

TEST REPORT

REPORT NO.: 2012FE0157

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Applicant : ALAM-CON SDN. BHD.

Summary : A specimen of a non-load bearing AAC block wall partition system has been subjected to a test in accordance with BS 476: Part 22:1987, Clause 5 to determine its fire resistance performance.

The single layer of non-load bearing AAC block wall partition system consisted of AAC blocks (said to be 'ACON' brand) each of size 599 mm (L) × 100 mm (w) × 200 mm (h). The blocks were bonded together by jointing mortar (Brand: SCI, Manufactured by Aalborg Portland Malaysia Sdn. Bhd.). The blocks were anchored to the restraint test frame horizontally using fish tail steel bracket of size 155 mm × 35 mm × 24 mm width as shown in Figure 6. The brackets were secured to the restraint test frame using wall plug. The brackets were positioned at the first block layer and subsequently at an interval of three block layers horizontally. Both sides of the block wall partition system were not plastered.

The AAC blocks were claimed to be processed from the following materials and proportioned respectively as stated :-

No	Materials	Mix Ratio (By Weight)
1.	Mining Sand + Gypsum + Tap Water + recycle batch mixing*	2100 kg
2.	Cement (Grade: OPC)	383 kg
3.	Lime	100 kg
4.	Aluminium paste (Grade: GLS-65)	1.7 kg

*Note: Mining Sand : Gypsum – 9 : 1

The density of the AAC block in oven-dried condition was found to be 511 kg/m³.

The overall size of the AAC block wall partition system size was 2995 mm (h) × 3000 mm (w) × 100 mm (t) exclusive of a 30 mm wide vertical gap along one edge to provide no lateral restraint to the specimen.

The AAC block wall partition system satisfied the performance requirements specified in Clause 5 of BS 476: Part 22, for non-load bearing wall partition, for the following periods:

Integrity : 250 minutes

Insulation : 250 minutes

The test was discontinued after a period of 250 minutes.

Date of Test : 16th April 2012



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1. PURPOSE OF TEST

To determine the fire resistance of the AAC block wall when tested in accordance with BS 476: Part 22: 1987 'Methods for determination of the fire resistance of non-load bearing elements of construction: Clause 5 – Determination of the fire resistance of partition'.

2. TEST SPECIFICATION

BS 476:Part 22:1987 states that the fire resistance of the specimen is the time, expressed in minutes, to failures under the following criteria;

2.1 Integrity

2.1.1 In general, a failure of the test construction to maintain integrity shall be deemed to have occurred when collapse or sustained flaming for more than 10 s on the unexposed face.

2.1.2 Under criteria for impermeability, failure shall be deemed to have occurred when one or other of the following conditions prevail :-

- a) Where cotton pad test is performed, flames and/or hot gases cause flaming and glowing of the cotton pad.
- b) Where the use of cotton pad is not suitable, failure shall be deemed to have occurred when either :
 - a through gap into the furnace exceeding 6 mm in width and 150 mm in length exists or develops in the specimen; or
 - a through gap into the furnace exceeding 25 mm in diameter exists or develops in the specimen.

2.2 Insulation

Failure shall be deemed to have occurred when one of the following occurs :-

- a) If the mean unexposed face temperature increases by more than 140° C above its initial value.
- b) If the temperature recorded at any position on the unexposed face is in excess of 180° C above the initial mean unexposed face temperature.
- c) When integrity failures as defined in 2.1 occur.



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3. TEST SPECIMEN

3.1 Product Description

One pallet (180 pieces) of AAC blocks (said to be 'ACON' brand and of model: **Nominal Size (600 mm (L) × 100 mm (W) × 200 mm (H))**) were submitted to the Fire Protection Section on the 14th March 2012. The blocks were said to be processed from the following materials and proportioned respectively as stated :-

No.	Materials	Mix Ratio (By Weight)
1.	Mining Sand + Gypsum + Tap Water + recycle batch mixing*	2100 kg
2.	Cement (Grade: OPC)	383 kg
3.	Lime	100 kg
4.	Aluminium paste (Grade: GLS-65)	1.7 kg

*Note: Mining Sand : Gypsum – 9 : 1

The description of products given above has been prepared from information provided by the applicant of the test.

3.2 Description of Test Specimen

The test specimen consisted of a non-load bearing AAC block wall partition system constructed onto the test frame. The AAC block wall partition system was attached to the test frame with cement mortar and anchored with fish tail steel brackets.

The overall specimen size was 2995 mm (h) × 3000 mm (w) × 100 mm (t) exclusive of a 30 mm wide vertical gap along one edge to provide no lateral restraint to the specimen.

Inspection was carried out during the construction of the AAC block wall partition system to verify on its design, dimensions and materials used. The construction of the wall was arranged and carried out by the applicant and its agent. Detailed drawings of the block wall partition system are as shown in Figure 3 to Figure 6.

4. MANUFACTURE OF THE TEST CONSTRUCTION

The non-load bearing AAC block wall partition system was constructed with the product as described in 3.1. The average dimensions of AAC blocks as measured was 599 mm (l) × 100 mm (w) × 200 mm (h) and the bulk density in oven-dried condition was found to be 511 kg/m³. The moisture content of the AAC blocks was found to be 33.9%.

The AAC blocks were laid and stretcher bonded together by 1 mm – 2 mm of jointing mortar (Brand: **SCI**, Manufactured by **Aalborg Portland Malaysia Sdn. Bhd.**). The blocks were anchored to the restraint test frame horizontally using fish tail steel bracket of size 155 mm × 35 mm × 24 mm width as shown in **Figure 6**. The brackets were secured to the restraint test frame using wall plug. The brackets were positioned at the first block layer and subsequently at an interval of three block layers horizontally.

Both side of the AAC block wall partition system were not plastered.

The AAC block wall partition system was constructed with one vertical side free end of 30 mm width to be filled with ceramic fiber insulation.



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5. CONDITIONING OF THE TEST CONSTRUCTION

Prior to test, the test construction was kept in the laboratory proper and was seasoned in ambient atmosphere for a period of 33 days.

6. FIRE RESISTANCE TEST

6.1 Date of Testing

After the AAC block wall partition system had seasoned, the fire resistance test was conducted on 16th April 2012.

6.2 Witnesses of Test

The fire resistance test was conducted in the presence of the following representatives:

- | | | |
|------------------------|---|--------------------|
| 1. Ms. Zaharah Mohamed | - | ALAM-CON SDN. BHD. |
| 2. Mr. Tony Toh | - | ALAM-CON SDN. BHD. |
| 3. Mr HS Seow | - | ALAM-CON SDN. BHD. |

6.3 Test Method

The test was conducted in accordance with the procedure specified in Clause 5 of BS 476:Part 22: 1987.

The ambient temperature at the beginning of the test was **28.9 ° C** and on completion of test, the ambient temperature was **28.5 ° C**. The temperature and pressure conditions were controlled to the limits defined in Clause 3.1 and 3.2 of BS 476: Part 20:1987.

Throughout the test, observations were made on the exposed and unexposed faces of the test specimen. In addition, observations were made of any sustained flaming on the unexposed face of the test specimen. Gap gauges were available to evaluate compliances with the requirements for imperviousness as defined in the BS 476: Part 20:1987.



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7. TEST RESULTS

7.1 The graph in Figure 1 shows the actual temperature/time curve of the furnace heating conditions in relation to the standard temperature/time curve.

Table 1 shows the actual mean furnace temperature and of the standard furnace temperature as defined in Clause 3.1 of BS 476: Part 20:1987. In addition the table shows the percentage differences between the areas under the standard curve and the areas under the actual curve compared with the percentage tolerances allowable within the standard.

