FIRE MODELLING & COMPUTING

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FIRE ENGINEERING REPORT

Assessment of an FRL of TIMBERCRETE 100 mm thick block wall

1. Description of the problem

Timbercrete load bearing block wall 190 mm thick was fire tested by CSIRO (Ref. 1) and found to have an FRL of 240/240/240.

This report is an assessment of fire resistance of a 100 mm thick block used for non-loadbearing application.

The report applies to the conditions in the proposed Priory for Carmelite Friars, at 347 St Andrews Road, Varroville NSW where timbercrete will be used for walls separating sole-occupancy units which are required to have an FRL of 60/60/60.

As far as this project is concerned, the report is an assessment in accordance with Clause A0.9(a) of the BCA, i.e. it is an evidence to support that the use of timbercrete meets Performance Requirements of the BCA.

2. Assessment

The test results by CSIRO have been compared with computation imitating heat transfer across a flat block. The computation has been carried out using program CONDUCTIVITY of the Fire Engineering software package FIREWIND created by Fire Modelling & Computing. This program is an implementation of rigorous heat transfer equations, albeit one-dimensional, so that effects of finite width and height of a block are not taken into account. Therefore, some deviations from results of a test carried out on a block 3 m wide and 3 m high are inevitable.

In computation, the properties of timbercrete have been assumed as listed in Ref. 2 for a product with density of 1000 kg/m^3 – such a density is reported in Ref. 1:

Thermal conductivity	0.314 W/m.K
Specific heat	850 J/kg.K

Absorptivity was assumed to be 0.7, as it is for most non-glaring solids.

The print-out of program CONDUCTIVITY for a block 190 mm thick is shown in Figure 1. The comparison of computed and tested temperatures on the side of the block which is not exposed to heat is presented in Figure 2. The difference between computed and tested results is from – 12°C to + 15 °C. Hence, the computation can be carried out also for a 100 mm thick block, and approximately similar accuracy can be anticipated.

The print-out of program CONDUCTIVITY for a block 100 mm thick is shown in Figure 3. The computed temperatures on the side not exposed to the fire in 1 hour of the standard fire test are depicted in Figure 4. It is evident that the temperature on the unexposed side of the 100 mm thick block in 1 hour of the standard test is approximately the same as that of a 190 mm thick block in 4 hours of the standard test. Hence, the heat to which the material is subjected for a the 100 mm thick block in 1 hour of the standard test is approximately the same as that of a 190 mm thick block in 4 hours of the standard test. However, these calculations do not provide a ground to use 100 mm thick blocks in loadbearing applications.

3. Conclusions

The 100 mm thick blocks of timbercrete can be recommended for use in the Priory for Carmelite Friars as non-loadbearing material where an FRL of **60/60/60** is required. For double-skin walls the external layer can be used as loadbearing. By virtue of Clause A0.5(b)(i) of the BCA, used in this application, timbercrete construction will comply with Performance Requirements of the BCA identified in accordance with Clause A0.10 of the BCA as following:

CP1: *The building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to –*

- *(a) the function or use of the building; and*
- *(b) the fire load; and*
- *(c) the potential fire intensity; and*
- *(d) the fire hazard; and*
- *(e) the height of the building; and*
- *(f) its proximity to other property; and*
- *(g) active fire safety systems installed in the building; and*
- *(h) the size of fire compartments; and*
- *(i) fire brigades intervention; and*
- *(j) other elements they support; and*
- *(k) the evacuation time.*

CP2(a) *The building will have elements which will, to the degree necessary, avoid spread of fire –*
(i) to exits; and …
(iv) in the building.

CP2(b) *Avoidance of the spread of fire referred to in (a) will be appropriate to –*
(i) the function or use of the building; and
(ii) the fire load; and
(iii) the potential fire intensity; and
(iv) the fire hazard; and
(v) the number of storeys in the building; and
(vi) the proximity to other property; and
(vii) any active fire systems installed in the building; and
(viii) the size of any fire compartment; and
(ix) fire brigade intervention; and
(x) other elements they support; and
(xi) the evacuation time.

Dr. Victor Shestopal
Director
Accredited Certifier in Mechanical and Fire Safety engineering
Reference Number BPB0374

References

1. Report FSV 1094 by CSIRO, Manufacturing & Infrastructure Technology “Fire-resistance test on a load-bearing block wall system” dated 11 February 2005.

