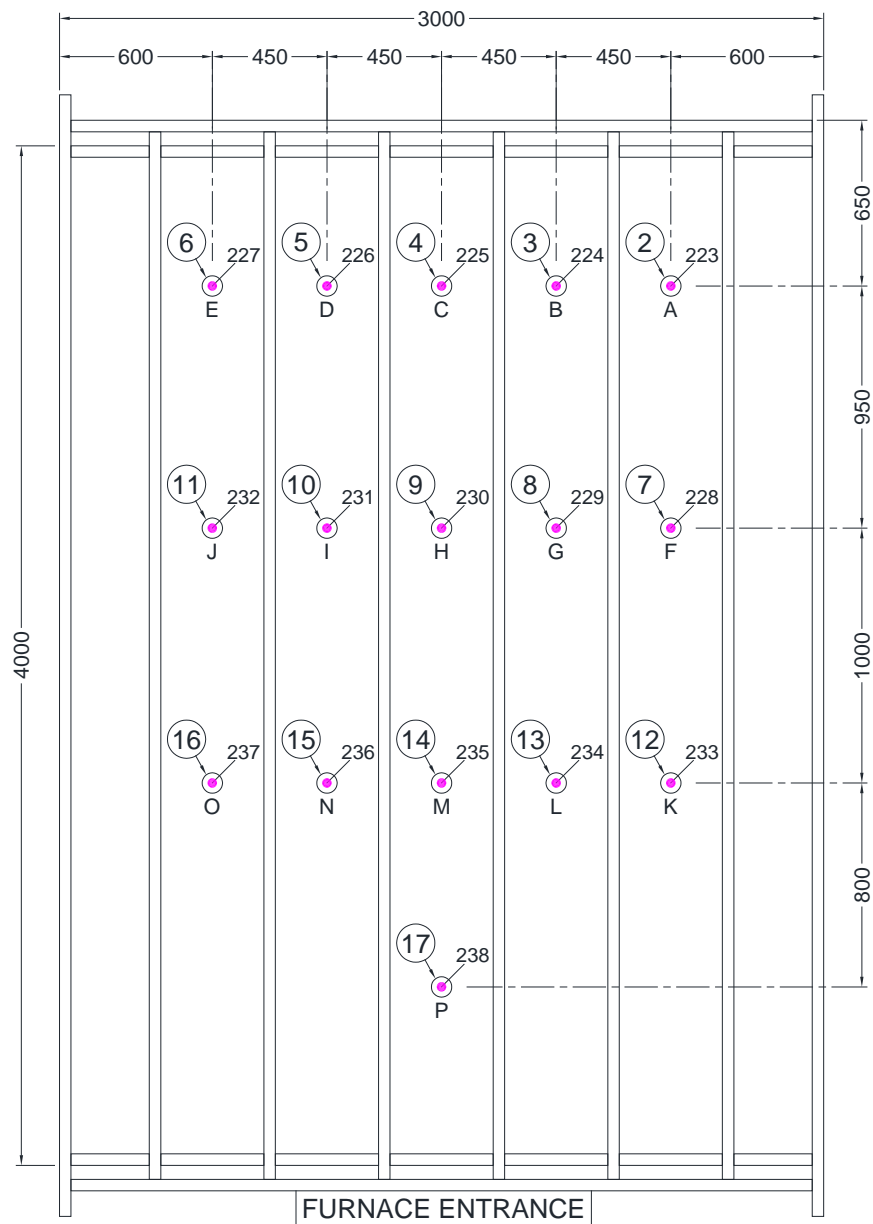


Key
 ■ Surface thermocouple
 PLAN OF THERMOCOUPLE POSITIONS



Do not scale. All dimensions are in mm

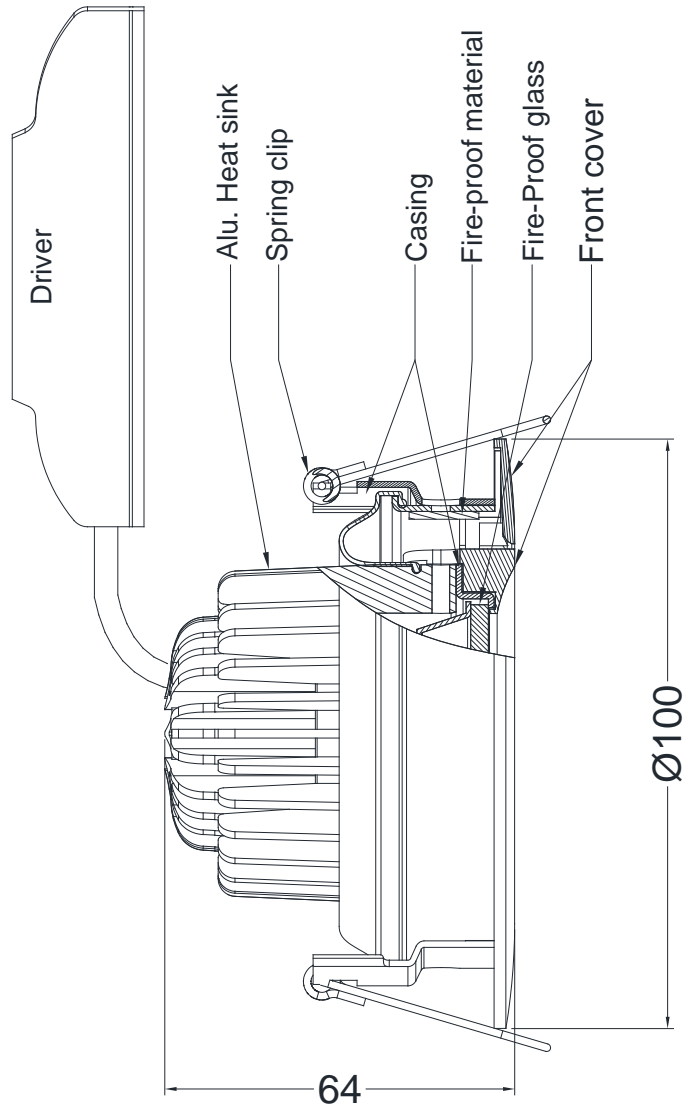
Figure 2 – Details of Downlighter Positions



● Mineral insulated thermocouples at mid-cavity height

Do not scale. All dimensions are in mm

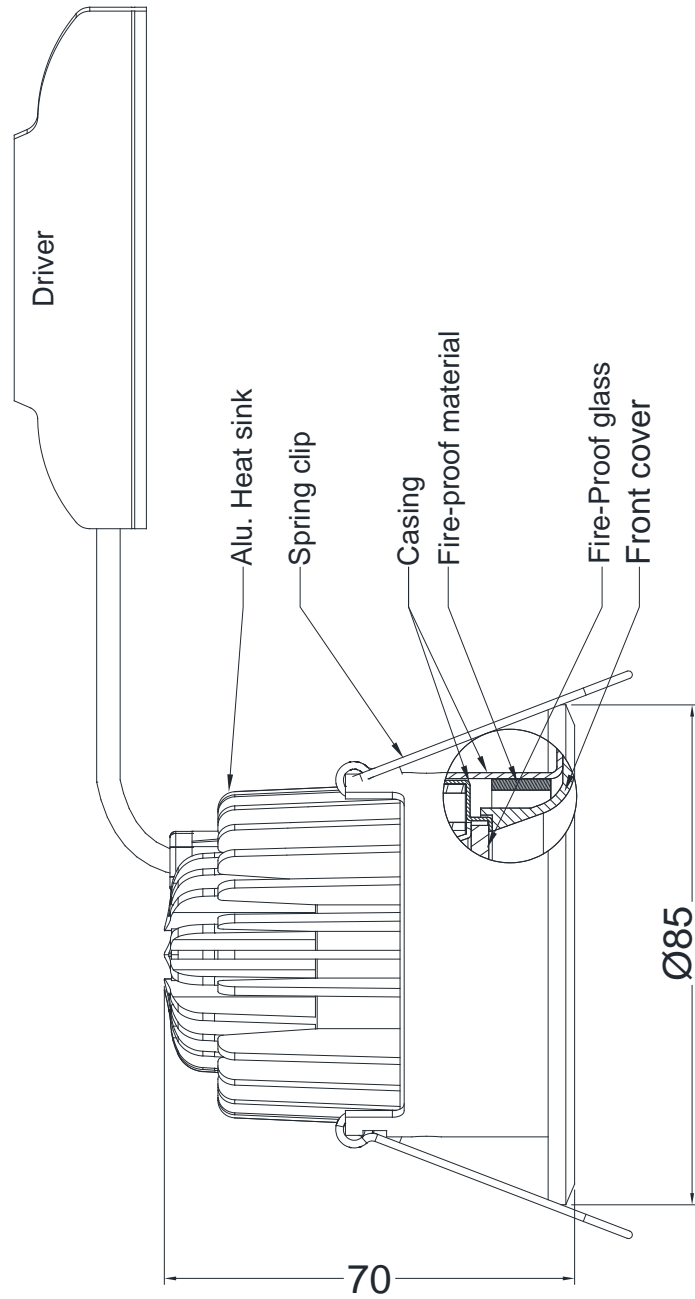
Figure 3 – Details of Downlighters Specimen K



Tilttable
With reflector ILDLFR92CXXX
Cut out: $\varnothing 92$

Do not scale. All dimensions are in mm

Figure 4 – Details of Downlighters Specimen M



Fixed
With reflector ILDLFR70AXXX
Cut out: Ø70

Do not scale. All dimensions are in mm

Schedule of Components

(Refer to Figures 1 to 4)
 (All values are nominal unless stated otherwise)
 (All other details are as stated by the sponsor)