7.2 The graph in Figure 2 shows the actual temperature rise recorded on the unexposed face of the test specimen as determined by the five thermocouples which are fixed approximately at the center of the specimen and at the center of the four quarters of the specimen and two additional thermocouples to record the individual maximum temperature.

7.3 Table 2 shows individual and mean temperature of the unexposed face of the specimen. In addition, the table shows the increase in mean temperature and maximum temperature rise at various time intervals.

7.4 Table 3 shows the deflection of the AAC block wall partition system measured at mid-height.

7.5 Observations are made during the test on the general behavior of the test specimen and these are given in Appendix 1 to this report.

7.6 Photographs of the test are included as Photo 1 – 12.

8. EVALUATION AGAINST THE PERFORMANCE CRITERIA

The performance of the specimen was judged against the following criteria of BS 476: Part 20: 1987.

8.1 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 **250 minutes** after which the test was discontinued.

8.2 Insulation

It is required that the mean temperature rise of the unexposed face shall not be greater than 140 °C and the maximum temperature rise shall not be greater than 180 °C. At **250 minutes** of test, the mean temperature rise and maximum temperature rise above initial mean temperature on the unexposed face of the AAC block wall partition system were **75 °C** and **144 °C** respectively.



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9. CONCLUSIONS

The AAC block wall partition system satisfied the requirements of the BS 476: Part 22: 1987 for the following period :-

Integrity : **250 minutes**

Insulation : **250 minutes**

The test was discontinued after a period of 250 minutes at the request of the applicant.

10. LIMITATIONS

- 10.1 The results only relate to the behavior 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 behavior in fires.
- 10.2 The test results relate only to the specimen tested. Appendix A of BS 476: Part 20: 1987 provides guidance information on the application of the fire resistance tests and the interpretation of test data.

Application of the results to assemblies of different dimensions or incorporating different components should be subjected to re-verification.



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APPENDIX 1

Observations made during the test

E - Observations from exposed face

U - Observations from unexposed face

TIME (min)	TEST FACE	OBSERVATIONS
0	-	Test commenced.
15	U	No significant change is observed.
30	U	Diagonal hairline crack is observed near T6 thermocouple.
52	U	No significant change is observed.
60	U	The wall still maintains its integrity and insulation.
71	U	No significant change is observed.
97	U	No significant change is observed.
120	U	No significant change is observed.
144	U	No significant change is observed.
165	U	No significant change is observed.
173	U	Diagonal hairline crack is observed at the bottom left of the wall.
221	U	No significant change is observed.
230	U	Hairline crack is observed at the bottom right corner of the wall.
231	U	Crack as mentioned at t = 30 minutes has increased in length.
240	U	The wall still maintains its integrity and insulation.
242	U	CPI test is applied at the top of the crack as mentioned at t = 30 minutes. The result is negative.
250	-	The test was terminated.



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TABLE 1 : SPECIFIED AND ACTUAL RECORDED FURNACE TEMPERATURE

TIME (mins)	STANDARD FURNACE TEMPERATURE (°C)	ACTUAL FURNACE TEMPERATURE (°C)	AREA UNDER STANDARD CURVE (°C.min)	AREA UNDER ACTUAL CURVE (°C.min)	PERCENTAGE DEVIATION	SPECIFIED PERCENTAGE TOLERANCE (+ or -)
0	20	31				
1	349	367				
2	445	466				
3	502	510				
4	544	548				
5	576	578				
6	603	604				
7	626	627				
8	645	647				
9	663	663				
10	678	678	5302.0	5364.5	1.2	15
12	705	704				
14	728	727				
16	748	747				
18	766	765				
20	781	783				
22	796	793				
24	809	808				
26	820	821				
28	832	831				
30	842	844	15490.0	15480.0	-0.1	10
35	865	862				
40	885	885				
45	902	902				
50	918	919				
55	932	931				
60	945	947				
65	957	958				
70	968	969				
75	979	979				
80	988	987				
85	997	997				
90	1006	1006				
95	1014	1016				
100	1022	1021				
105	1029	1027				
110	1036	1035				
115	1043	1043				
120	1049	1048				

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TABLE 1 : SPECIFIED AND ACTUAL RECORDED FURNACE TEMPERATURE

TIME (mins)	STANDARD FURNACE TEMPERATURE (°C)	ACTUAL FURNACE TEMPERATURE (°C)	AREA UNDER STANDARD CURVE (°C.min)	AREA UNDER ACTUAL CURVE (°C.min)	PERCENTAGE DEVIATION	SPECIFIED PERCENTAGE TOLERANCE (+ or -)
130	1061	1060				
140	1072	1072				
150	1082	1083				
160	1092	1092				
170	1101	1100				
180	1110	1109				
190	1118	1116				
200	1126	1123				
210	1133	1134				
220	1140	1141				
230	1146	1146				
240	1153	1154				
250	1159	1160	231537.5	231490.0	0.0	5



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TABLE 2 : UNEXPOSED FACE TEMPERATURE OF THE AAC BLOCK PARTITION SYSTEM

TIME (mins)	THERMOCOUPLE NO.							MEAN TEMP. (°C)	TEMP. RISE ABOVE MEAN TEMP. (°C)	
	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	T5 (°C)	T6 (°C)	T7 (°C)		MEAN TEMP.	MAX. TEMP.
0	30	30	30	30	30	30	29	30	0	0
10	30	30	30	30	30	30	30	30	0	0
20	30	30	30	30	30	30	30	30	0	0
30	34	33	35	33	34	33	33	34	4	5
40	46	48	52	47	50	47	46	49	19	22
50	62	67	70	64	68	66	65	66	36	40
60	71	74	76	73	74	76	73	74	44	46
70	73	76	78	75	76	79	75	76	46	49
80	75	77	79	77	78	79	75	77	47	49
90	75	78	80	78	78	80	76	78	48	50
100	76	79	80	79	79	80	78	79	49	50
110	77	80	81	80	80	82	79	80	50	52
120	78	81	82	81	81	83	80	81	51	53
130	79	82	83	82	83	84	81	82	52	54
140	80	83	83	83	83	85	83	82	52	55
150	81	84	83	84	84	86	83	83	53	56
160	81	84	83	85	84	87	84	83	53	57
170	82	85	84	85	84	87	84	84	54	57
180	83	85	84	86	84	88	85	84	54	58
190	83	85	84	86	84	88	85	84	54	58
200	84	85	84	86	85	88	85	85	55	58
210	84	85	85	86	85	89	87	85	55	59
220	85	86	86	87	86	90	88	86	56	60
230	86	87	87	89	88	91	100	87	57	70
240	91	89	89	90	95	93	119	91	61	89
250	106	95	112	93	118	98	144	105	75	114

- Note :
- 1) Thermocouples T1 to T5 were used to assess the ability of the AAC block partition system to satisfy the mean unexposed surface temperature criterion.
 - 2) Thermocouples T1 to T7 were used to assess the ability of the AAC block partition system to satisfy the maximum unexposed surface temperature criterion



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TABLE 3 : RECORDED DEFLECTION OF THE AAC BLOCK PARTITION SYSTEM TOWARDS THE FURNACE

TIME (mins)	MEASURING POINTS				
	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
10	3	4	5	5	3
20	1	4	5	5	3
30	0	3	3	5	2
40	0	0	1	2	0
50	0	0	0	1	0
60	0	0	0	1	-1
70	-2	-1	0	1	2
80	-2	-2	-2	0	-2
90	-2	-2	-2	0	-2
100	-1	-2	-2	-2	-2
110	-2	-3	-3	-1	-3
120	-2	-3	-4	-3	-4
130	-2	-4	-5	-3	-4
140	-3	-5	-6	-4	-5
150	-4	-5	-7	-5	-6
160	-4	-7	-8	-6	-6
170	-5	-8	-10	-8	-7
180	-5	-9	-10	-9	-8
190	-6	-10	-11	-10	-8
200	-7	-11	-12	-10	-8
210	-7	-12	-13	-11	-9
220	-7	-12	-13	-11	-9
230	-8	-12	-13	-11	-9
240	-6	-11	-10	-7	-6

NOTE: Positive value indicates movement towards the furnace.
 Negative value indicates movement away the furnace.

