

Title:

Additional test report of a fire resistance test utilising the general principles of BS 476: Part 20: 1987 on four specimens of wall and four specimens of floor mounted linear gap seals

Note: This report is additional to that issued as WARRES No. 150608 and dated 9th February 2005. The original report remains valid and is not replaced by this additional report.

Report No:

181672

**Prepared for:**

**PFE Technologies
Private Limited**
9 Gul Street 4
Jurong Industrial Estate
Singapore 629238

Date: 24th March 2009

Summary

Objective A fire resistance test has been conducted to assess the ability of four floor and four wall specimens of linear gap sealing systems, to reinstate the fire resistance of pre-cast aerated concrete floor constructions. The performance of the specimens was assessed, with respect to the integrity and insulation (maximum temperature rise only) performance criteria, as defined in BS 476: Part 20: 1987.

Sponsor **PFE Technologies Private Limited**, 9 Gul Street 4, Jurong Industrial Estate, Singapore 629238

Summary of the Tested Specimens For the purpose of the test the specimens were referenced A to H.

The section of wall had overall dimensions of 1000 mm long by 1000 mm wide by 250 mm thick and was provided with four linear joints, referenced Specimens A, B, C, and D. The section of floor had overall dimensions of 1200 mm high by 1200 mm wide by 250 mm thick and was provided with four linear joints, referenced Specimens E, F, G, and H.

If the performance of the specimens were assessed against the integrity and insulation (maximum temperature rise only) performance criteria of BS 476: Part 20: 1987. The results obtained could be expressed as follows:


Test Results	Seal A	Seal B	Seal C	Seal D	Seal E	Seal F	Seal G	Seal H
Integrity	240 minutes	240 minutes	240 minutes	240 minutes	155 minutes	240 minutes	240 minutes	240 minutes
Insulation	122 minutes	95 minutes	240 minutes	126 minutes	47 minutes	92 minutes	207 minutes	73 minutes


The test was discontinued after a period of 240 minutes.

Date of Test 19th December 2005

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Signatories


Responsible Officer N. Howard* Testing Officer


Approved A. Kearns * Technical Manager

* For and on behalf of warringtonfire.

Report Issued Date : 24 th March 2009

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Test Procedure

Introduction

Walls and floors often incorporate gaps to accommodate expansion, contraction or other movement of the structure. The fire resistance of such elements is only as good as their weakest point and it is, therefore, important that any gaps or apertures are adequately sealed, such that weaknesses are not created at these positions.

There was not, at the time of the test, any specified British Standard fire test method for evaluating gap seals which are designed to act as an effective barrier to the penetration of fire and to reinstate the necessary fire resistance performance of the separating element. However, the fire resistance of walls and floors is determined by tests utilising the general principles given in BS 476: Part 20: 1987, and it would appear appropriate to use the principles of that Standard to evaluate the performance of gap sealing systems. Some additional guidelines were adopted from the draft European document referenced prEN 1366-4, relating to the testing of these types of sealing systems. This report should be read in conjunction with the above mentioned documents.

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 19th December 2005 at the request of the original sponsor of the test.

The test was witnessed by Mr. W. Hluchan and Mr J. Fitzsimons representatives of the original test sponsor.

Test Specimen 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 specimens and information supplied by the original sponsor of the test.

Installation

The wall and floor constructions were supplied by warringtonfire. The specimen seals were provided and installed by the original test sponsor on the 22nd November 2005.