<u>Item</u>	<u>Description</u>
1. Timber Floor	
1.1 Floor Joists	
Material	: British Home-grown, rough sawn softwood, kiln dried
Grade	: C16, to BS EN 519
Density	: 511 kg/m ³
Size	: 45 mm x 197 mm
Joist centres	: 450 mm
1.2 Noggins	
Material	: British Home-grown, rough sawn softwood, kiln dried
Grade	: C24, to BS EN 519
Density	: 511 kg/m ³
Size	: 65 mm x 45 mm
Joist centres	: 1200 mm
1.2 Floor Boards	
Material	: Flooring grade tongue and groove chipboards
Reference	: FSC E1 P5
Thickness	: 22 mm
Size	: 450 mm wide
Fixing	: Fixed in a single layer with 6 mm diameter x 60 mm long countersunk steel screws to floor joists at 300 mm centres
1.3 Ceiling Boards	
Manufacturer	: British Gypsum
Type / reference	: Gyproc Fireline Wallboard
Density	: 803 kg/m ³
Thickness	: 30 mm, 2 layers of 15 mm thick
Fixing	
i. method	: The boards were screw fixed to the soffit of the joists with all joints in the second layer staggered with respect to those of the first layer
ii. fixings	: Drywall self drill and tapping screws 38 mm and 50 mm long for the 1 st and 2 nd board layers respectively
iii. frequency	: 150 mm centres along joints and 150 mm to the perimeter of the ceiling

<u>Item</u>	<u>Description</u>
2. Specimen A	: Item reported separately
3. Specimen B	: Item reported separately
4. Specimen C	: Item reported separately
5. Specimen D	: Item reported separately
6. Specimen E	: Item reported separately
7. Specimen F	: Item reported separately
8. Specimen G	: Item reported separately
9. Specimen H	: Item reported separately
10. Specimen I	: Item reported separately
11. Specimen J	: Item reported separately
12. Specimen K	
Manufacturer	: Integral LED
Type	: Round, tiltable, LED recessed downlight
Reference	: ILDLFR92CXXX
Materials	
i. casing	: Mild steel
ii. front cover	: Die cast aluminium
iii. heat sink	: Die cast aluminium
iv. spring clip	: Stainless steel
v. gasket	: 4.3 mm wide x 1.7 mm thick flexible plastics ring
Overall dimensions and construction	: See Figure 13 for details
Cut out size	: 92 mm diameter
Driver	: None
Lamp	: COB
14. Specimen M	
Manufacturer	: Integral LED
Type	: Round, fixed, LED recessed downlight
Reference	: ILDLFR70AXXX
Materials	
i. casing	: Mild steel
ii. front cover	: Die cast aluminium
iii. heat sink	: Die cast aluminium
iv. spring clip	: Stainless steel
v. gasket	: 4.3 mm wide x 1.7 mm thick flexible plastics ring
Overall dimensions and construction	: See Figure 15 for details
Cut out size	: 70 mm diameter
Driver	: None
Lamp	: COB
15. Specimen N	: Item reported separately
16. Specimen O	: Item reported separately
17. Specimen P	: Item reported separately

Instrumentation

General	The instrumentation was provided in accordance with the requirements of the Standard.
Furnace	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 ceiling.
Thermocouple Allocation	<p>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:</p> <p>The locations and reference numbers of the various unexposed surface and internal thermocouples are shown in Figures 1 and 2.</p>
Roving Thermocouple	A roving thermocouple was available to measure temperatures on the unexposed surface of the floor at any position which might appear to be hotter than the temperatures indicated by the fixed thermocouples.
Integrity criteria	Cotton pads and gap gauges were available to evaluate the impermeability of the test construction to hot gases.
Furnace Pressure	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 20 (+0, -2) Pa.

Test Observations

Time		All observations are from the unexposed face unless noted otherwise.
mins	secs	The ambient air temperature in the vicinity of the test construction was 19°C at the start of the test with a maximum variation of +2°C during the test.
00	00	The test commences.
12	34	Small amount of smoke issue from both ends of the floor.
15	43	Viewed from exposed face: Jointing tape detached from all joints in the plasterboard.
20	45	Viewed from exposed face: Bezels from downlighters I and D detached.
23	23	Temperature above downlighter A reaches 200°C.
26	17	Viewed from exposed face: Downlighter J detaches.
30	00	No significant visible change to unexposed face.
60	00	No significant visible change to unexposed face.
60	50	Viewed from exposed face: All joints in first layer of plasterboard widened to approximately 3mm.
62	45	Viewed from exposed face: Joint in first layer of plasterboard at approximately mid-length of the assembly widened to approximately 5mm.
70	07	Viewed from exposed face: Downlighter N detached from the assembly. Cavity temperature directly above 500°C. Hole through the plasterboard is evident.
72	39	Smoke release from both floor ends significantly increased in volume.
74	21	Viewed from exposed face: Joint in the first layer of plasterboard at approximately mid-length of the assembly widened to approximately 10mm.