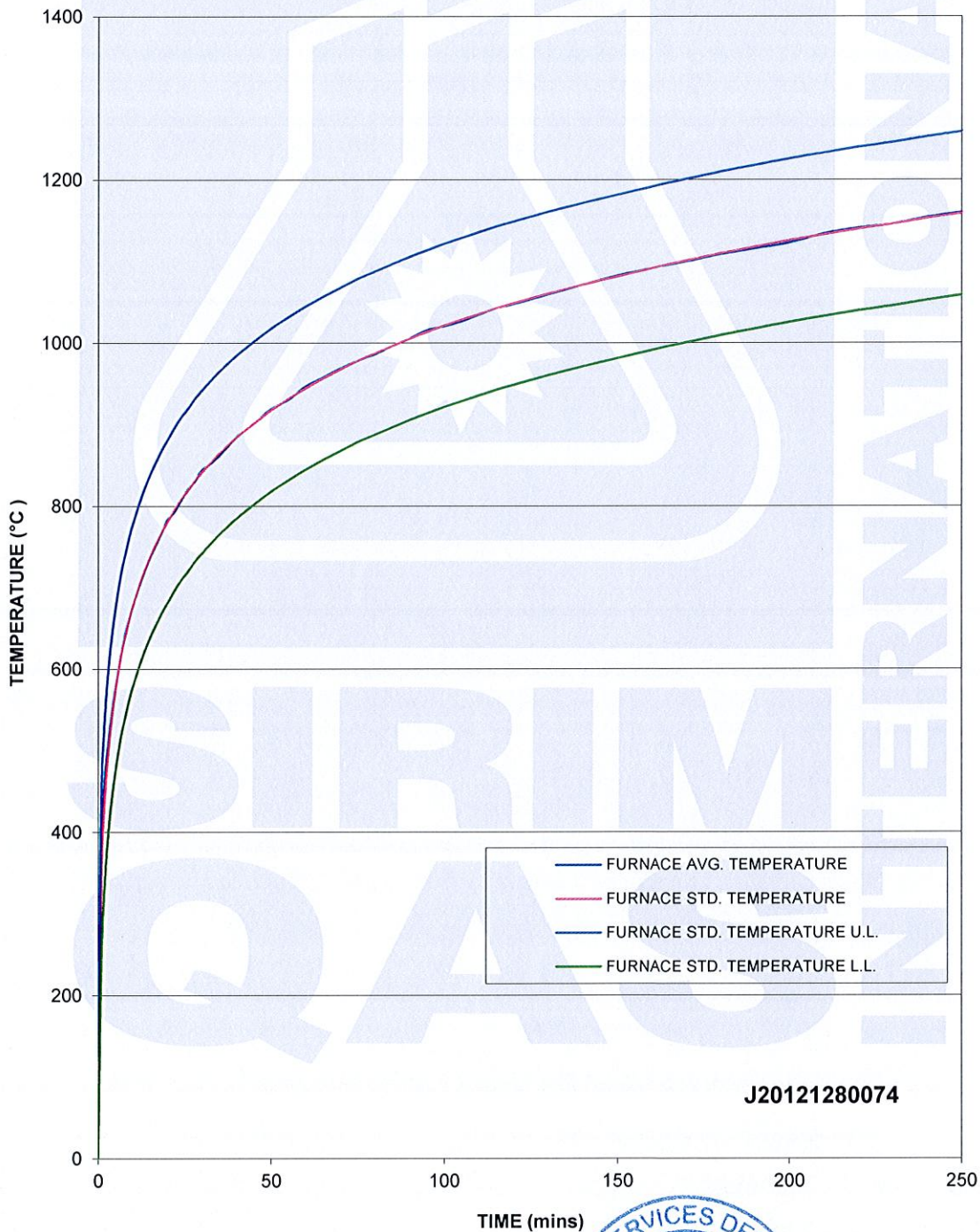


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FIGURE 1: ACTUAL FURNACE TEMP. / TIME CURVE



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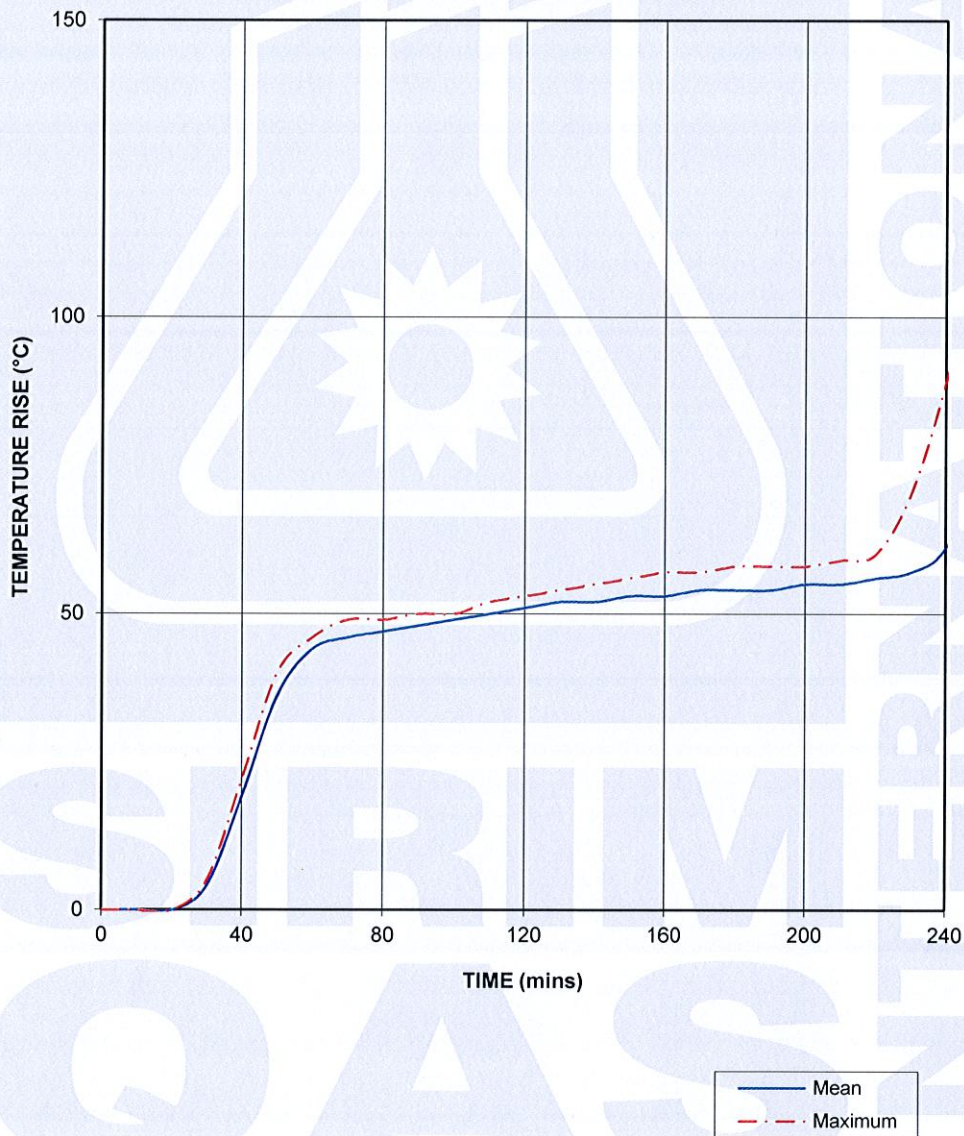