Sampling

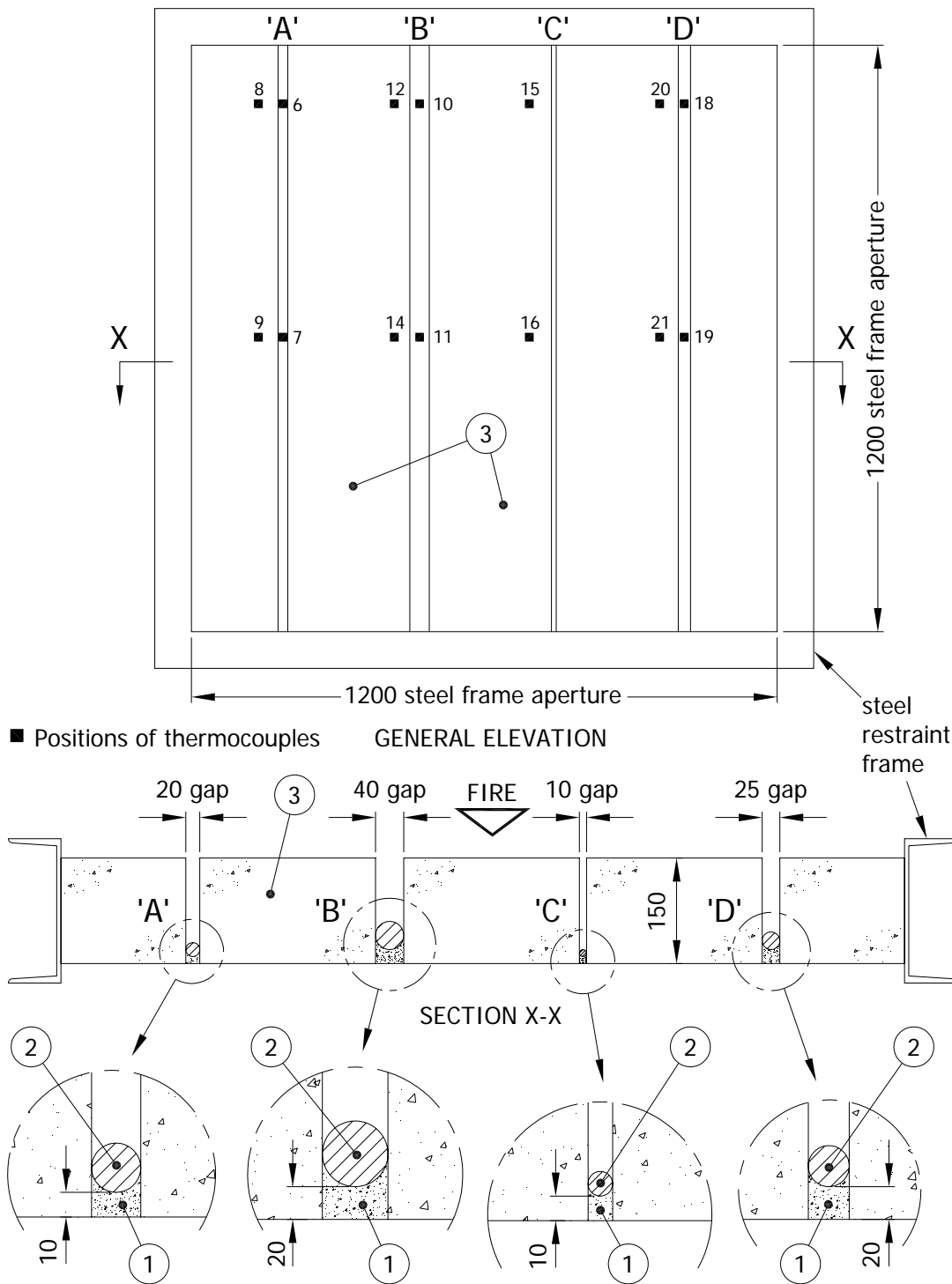
warringtonfire was not involved in any sampling or selection procedure of the sealing system components.

Instrumentation

General	The instrumentation and measuring equipment provided was in accordance with BS 476: Part 20: 1987 and the draft European document, where appropriate.
Furnace	The furnace was controlled so that its mean temperature complied with the requirements of BS 476: Part 20: 1987, Clause 3.1, using four mineral insulated thermocouples distributed over a plane 100 mm from the surface of the wall construction.
Thermocouple Allocation	<p>Thermocouples were provided to monitor the unexposed surface of the specimens and the output of all instrumentation was recorded at no less than one minute intervals as follows:</p> <p>At a minimum of two positions on the surface of the sealant material of each specimen, one nominally 100 mm from each end and one at mid span. All positioned at nominally mid-width.</p> <p>At a minimum of two positions on the surface of the wall and floor assembly, 25 mm away from the edge of each seal and adjacent to the positions of the thermocouples on the surface of the sealant.</p> <p>The locations and reference numbers of the various unexposed surface thermocouples are shown in Figure 1.</p>
Roving Thermocouple	A roving thermocouple was available to measure temperatures on the unexposed surface of the specimens 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 integrity of the specimens.
Furnace Pressure	After the first five minutes of testing, the furnace pressure was controlled to maintain a slightly positive pressure relative to the pressure of the laboratory. The furnace atmospheric pressure was measured and controlled such that, at a point 100 mm below the soffit of the floor assembly, the differential pressure was calculated to be between 18 Pa and 20 Pa.