Time

mins secs

78	17	Viewed from exposed face: Big chunk of first layer of plasterboard detached from approximately the centre of the assembly.
80	06	Viewed from exposed face: First layer of plasterboard adjacent to downlighter N position has sagged down by approximately 15mm.
81	54	Viewed from exposed face: Big chunk of first layer of plasterboard detached from approximately the centre of the assembly.
85	26	Viewed from exposed face: Approximately 50% of the first layer of the plasterboard is detaching from the ceiling.
86	40	Viewed from exposed face: Unable to see inside due to smoke within furnace chamber. Cavity temperatures in excess of 700°C.
90	00	Specimen is still satisfying loadbearing capacity, integrity and insulation criteria allowing test to continue.
93	00	Test discontinued.

Test Photographs

The unexposed face for the assembly after a test duration of 12 minutes



The unexposed face of the assembly after 30 minutes of testing



The unexposed face of the assembly after a test duration of approximately 60 minutes



The unexposed face of the assembly after 90 minutes of testing



Temperature & Deflection Data

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	33
3	502	505
6	603	602
9	663	667
12	706	677
15	739	728
18	766	774
21	789	789
24	809	816
27	826	832
30	842	844
33	856	855
36	869	869
39	881	876
42	892	888
45	902	913
48	912	915
51	921	922
54	930	930
57	938	939
60	945	947
63	953	957
66	960	965
69	966	976
72	973	981
75	979	978
78	985	988
81	990	993
84	996	995
87	1001	989
90	1006	992
93	1011	997

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

Time Mins	T/C Number 212 Deg. C	T/C Number 213 Deg. C	T/C Number 214 Deg. C	T/C Number 215 Deg. C	T/C Number 216 Deg. C	Mean Temp Deg. C
0	22	22	22	19	19	21
3	22	22	22	19	19	21
6	22	22	21	19	19	21
9	22	22	21	19	19	21
12	22	22	21	19	19	21
15	22	22	22	20	19	21
18	24	23	22	21	20	22
21	26	25	23	23	22	24
24	28	27	24	26	24	26
27	31	29	25	28	26	28
30	34	31	27	31	28	30
33	37	33	28	33	30	32
36	40	35	30	35	32	34
39	43	37	31	37	34	36
42	45	38	32	38	36	38
45	47	40	34	40	37	40
48	48	42	35	41	38	41
51	50	43	36	42	40	42
54	51	44	37	43	40	43
57	52	46	38	44	41	44
60	52	47	38	45	42	45
63	53	48	39	46	43	46
66	54	48	40	47	43	46
69	54	49	41	47	44	47
72	55	50	41	48	46	48
75	55	50	41	49	49	49
78	56	51	42	50	56	51
81	58	53	43	51	64	54
84	60	55	45	54	71	57
87	62	58	48	57	77	60
90	67	61	64	73	82	69
93	74	71	75	82	82	77

Individual temperatures recorded adjacent to joints in the flooring

Time Mins	T/C Number 217 Deg. C	T/C Number 218 Deg. C	T/C Number 219 Deg. C	T/C Number 220 Deg. C	T/C Number 221 Deg. C	T/C Number 222 Deg. C
0	20	20	19	20	20	19
3	20	20	19	20	20	19
6	19	20	19	20	20	19
9	19	20	19	20	20	19
12	19	20	19	20	21	19
15	20	20	19	20	22	20
18	21	20	20	20	23	21
21	22	21	21	21	25	23
24	24	23	23	22	28	25
27	26	24	25	24	31	27
30	29	26	28	25	34	30
33	32	26	30	27	36	30
36	34	28	32	28	39	35
39	37	31	34	30	42	39
42	39	34	35	31	44	42
45	41	35	37	33	46	44
48	43	37	38	34	48	46
51	45	39	39	35	50	47
54	46	40	40	37	51	49
57	48	42	41	38	52	50
60	49	44	42	39	53	51
63	50	45	42	40	54	52
66	51	46	43	41	54	53
69	51	48	44	42	55	55
72	52	50	44	43	56	58
75	53	53	45	44	58	62
78	53	58	46	47	60	66
81	54	66	48	51	63	71
84	56	74	51	61	67	77
87	58	78	55	74	72	80
90	61	80	64	80	76	83
93	79	81	79	83	78	88

Individual temperatures recorded adjacent to the light fittings at mid height of the cavity