2. Report “Timbercrete Pty Ltd. Thermal properties of timbercrete” by Electronic Blueprint dated 21 July 2007.

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Program Conductivity


Plate thickness 190 mm
Material properties:
  density 1000 kg/m3
  thermal conductivity 0.314 W/(m.K)
  specific heat 850 J/(kg.K)
  absorptivity 0.7
Ambient temperature 23 oC
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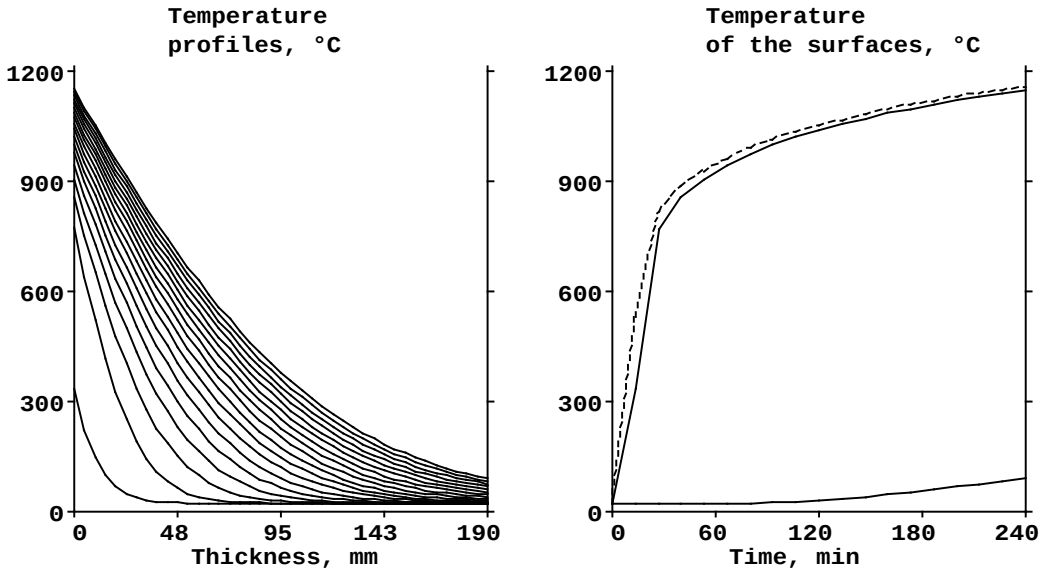

		Depth, mm										
Time, min	Fire	0.00	19.00	38.00	57.00	76.00	95.00	114.00	133.00	152.00	171.00	190.00
		Temperature, °C										
0.0	0.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
13.3	530.3	332.8	68.1	27.8	23.4	23.0	23.0	23.0	23.0	23.0	23.0	23.0
26.7	818.7	770.5	325.0	108.1	40.8	25.9	23.4	23.0	23.0	23.0	23.0	23.0
40.0	888.0	856.4	477.3	227.6	98.1	45.4	28.5	24.1	23.2	23.0	23.0	23.0
53.3	928.0	904.3	569.8	320.7	163.8	80.6	43.3	29.2	24.6	23.4	23.1	23.0
66.7	962.3	942.9	635.8	393.1	224.3	121.1	65.7	39.5	28.7	24.8	23.5	23.2
80.0	991.0	974.1	686.5	451.7	277.9	161.8	92.0	54.2	35.9	27.8	24.7	23.8
93.3	1013.7	998.8	728.1	500.8	325.2	200.7	119.9	71.9	45.8	32.9	27.1	25.1
106.7	1034.0	1020.7	763.3	542.8	367.2	237.2	148.1	91.3	57.9	39.8	30.9	27.5
120.0	1052.0	1039.8	793.3	579.3	404.8	271.3	175.7	111.7	71.6	48.4	36.2	30.9
133.3	1067.3	1056.1	819.7	611.7	438.7	302.9	202.4	132.4	86.5	58.4	42.7	35.5
146.7	1081.7	1071.3	843.2	640.5	469.5	332.4	228.2	153.1	102.1	69.5	50.4	41.0
160.0	1095.0	1085.2	864.2	666.6	497.7	359.9	252.8	173.6	118.1	81.4	59.0	47.2
173.3	1107.0	1097.8	883.5	690.4	523.6	385.6	276.4	193.8	134.4	93.9	68.4	54.0
186.7	1118.3	1109.6	901.2	712.3	547.6	409.7	298.9	213.5	150.7	106.8	78.2	61.2
200.0	1129.0	1120.7	917.5	732.5	570.0	432.5	320.4	232.7	166.9	120.0	88.3	68.5
213.3	1138.3	1130.5	932.5	751.3	590.9	453.9	341.0	251.3	183.0	133.1	98.5	75.9
226.7	1147.3	1139.8	946.5	768.7	610.5	474.2	360.6	269.4	198.8	146.2	108.8	83.2
240.0	1156.0	1148.8	959.6	785.1	628.9	493.4	379.5	286.9	214.2	159.1	118.9	90.4

Figure 1. Print-out of program CONDUCTIVITY approximating CSIRO fire test.