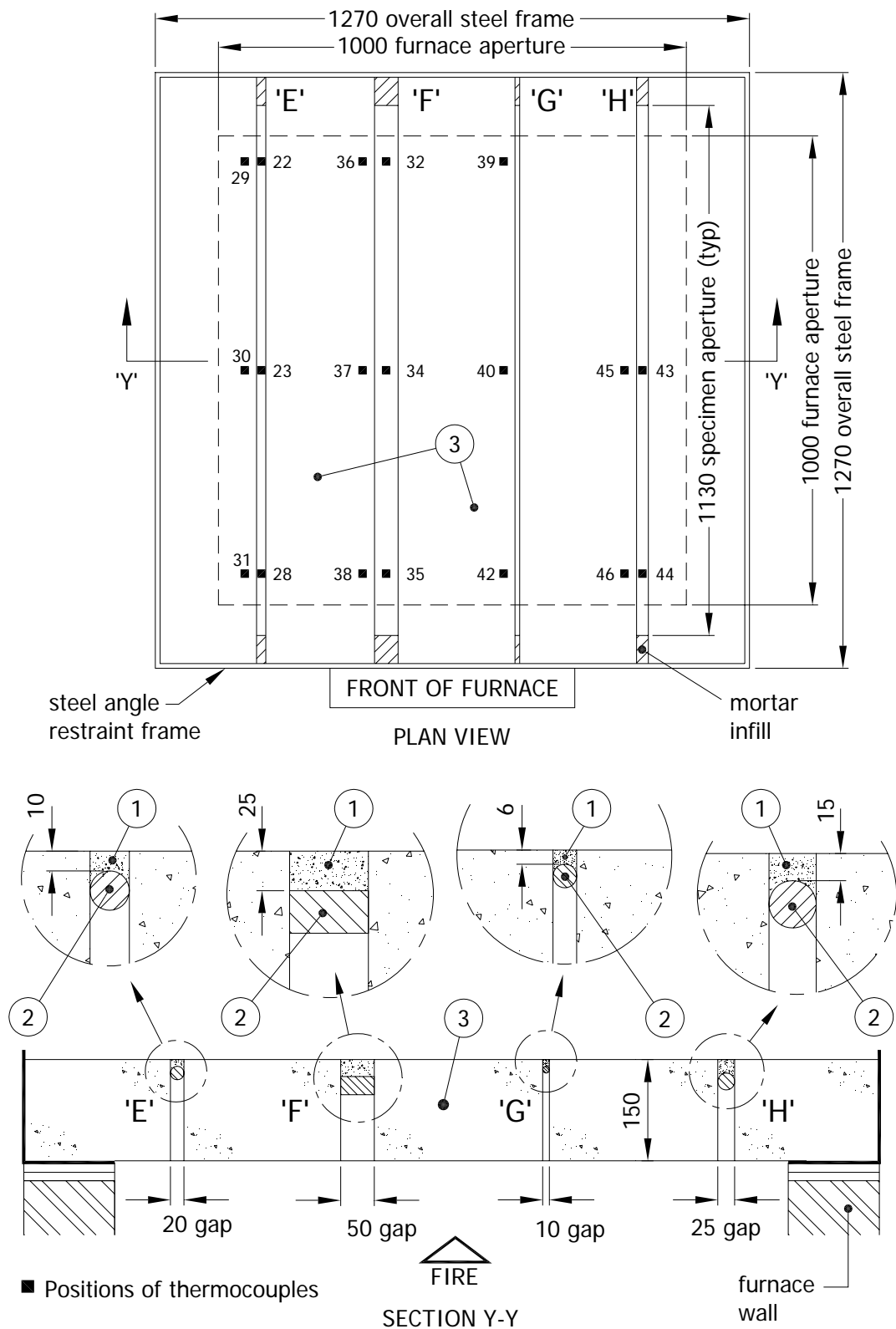
Test Specimen

Figure 1- General Elevation of Wall Specimens and Unexposed Face Thermocouples



Do not scale. All dimensions are in mm

Figure 2 – General Plan of Floor Specimens and Unexposed Face Thermocouples



Do not scale. All dimensions are in mm

Schedule of Components

(Refer to Figures 1 & 2)

(All values are nominal unless stated otherwise)

(All other details are as stated by the sponsor)

<u>Item</u>	<u>Description</u>
1. Cavity Barrier	
Supplier	: PFE Technologies Private Limited
Suppliers Reference	: Pereseal FR High Performance Intumescent Acrylic Sealant
Batch Number	: 08511208
Material	: Intumescent acrylic sealant (water based)
Overall Size of Sealant (width x depth)	
i. Specimen 'A' & 'E'	: 20 mm x 10 mm
ii. Specimen 'B'	: 40 mm x 20 mm
iii. Specimen 'C'	: 10 mm x 10 mm
iv. Specimen 'D'	: 25 mm x 20 mm
v. Specimen 'F'	: 50 mm x 25 mm
vi. Specimen 'G'	: 10 mm x 6 mm
vii. Specimen 'H'	: 25 mm x 15 mm
Application method	: Cartridge gun
Application rate	
i. Specimen 'A' & 'E'	: 200 ml per metre
ii. Specimen 'B'	: 800 ml per metre
iii. Specimen 'C'	: 100 ml per metre
iv. Specimen 'D'	: 500 ml per metre
v. Specimen 'F'	: 1250 ml per metre
vi. Specimen 'G'	: 60 ml per metre
vii. Specimen 'H'	: 375 ml per metre
2. Backing Rod	
Material	: Polyethylene
Overall Section Size (nominal)	
i. specimen 'A' & 'E'	: 20 mm diameter
ii. specimen 'B'	: 40 mm diameter
iii. specimen 'C' & 'G'	: 10 mm diameter
iv. specimen 'D' & 'H'	: 25 mm diameter
v. specimen 'F'	: 50 mm wide x 25 mm deep
Fixing method	: Friction fit within aperture
3. Concrete Slabs	
Material	: Autoclaved aerated concrete lintels
Density	: 670 kg/m ³
Overall section size	: 250 mm wide x 150 mm deep

Test Observations

Time		All observations are from the unexposed face unless noted otherwise.
mins	secs	
00	00	The test commences.
14	00	Slight smoke/steam release issues from all floor specimens.
21	30	Smoke/steam release mentioned at 14 minutes increases.
30	00	No further significant changes are evident.
36	00	Specimens B and E turn nodular in appearance.
40	00	Specimen F turns nodular in appearance.
47	00	A temperature rise in excess of 180°C is recorded by thermocouple number 23 on specimen E. Insulation failure of Specimen E is deemed to occur.
55	30	Specimens A and D turn nodular in appearance.
64	00	Specimens C, G and H turn nodular in appearance
73	00	A temperature rise in excess of 180°C is recorded by thermocouple number 44 on specimen H. Insulation failure of Specimen H is deemed to occur.
77	00	Specimen E shows signs of discolouration along its length.
86	00	Specimen E turns black in colour at it's approximate centre.
90	00	No further significant changes are evident.
92	00	A temperature rise in excess of 180°C is recorded by thermocouple number 33 on specimen F. Insulation failure of Specimen F is deemed to occur.
95	00	A temperature rise in excess of 180°C is recorded by thermocouple number 11 on specimen B. Insulation failure of Specimen B is deemed to occur.
106	00	Specimen F shows signs of discolouration along its length.
110	00	Specimen F begins to descend towards the furnace chamber along its entire length.
122	00	A temperature rise in excess of 180°C is recorded by thermocouple number 7 on specimen A. Insulation failure of Specimen A is deemed to occur.