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FIGURE 2. UNEXPOSED FACE TEMPERATURE CURVE
Temperature rise above initial mean temperature



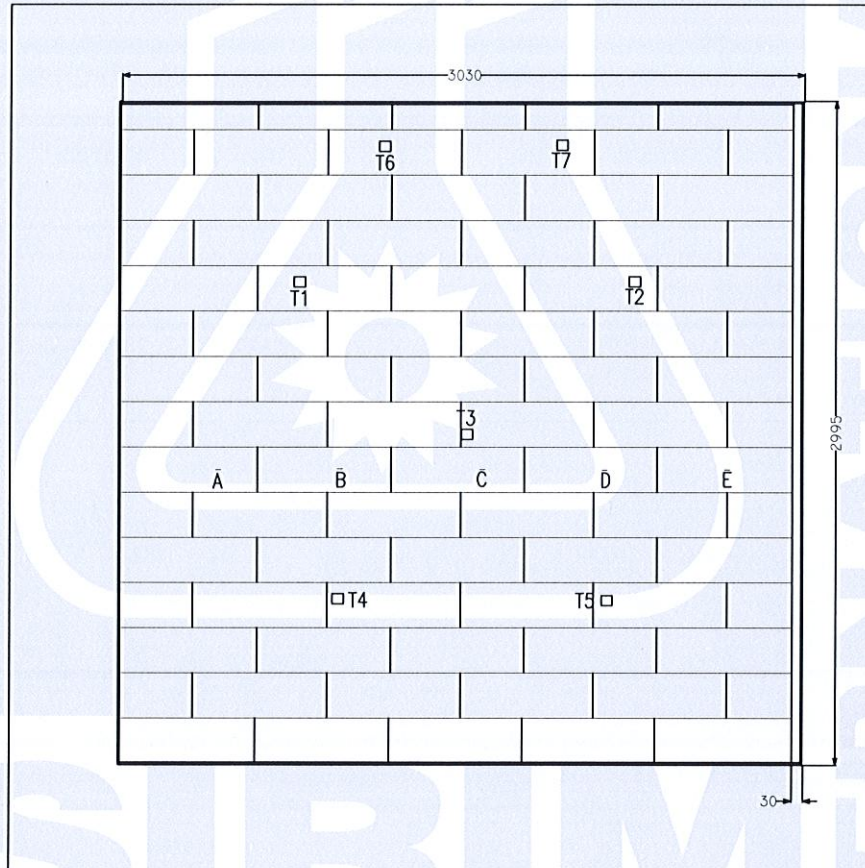
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UNEXPOSED FACE

- (a) Thermocouple Points on the Unexposed Face
- (-) Deflection Measuring Points on the Mid-Width of the Partition System



FIGURE 3 : GENERAL ARRANGEMENT OF THE AAC BLOCK WALL PARTITION SYSTEM

NOTE:

1. All dimensions are in mm
2. Drawing not to scale

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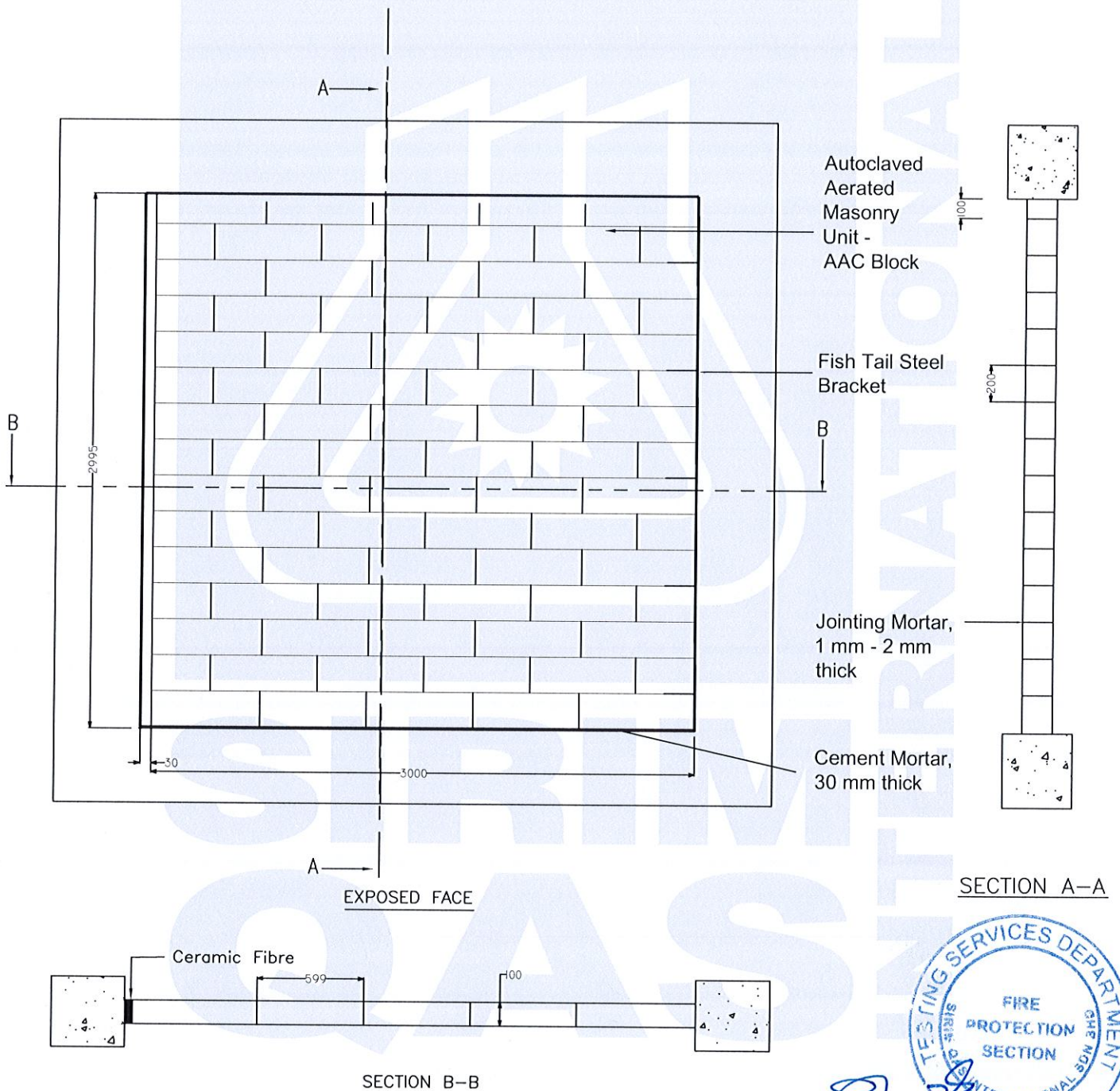


FIGURE 4 : GENERAL CONSTRUCTION OF THE AAC BLOCK WALL PARTITION SYSTEM

NOTE:

1. All dimensions are in mm
2. Drawing not to scale

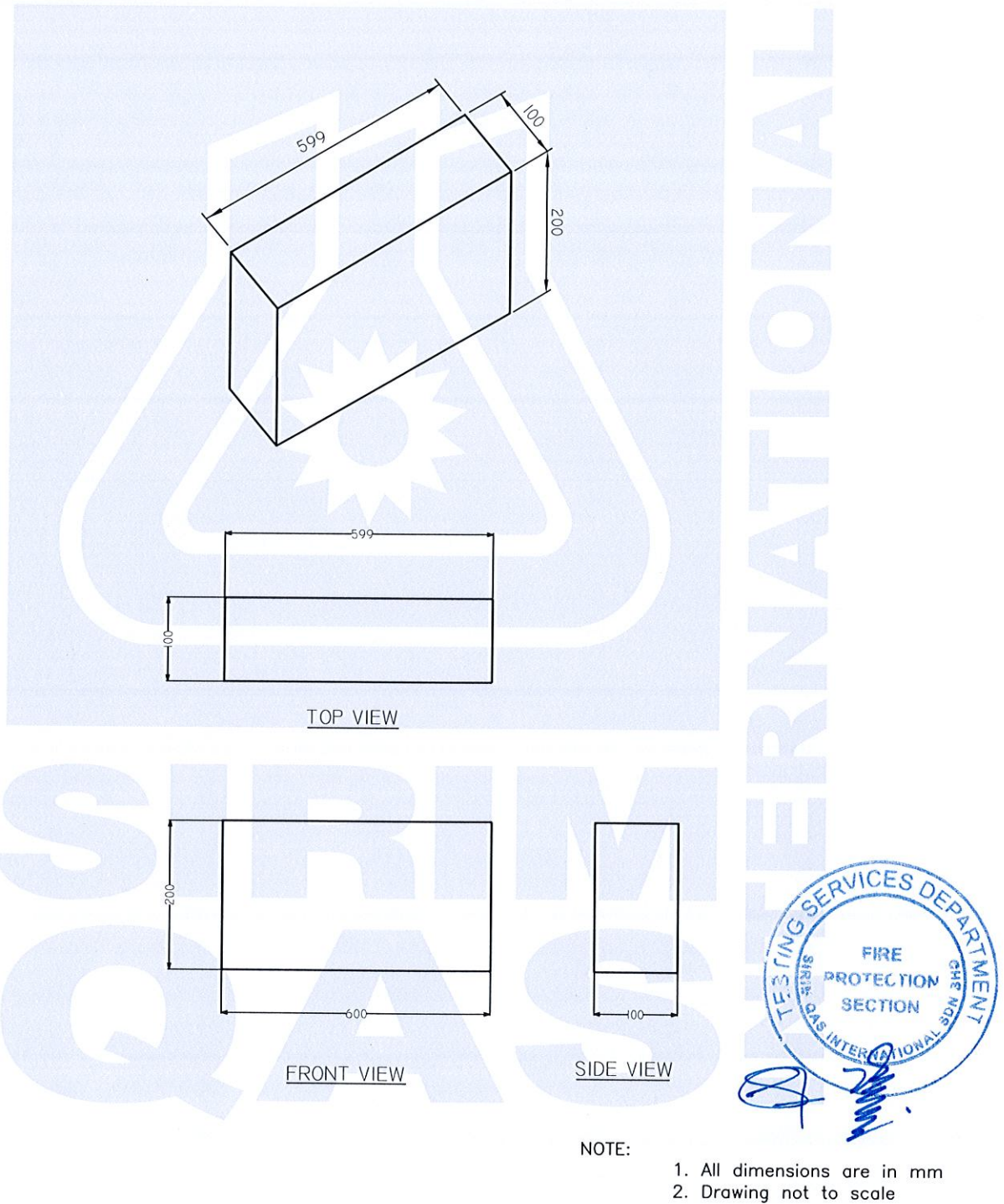
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NOTE:

1. All dimensions are in mm
2. Drawing not to scale

FIGURE 5: DETAIL OF AUTOCLAVED AERATED CONCRETE MASONRY UNIT - AAC BLOCK

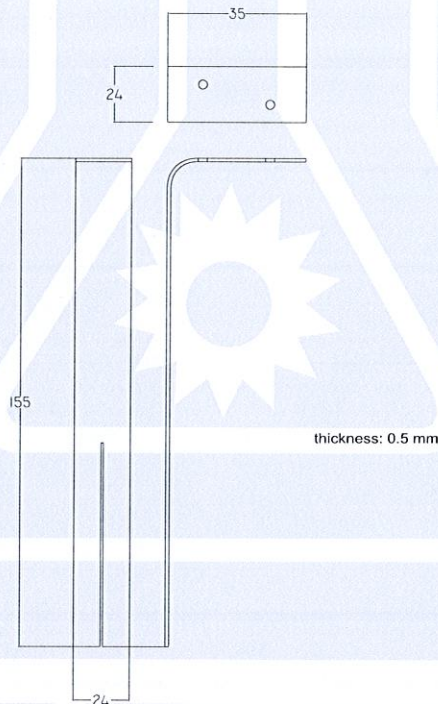
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NOTE:

1. All dimensions are in mm
2. Drawing not to scale

FIGURE 6: FISH TAIL STEEL BRACKET



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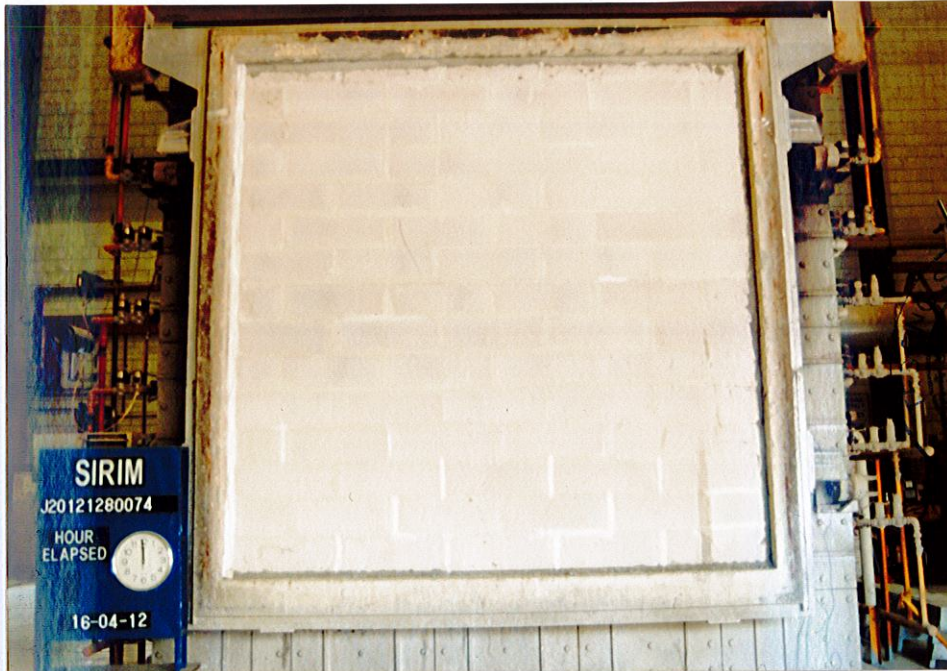


Photo 1 : The exposed face of the AAC block wall partition system before the test