Time Mins	T/C Number 223 Deg. C	T/C Number 224 Deg. C	T/C Number 225 Deg. C	T/C Number 226 Deg. C	T/C Number 227 Deg. C	T/C Number 228 Deg. C	T/C Number 229 Deg. C	T/C Number 230 Deg. C
0	20	20	20	21	21	22	20	20
3	21	21	20	21	22	22	21	22
6	32	43	48	35	35	45	34	31
9	47	81	89	54	53	71	42	47
12	57	114	126	86	78	108	56	64
15	68	123	128	99	94	130	66	78
18	125	133	129	112	100	125	79	87
21	178	125	135	128	119	124	87	92
24	200	133	141	128	145	133	123	95
27	198	110	152	135	155	182	106	96
30	224	121	151	132	167	182	129	99
33	247	101	163	132	188	214	137	108
36	237	97	190	119	194	188	134	203
39	224	103	198	116	194	191	164	258
42	205	110	200	119	230	173	130	242
45	218	118	222	117	246	175	131	273
48	251	132	214	120	225	170	129	283
51	233	127	222	123	179	171	136	246
54	239	133	230	122	158	165	147	246
57	234	136	245	126	161	164	148	227
60	235	132	248	131	158	158	152	212
63	222	133	264	140	167	165	185	250
66	159	142	276	165	166	168	188	263
69	149	160	293	190	168	184	200	244
72	166	182	303	211	182	201	226	238
75	188	198	304	230	201	214	232	257
78	205	213	270	242	217	226	251	326
81	215	229	303	260	233	228	301	393
84	233	245	311	274	245	279	358	433
87	247	312	344	302	287	336	786	770
90	301	480	602	493	338	414	876	933
93	857	887	900	877	429	868	963	982

Individual temperatures recorded adjacent to the light fittings at mid height of the cavity

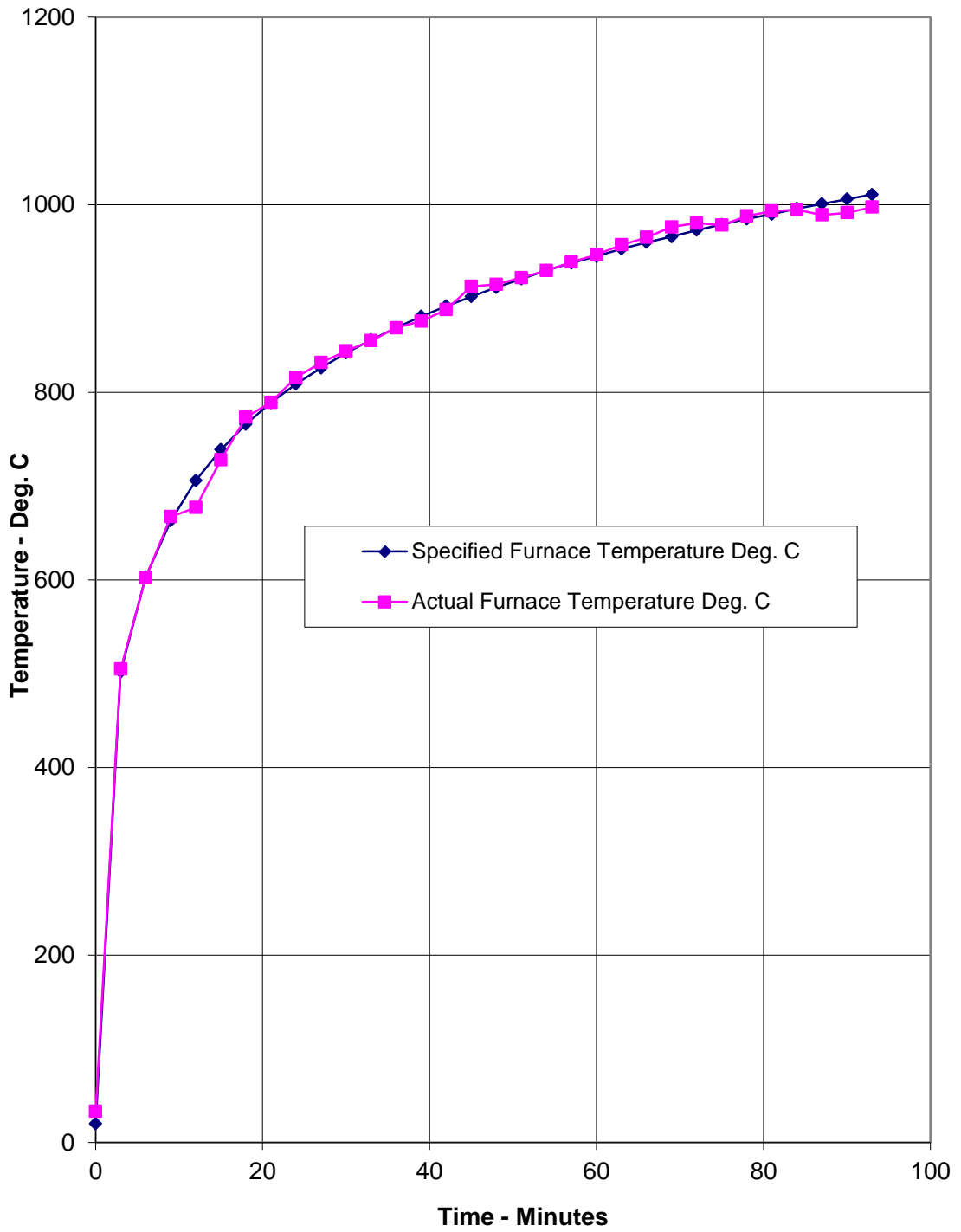
Time Mins	T/C Number 231 Deg. C	T/C Number 232 Deg. C	T/C Number 233 Deg. C	T/C Number 234 Deg. C	T/C Number 235 Deg. C	T/C Number 236 Deg. C	T/C Number 237 Deg. C	T/C Number 238 Deg. C
0	20	21	21	21	20	20	20	20
3	21	21	22	21	21	21	20	*
6	50	27	35	35	35	34	38	
9	62	40	45	67	54	52	54	
12	70	53	69	74	71	68	67	
15	92	65	132	73	79	66	88	
18	107	76	91	78	90	71	101	
21	127	83	115	82	90	77	104	
24	138	100	138	85	93	84	111	
27	151	91	95	88	99	88	109	
30	149	95	102	94	104	94	105	
33	150	102	122	99	110	102	107	
36	139	117	125	107	115	152	107	
39	134	159	135	134	122	166	113	
42	136	141	151	149	130	180	118	
45	134	165	165	155	137	167	121	
48	135	172	211	160	151	150	129	
51	143	155	256	163	149	163	134	
54	140	156	258	164	162	178	134	
57	142	148	251	160	172	175	135	
60	145	144	221	156	172	166	136	
63	156	146	263	155	189	155	141	
66	176	162	240	165	216	158	141	
69	197	165	524	187	234	186	158	
72	217	183	524	218	272	235	183	
75	233	200	569	250	289	277	229	
78	245	208	563	259	300	288	242	
81	259	219	540	264	332	297	239	
84	278	230	440	405	386	335	252	
87	702	673	449	840	872	799	745	
90	878	782	504	917	962	915	870	
93	940	825	823	913	979	944	886	