Time

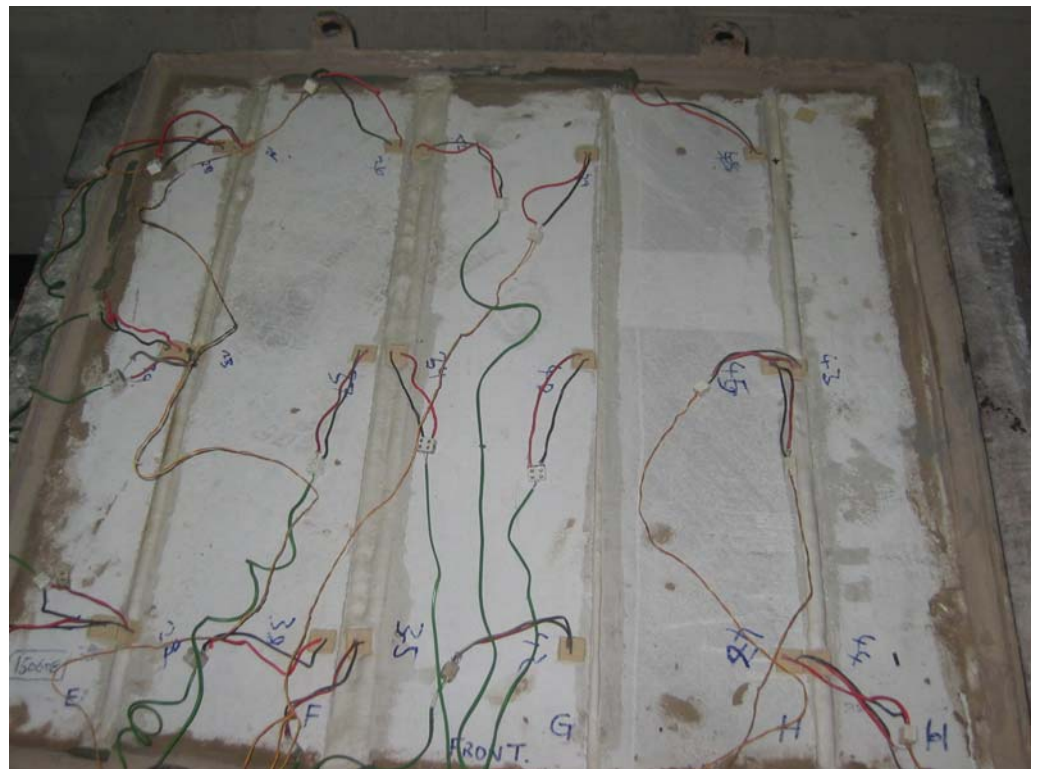
mins	secs	
126	00	A temperature rise in excess of 180°C is recorded by thermocouple number 18 on specimen D. Insulation failure of Specimen D is deemed to occur.
130	00	An area of glowing is evident at the approximate centre of specimen E. A cotton pad is applied but fails to ignite.
142	00	Specimen B shows signs of discolouration along its length.
146	00	A cotton pad is applied to the area of glowing on specimen E but fails to ignite.
155	00	A cotton pad is applied to the area of glowing on specimen E and ignites. Integrity failure of specimen E is deemed to occur.
158	00	Specimen F continues to descend into its cavity, turning black over its length.
180	00	No further significant changes are evident.
207	00	A temperature rise in excess of 180°C is recorded by the roving thermocouple on Specimen G. Insulation failure of Specimen G is deemed to occur.
240	00	The test is discontinued at the request of the sponsor.