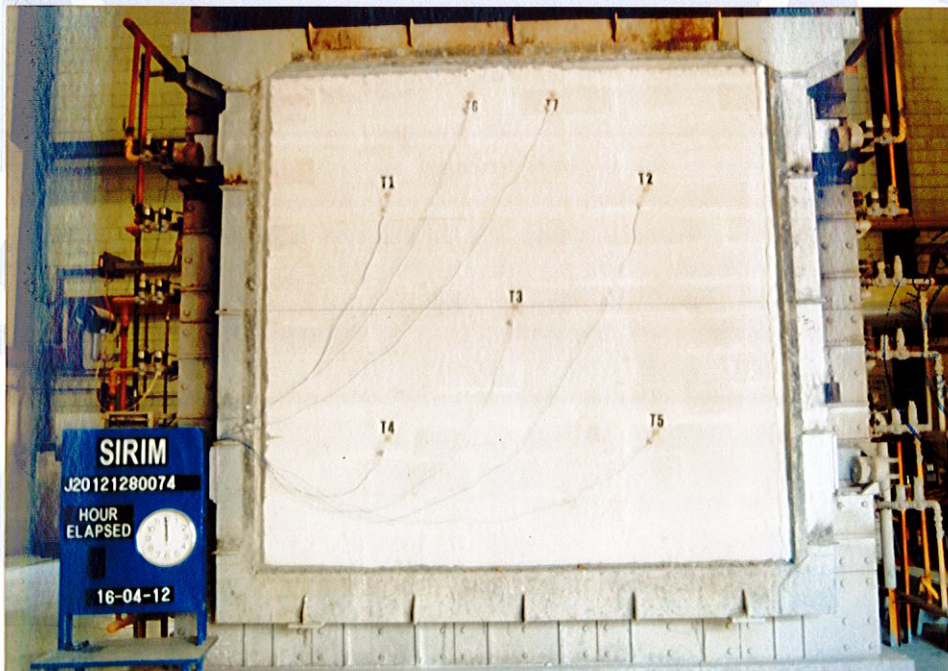


Photo 2 : The unexposed face of the AAC block wall partition system before the test

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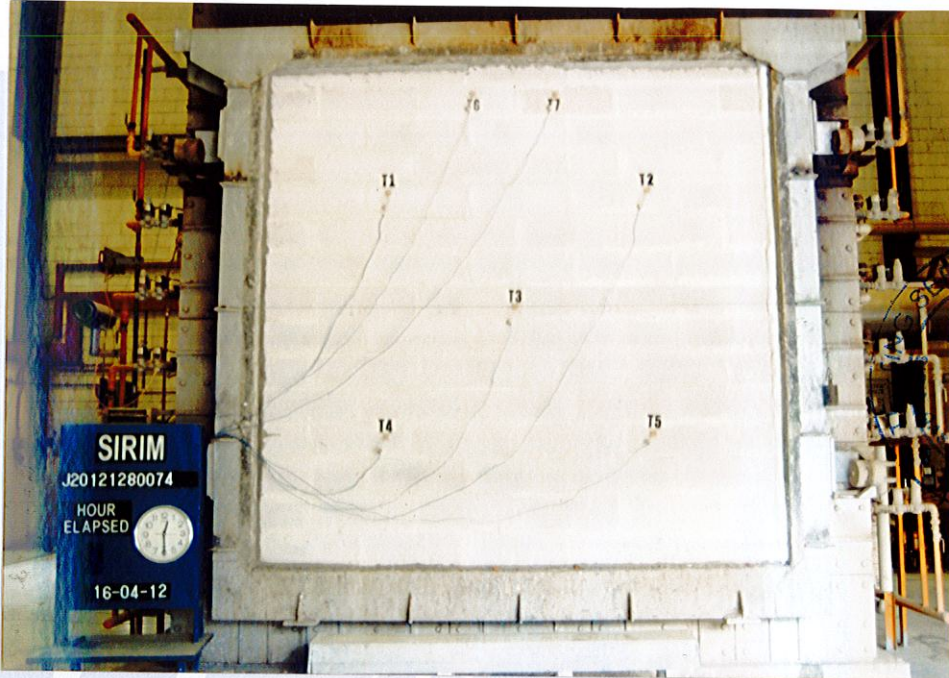


Photo 3 : At about 30 minutes of test.

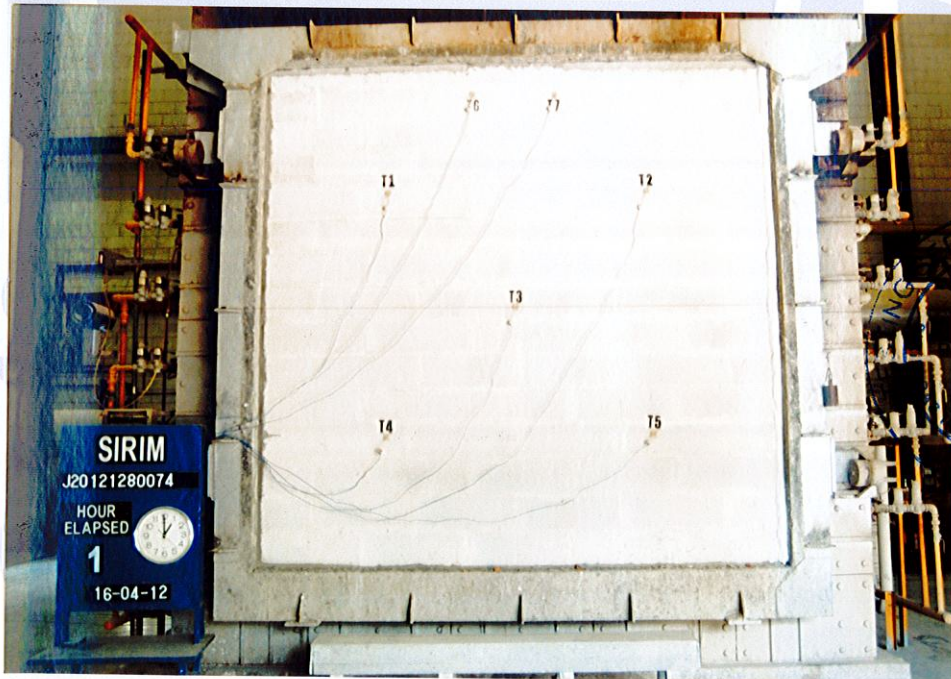


Photo 4 : At about 60 minutes of test

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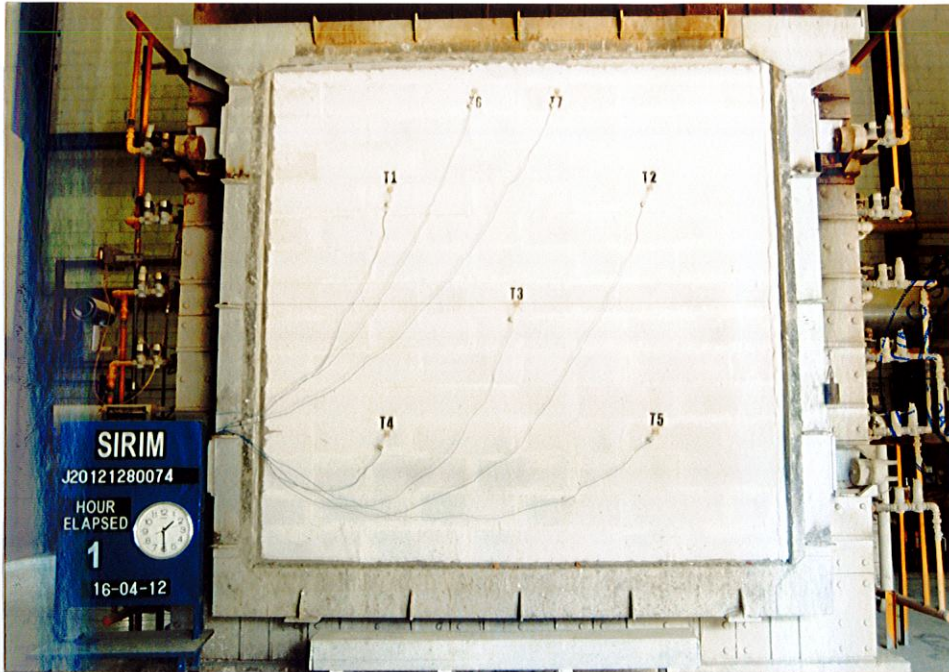