* Thermocouple malfunction

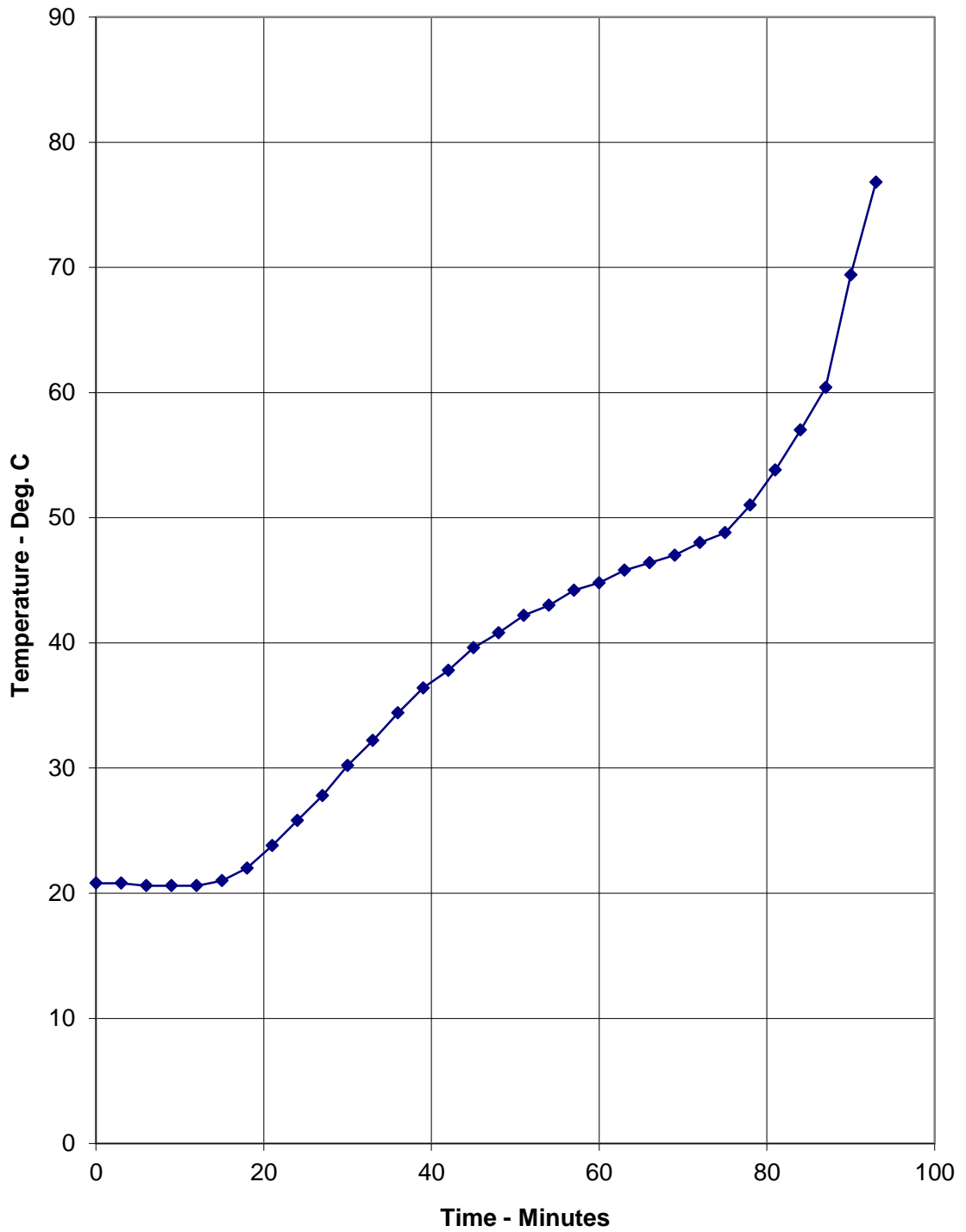
Deflection and rate of deflection of the floor assembly during the test