Test Photographs

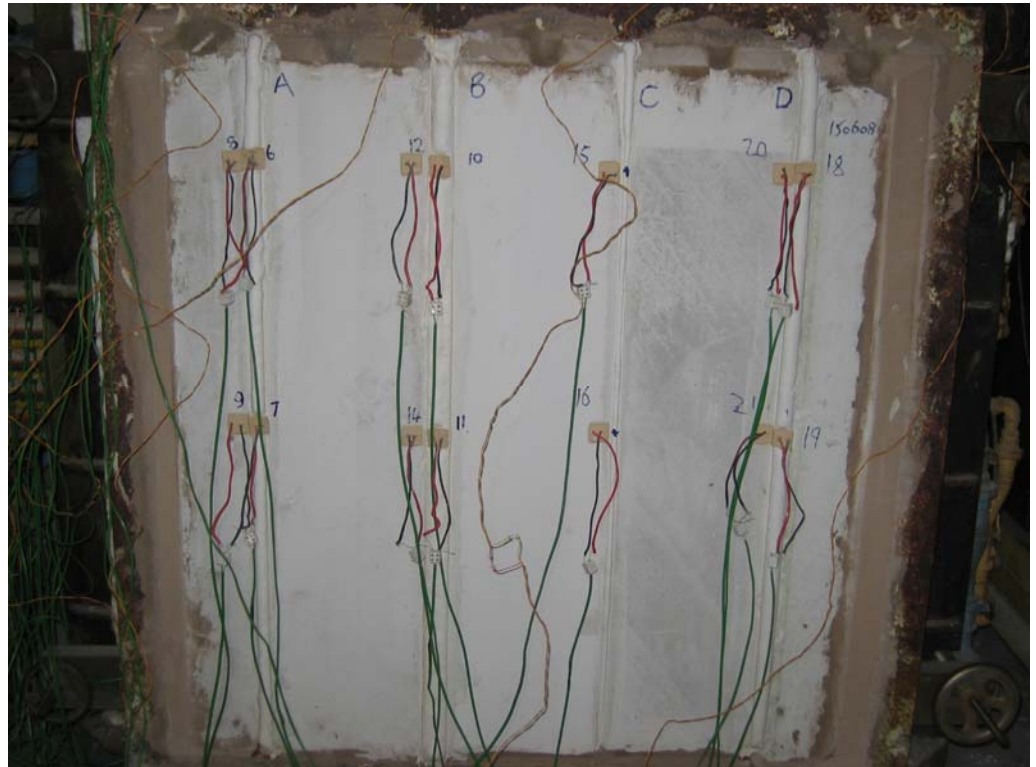
The unexposed face of the wall construction prior to testing



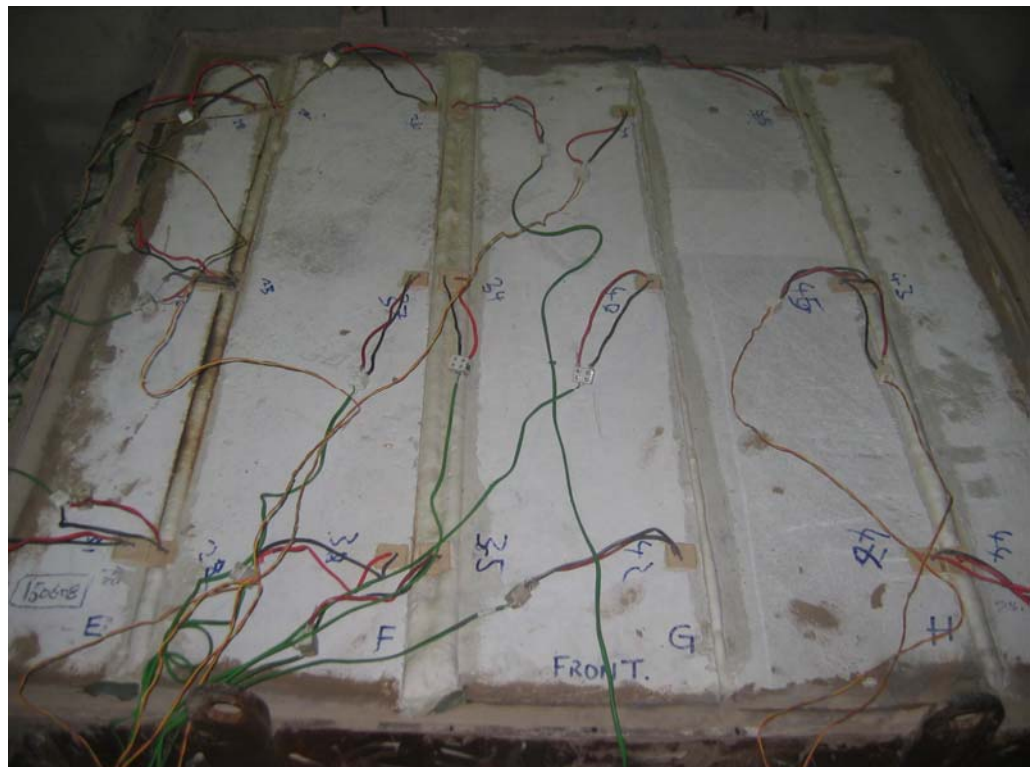
The unexposed face of the floor construction prior to testing