Photo 5 : At about 90 minutes of test

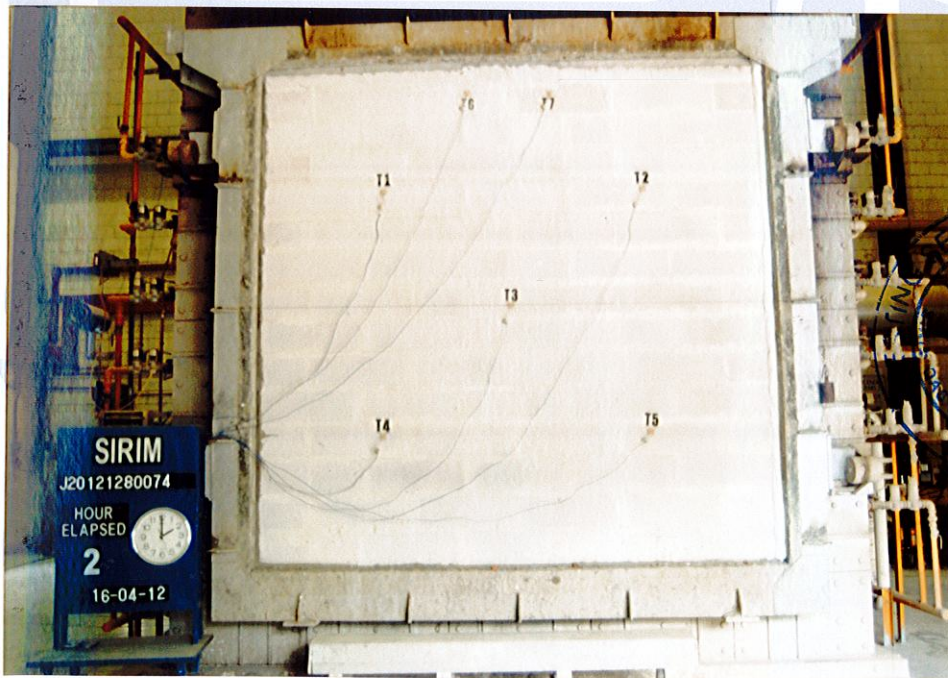


Photo 6 : At about 120 minutes of test

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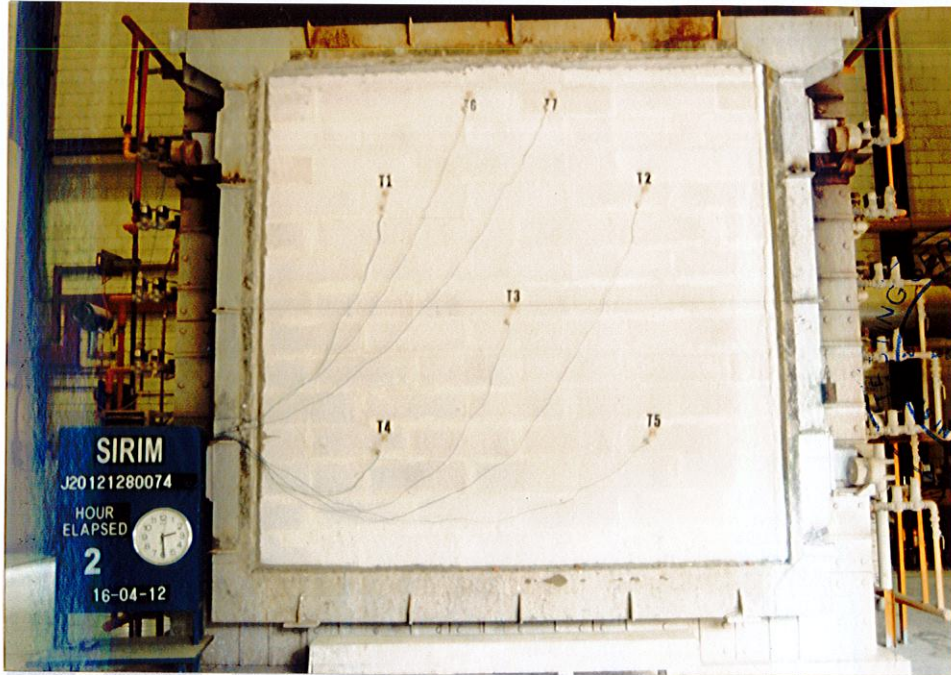


Photo 7 : At about 150 minutes of test

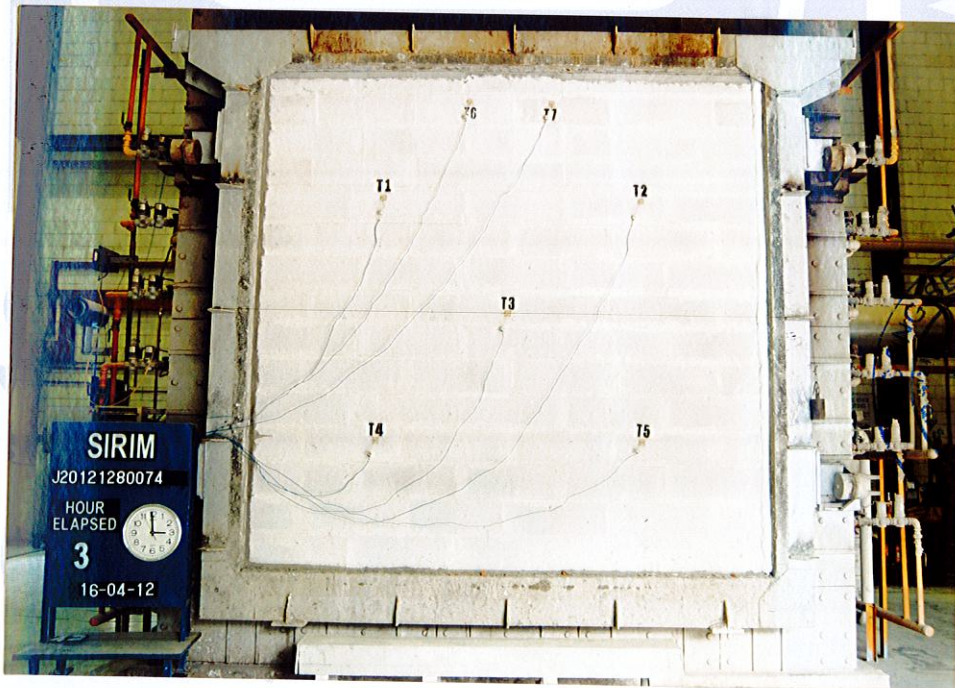


Photo 8 : At about 180 minutes of test

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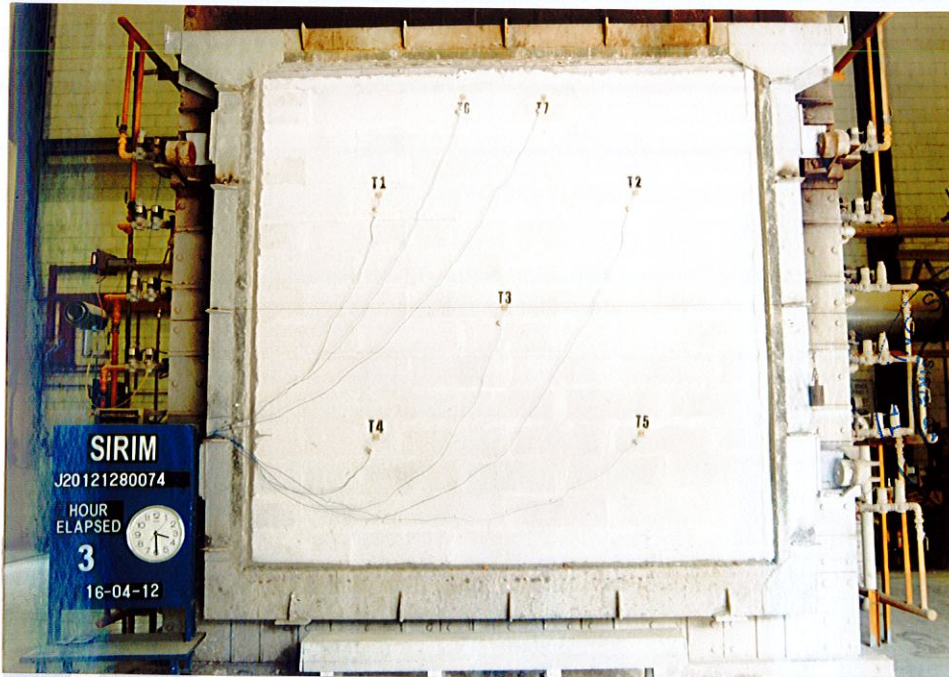