Time Mins	Central Vertical Deflection mm	Rate of Deflection mm/min
0	0.0	0.0
3	0.6	0.3
6	1.3	0.0
9	1.4	0.0
12	1.6	0.0
15	1.9	0.0
18	2.3	0.0
21	2.8	0.2
24	3.5	0.3
27	4.1	0.2
30	4.8	0.3
33	5.7	0.3
36	6.6	0.3
39	7.2	0.3
42	8.0	0.2
45	8.5	0.1
48	9.0	0.1
51	9.3	0.1
54	9.7	0.2
57	10.0	0.2
60	10.3	-0.1
63	10.6	0.2
66	10.8	0.0
69	11.1	0.2
72	11.6	0.2
75	12.4	0.3
78	13.7	0.5
81	15.0	0.5
84	17.4	0.7
87	21.7	2.2
90	32.7	4.4
93	50.3	6.7

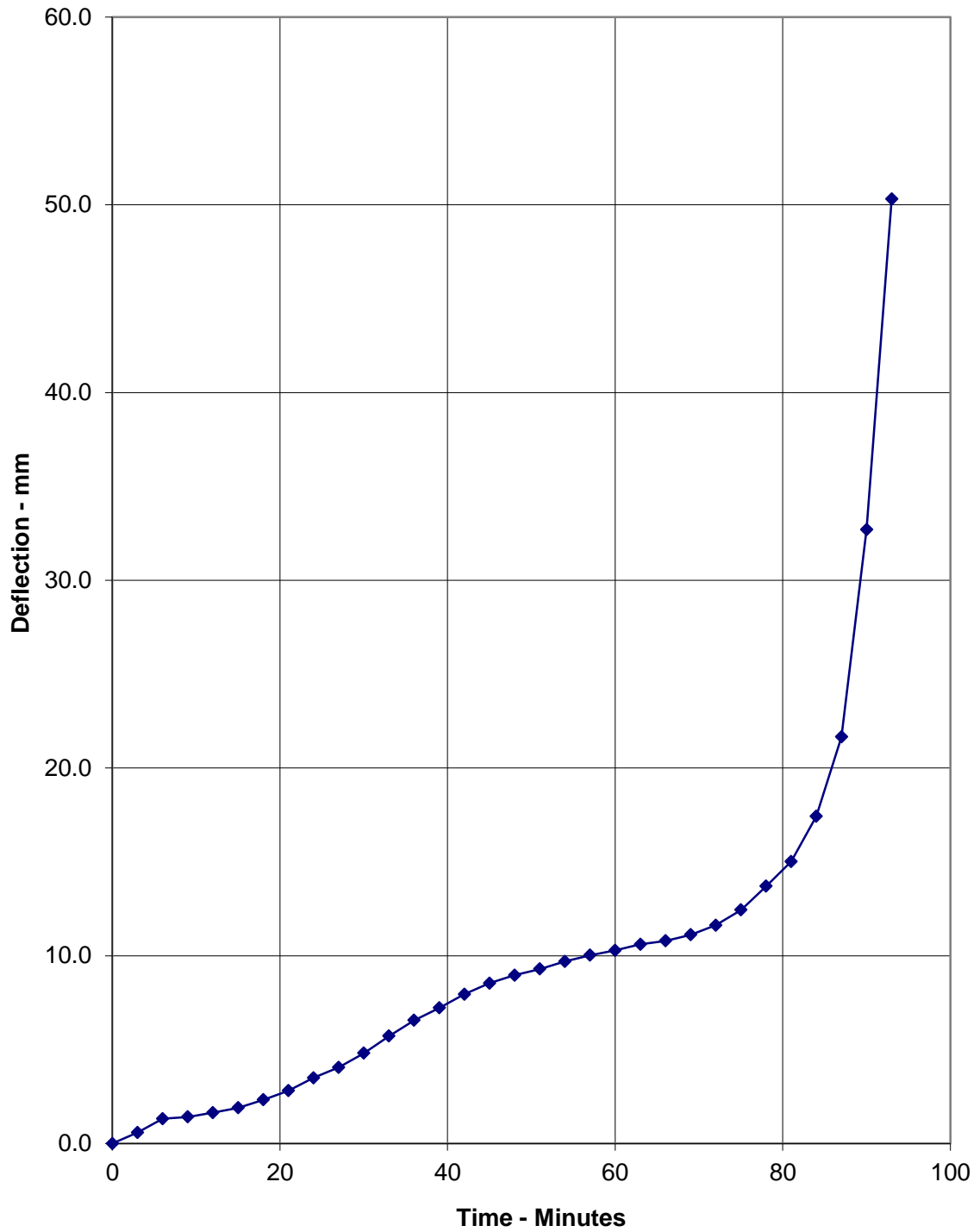
Graph showing specified and actual furnace temperatures