The unexposed face of the wall construction after 120 minutes of testing



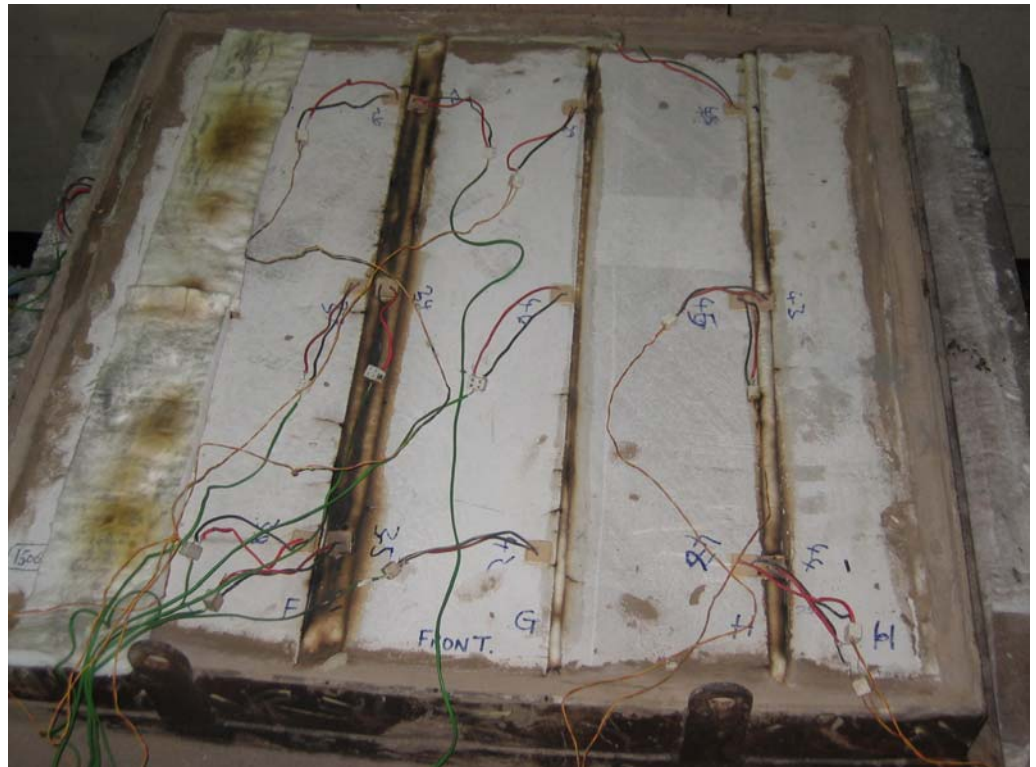
The unexposed face of the floor construction after 120 minutes of testing



The unexposed face of the wall construction after 240 minutes of testing



The unexposed face of the floor construction after 240 minutes of testing



Temperature 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	13
10	678	643
20	781	782
30	842	834
40	885	878
50	918	901
60	945	951
70	968	970
80	988	991
90	1006	1009
100	1022	1026
110	1036	1037
120	1049	1048
130	1061	1059
140	1072	1071
150	1082	1075
160	1092	1087
170	1101	1094
180	1110	1100
190	1118	1107
200	1126	1115
210	1133	1121
220	1140	1123
230	1146	1130
240	1153	1131

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal A**

Time Mins	T/C Number 6 Deg. C	T/C Number 7 Deg. C	T/C Number 8 Deg. C	T/C Number 9 Deg. C
0	12	12	13	13
10	14	15	13	*
20	43	48	17	
30	74	83	34	
40	87	94	51	58
50	93	100	65	70
60	96	107	77	78
70	99	121	84	85
80	101	139	88	88
90	107	157	89	90
100	121	171	89	96
110	132	181	90	108
120	146	192	90	116
130	157	198	92	125
140	167	204	95	132
150	175	209	109	139
160	184	214	121	146
170	190	219	129	153
180	197	224	137	158
190	204	182	145	163
200	212	186	152	171
210	221	218	157	181
220	225	234	163	188
230	229	235	169	192
240	235	240	172	194

* Thermocouple Malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal B**

Time	T/C	T/C	T/C	T/C
Mins	Number	Number	Number	Number
	10	11	12	14
	Deg. C	Deg. C	Deg. C	Deg. C
0	14	14	13	13
10	16	16	12	12
20	66	74	17	19
30	88	91	33	40
40	95	98	49	58
50	101	107	59	69
60	113	121	68	76
70	135	144	74	81
80	157	168	80	86
90	175	186	86	94
100	188	200	96	108
110	199	210	108	123
120	207	222	117	134
130	215	232	127	145
140	221	241	135	154
150	229	248	142	162
160	237	254	147	167
170	243	259	151	172
180	249	263	157	177
190	254	267	161	182
200	258	270	167	187
210	262	273	170	191
220	263	275	174	194
230	266	279	178	198
240	270	281	183	202

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal C**

Time Mins	T/C Number Deg. C	T/C Number Deg. C
0	13	14
10	13	14
20	16	16
30	30	22
40	47	33
50	59	44
60	67	53
70	73	60
80	79	67
90	84	71
100	92	76
110	100	82
120	107	87
130	115	96
140	123	104
150	131	114
160	139	123
170	144	132
180	151	141
190	157	149
200	162	156
210	167	162
220	171	167
230	175	169
240	177	174

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal D**

Time	T/C	T/C	T/C	T/C
Mins	Number	Number	Number	Number
	18	19	20	21
	Deg. C	Deg. C	Deg. C	Deg. C
0	14	14	14	12
10	15	14	14	12
20	51	32	19	*
30	83	63	37	31
40	93	79	52	46
50	97	88	63	59
60	102	92	71	66
70	113	97	78	73
80	135	99	88	78
90	153	103	101	85
100	168	108	114	91
110	179	118	126	106
120	189	129	135	117
130	198	140	147	128
140	207	150	156	135
150	218	158	166	143
160	228	166	174	149
170	239	173	182	159
180	251	180	193	165
190	262	186	199	169
200	270	190	205	172
210	275	194	210	175
220	274	197	208	178
230	275	200	210	182
240	278	204	213	184