Photo 9 : At about 210 minutes of test

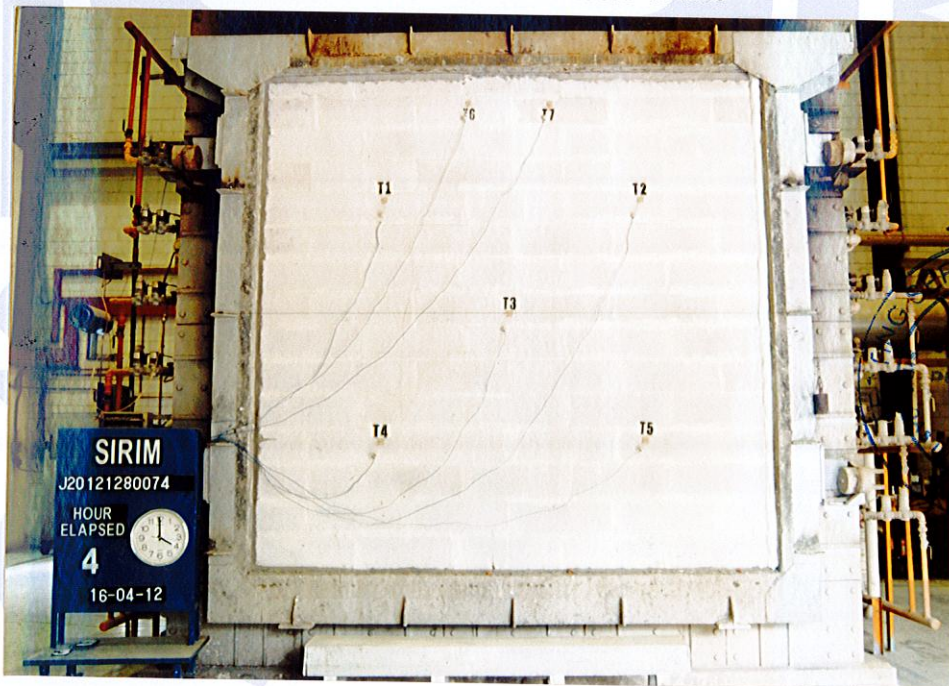


Photo 10 : At about 240 minutes of test

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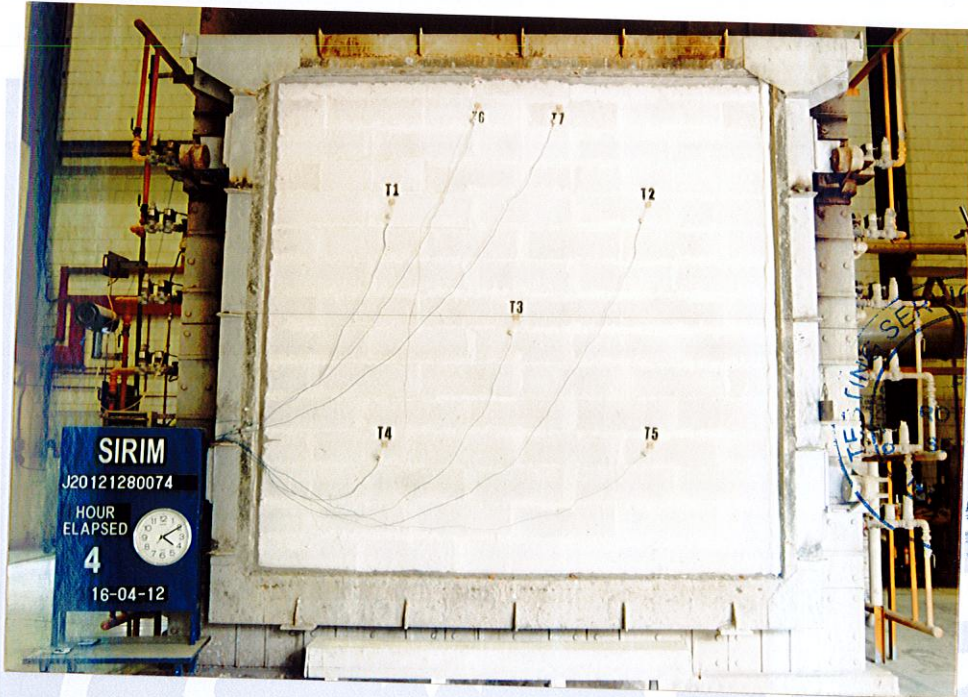


Photo 11 : At about 250 minutes of test

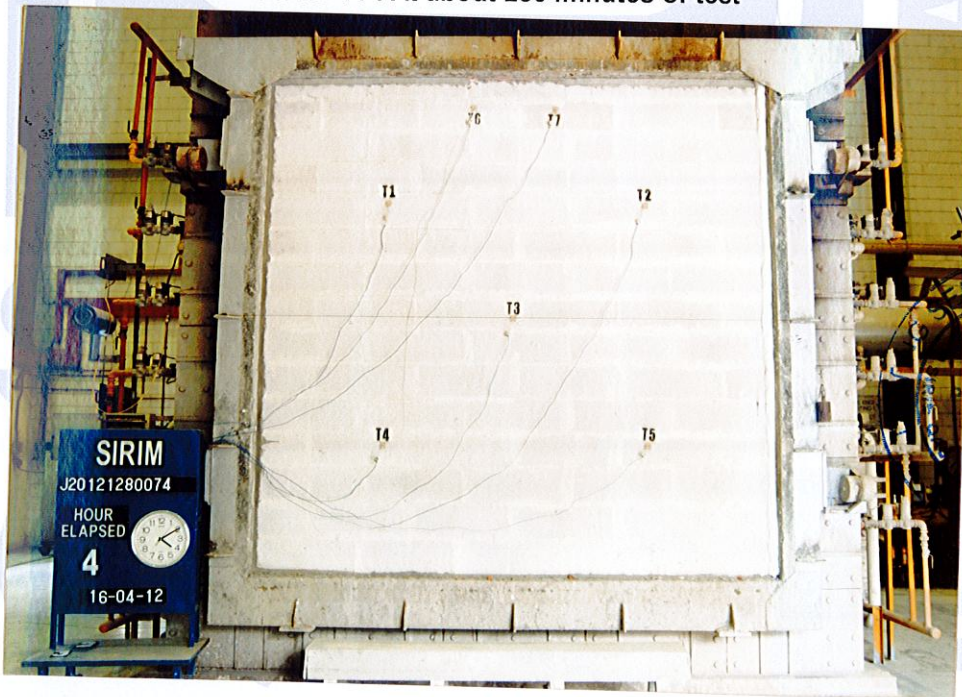


Photo 12 : The exposed face of the AAC block wall partition system after the test

[Handwritten signatures]

04 MAY 2012