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

1. Physical Parameters of Timber Joists

Measured Joist dimensions (d x b)	: 195 mm deep by 38 mm thick
Mean spacing (M)	: 450 mm
Effective span (L)	: 4400 mm
Timber grade of joists	: C16

2. Parameters - BS 5268: Part 2: 2002

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

3. Total Loading Required Per Joist

Moment of Inertia (I)	: $bd^3/12$: $(38 \times 195^3)/12$: 23480437.5 mm ⁴
Distance from neutral axis to base of joist (y)	: 97.5 mm
Maximum bending stress	: F/y : $(5.83 \times 23480437.5)/97.7$: 1404009.75 N/mm ²
Also maximum bending stress	: $wL^2/8$: 1404009.75 N/mm ²
Where w	= Load per unit length
∴ w	= $(1404009.75 \times 8) / (4400 \times 4400)$ = 0.580 N/mm = 580 N/m
∴ Total loading (W)	: 2552 N : 260.2 kg

4. Dead Weight

Combined weight of overall specimen:

Actual density of joist	: 360.2 kg/m ³
Actual density of floor boarding	: 652.2 kg/m ³
Actual density of ceiling board	: 911.7 kg/m ³

Effective width of floor supported per joist (m) : 0.45 m

weight of joist	: 11.7 kg
weight of floorboard	: 28.4 kg
weight of ceiling (two layers)	: 54.15 kg

Total dead weight per joist : 94.2 kg

5. **Imposed Load**

Imposed load per joist required : total load per joist - dead weight per joist
: 260.2 – 94.2
: 166 kg

Assuming even distribution of loading

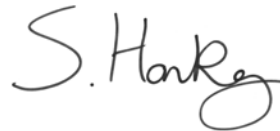
Maximum imposed load per metre square : $(166 \times 9.81) / (4.4 \times 0.45)$
: 822.45 N/m²
: **0.822 kN/m²**
: 83.8 kg/m²

Calculation made by



W. Drazkiewicz
Technical Officer
Fire Resistance Department

Checked by



S. Hankey
Business Unit Head
For and on behalf of
Warringtonfire

Performance Criteria and Test Results

Loadbearing Capacity

The maximum allowable deflection and the maximum rate of deflection for the specimen, as specified by the Standard, are calculated as 200 mm and 9.11 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 test construction satisfied this requirement for the total test duration of 93 minutes.

Integrity

It is required that there is no collapse of the specimen floor assembly, no sustained flaming on the unexposed surface and no loss of impermeability. The test construction satisfied this requirement for the total test duration of 93 minutes.

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. The test construction satisfied this requirement for the total test duration of 93 minutes.

Ongoing Implications

Limitations

The results relate only to the behaviour of the floor/ceiling assembly with downlighter specimens as an 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 light fittings 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

Evaluation against objective A specimen of a loadbearing timber floor assembly, protected by a plasterboard ceiling incorporating sixteen down lighter fittings 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:

Loadbearing Capacity	93 minutes*
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Integrity	93 minutes*
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Insulation	93 minutes*
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*The test was discontinued after a period of 93 minutes.