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal E**

Time	T/C	T/C	T/C	T/C	T/C	T/C
Mins	Number	Number	Number	Number	Number	Number
	22	23	28	29	30	31
	Deg. C	Deg. C	Deg. C	Deg. C	Deg. C	Deg. C
0	14	13	14	14	14	14
10	36	*	24	15	16	14
20	97	99	80	28	42	24
30	119	128	98	44	65	44
40	155	169	106	57	79	58
50	186	199	125	68	88	67
60	211	223	152	74	106	72
70	231	248	174	78	125	76
80	247	278	192	83	144	82
90	267	322	206	89	162	92
100	286	393	220	100	183	101
110	302	533	232	107	203	110
120	318	572	243	116	222	117
130	332	610	258	121	229	125
140	350	*	271	129	237	131
150	365		286	133	241	139
160	378		304	140	248	145
170	*		*	*	*	*
180						
190						
200						
210						
220						
230						
240						

* Thermocouple Malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal F**

Time	T/C	T/C	T/C	T/C	T/C	T/C
Mins	Number	Number	Number	Number	Number	Number
	32	34	35	36	37	38
	Deg. C	Deg. C	Deg. C	Deg. C	Deg. C	Deg. C
0	13	14	13	14	14	14
10	14	16	15	14	14	14
20	60	70	74	18	22	21
30	86	90	93	33	42	41
40	93	94	96	49	56	58
50	97	98	*	60	64	71
60	110	110		67	69	79
70	136	134		74	76	84
80	167	165		81	86	180
90	191	190		93	98	101
100	*	208		104	109	109
110		222		114	119	119
120		233		124	128	127
130		245		131	137	138
140		253		138	145	145
150		262		145	153	156
160		269		153	159	170
170		273		156	164	182
180		277		159	167	189
190		284	282	166	174	196
200		288	289	173	176	207
210		290	299	175	180	211
220		293	280	176	183	210
230		296	282	179	187	214
240		298	297	180	187	220

* Thermocouple Malfunction

**Individual Temperatures Recorded On The Unexposed Surface Of
 And Adjacent To Seal G**

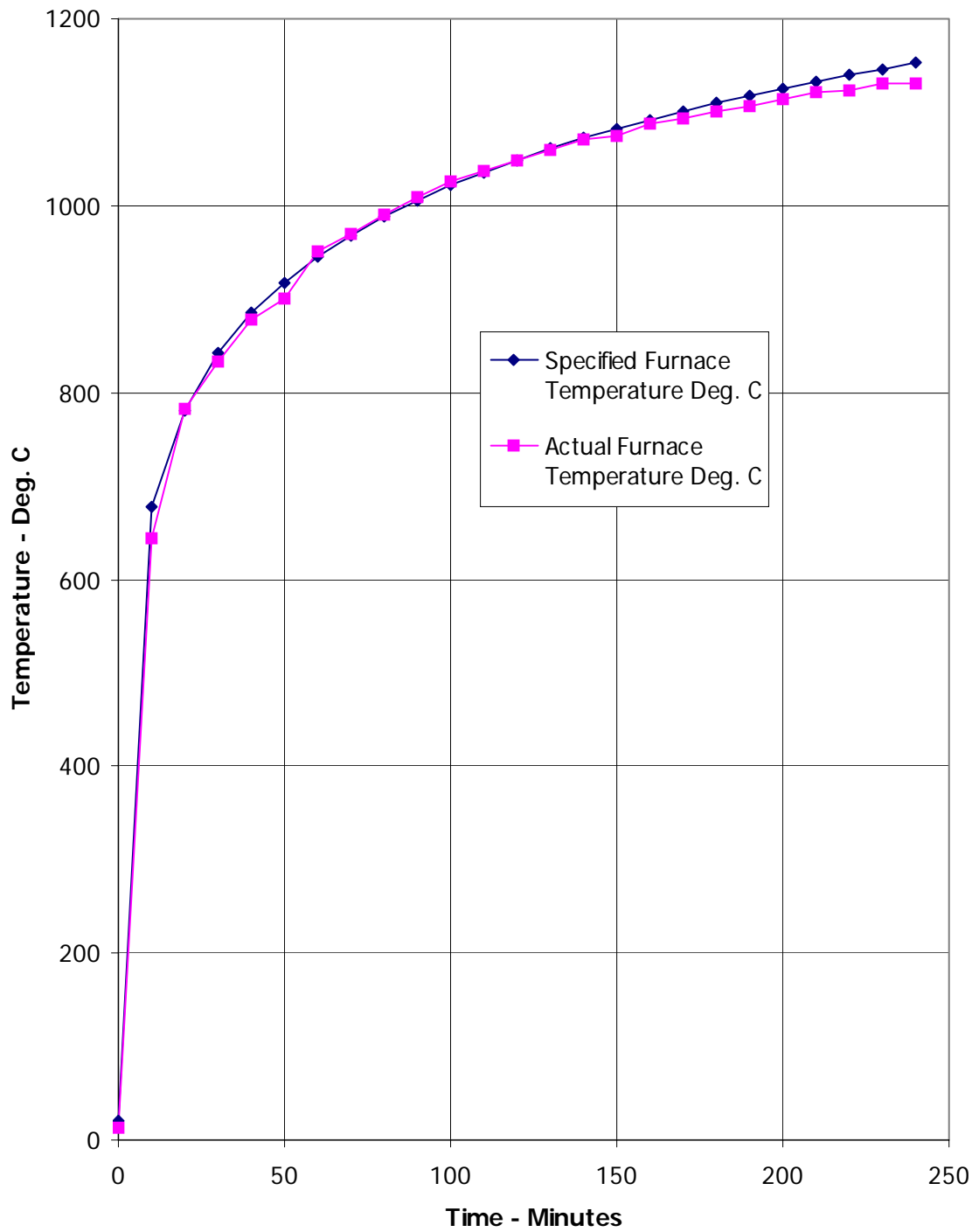
Time	T/C	T/C	T/C
Mins	Number	Number	Number
	39	40	42
	Deg. C	Deg. C	Deg. C
0	14	13	13
10	15	15	13
20	23	21	19
30	38	24	30
40	49	28	40
50	58	31	49
60	65	61	56
70	71	66	62
80	77	61	65
90	81	67	67
100	86	77	71
110	92	85	76
120	98	92	79
130	103	97	85
140	108	101	89
150	114	105	94
160	119	111	99
170	125	137	103
180	132	139	110
190	141	147	114
200	149	148	122
210	158	153	129
220	164	154	132
230	171	154	137
240	180	154	143

**Individual Temperatures Recorded On The Unexposed Surface Of
And Adjacent To Seal H**

Time Mins	T/C Number 43 Deg. C	T/C Number 44 Deg. C	T/C Number 45 Deg. C	T/C Number 46 Deg. C
0	13	14	14	14
10	13	29	*	14
20	14	87		28
30	15	99		43
40	18	108		55
50	19	136		79
60	19	166		98
70	21	189		100
80	21	206		100
90	22	220		101
100	22	229		108
110	25	242		117
120	24	257		125
130	25	273		133
140	26	287		141
150	26	300		150
160	28	310		158
170	29	322		165
180	30	332		172
190	32	338		177
200	33	342		180
210	33	352		186
220	34	350		190
230	34	354		193
240	35	366		201

* Thermocouple Malfunction

Graph Showing Mean Furnace Temperature, Together With The Temperature/Time Relationship Specified In The Standard



Performance Criteria and Test Results

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 periods given in the table below:

Seal A	Seal B	Seal C	Seal D	Seal E	Seal F	Seal G	Seal H
240 minutes	240 minutes	240 minutes	240 minutes	155 minutes	240 minutes	240 minutes	240 minutes

Insulation

The mean and maximum temperature rise allowable on the unexposed face of the specimen by BS 476: Part 20: 1987 are 140°C and 180°C respectively, however, due to the reduced size of the specimens only the maximum temperature rise criterion was utilised. These requirements were satisfied for the periods given in the table below:

Seal A	Seal B	Seal C	Seal D	Seal E	Seal F	Seal G	Seal H
122 minutes	95 minutes	240 minutes	126 minutes	47 minutes	92 minutes	207 minutes	73 minutes

Ongoing Implications

Limitations

The results relate only to the behaviour of the specimens 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 results may not be applicable to situations where the joint widths, orientations and supporting construction vary from those tested.

As no movement was induced into the specimens during the test there can be no evaluation of the performance of the seals where movement is induced in a building under actual fire conditions.

This test report is additional to that issued as WARRES No. 150608 and dated 9th February 2005. The original test report remains valid and is not replaced by this additional test report. The product which was the subject of the test has not been retested and this additional report does not involve any technical change or technical review of the original test report. Details of the original product name and sponsor of the test are documented by WFRC and are maintained in confidential company records.

Review

This report covers a test which was conducted to a procedure which is not the subject of any British Standard specification, but the test utilised the general principles of fire resistance testing given in BS 476: Part 20: 1987 and prEN 1366-4: 2005. Since fire tests are the subject of a continuing Standardisation process, and because existing standards are the subject of review and possible amendment and new interpretations, it is recommended that the report be referred back to the test laboratory after a period of two years to ensure that the methodology adopted and the results obtained remain valid in the light of the situation prevailing at that time.

Conclusions

Evaluation against objective

A fire resistance test which utilised the general principles of BS 476: Part 20: 1987, in conjunction with additional guidelines adopted from prEN 1366-4: 2005, has been conducted to assess the ability of four specimens of wall and four specimens of floor mounted linear gap seals to reinstate the integrity and insulation performance (as defined in BS 476: Part 20: 1987) of a simulated wall and floor construction where adjacent structures abut.

If the performance of each specimen was assessed against the performance requirements for integrity and insulation (maximum temperature rise) specified in BS 476: Part 20: 1987, the results obtained could be expressed as follows:

Test Specimens:

Test Results

Integrity

Insulation

	Seal A	Seal B	Seal C	Seal D	Seal E	Seal F	Seal G	Seal H
Integrity	240 minutes	240 minutes	240 minutes	240 minutes	155 minutes	240 minutes	240 minutes	240 minutes
Insulation	122 minutes	95 minutes	240 minutes	126 minutes	47 minutes	92 minutes	207 minutes	73 minutes

The test was discontinued after a period of 240 minutes.



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