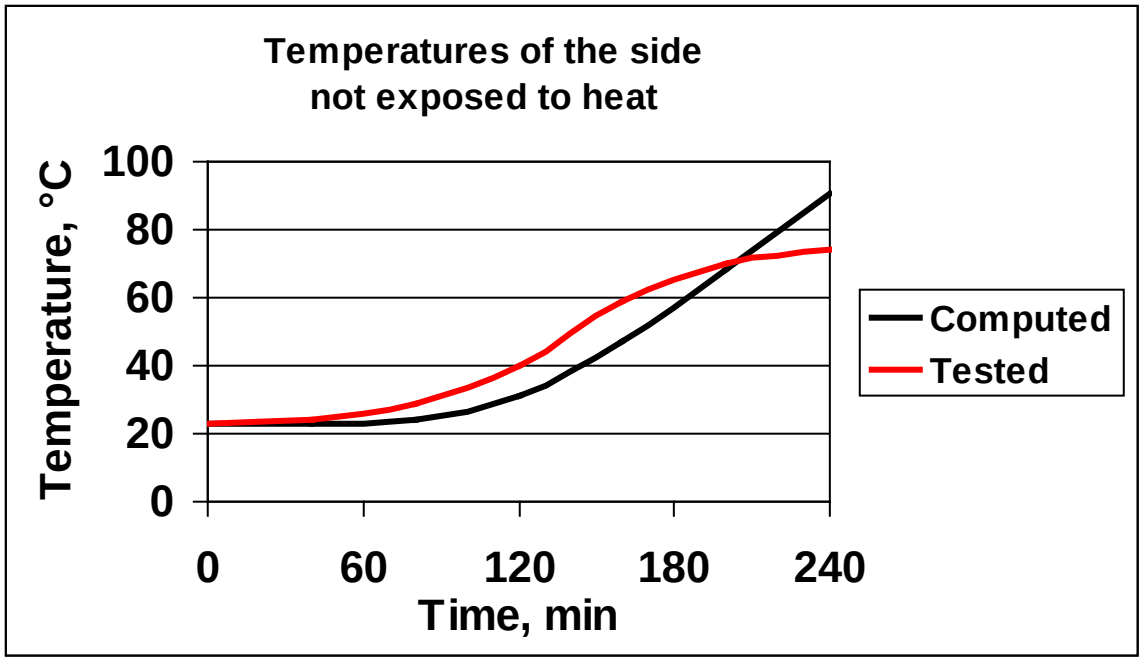

Figure 2. Comparison of computed and tested temperatures on the side not exposed to heat in a test according to AS 1530.4.

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Program Conductivity

Plate thickness 100 mm
Material properties:
  density 1000 kg/m3
  thermal conductivity 0.314 W/(m.K)
  specific heat 850 J/(kg.K)
  absorptivity 0.7
Ambient temperature 23 oC
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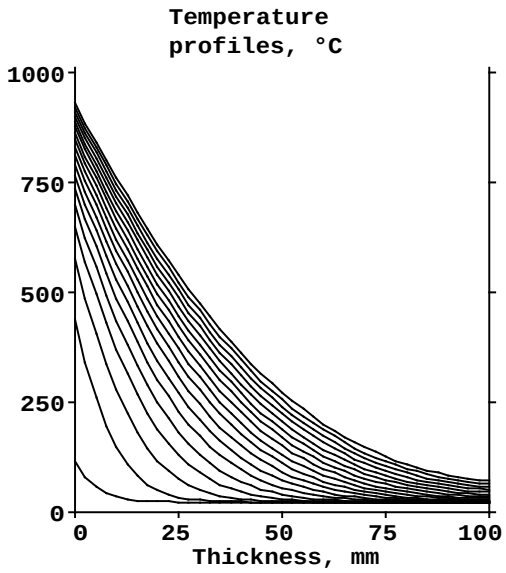

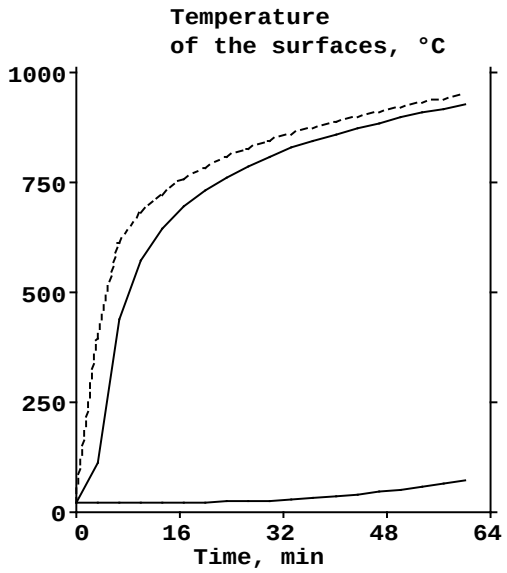

		Depth, mm										
	Fire	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
Time, min		Temperature, °C										
0.0	0.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
3.3	393.8	113.4	34.7	24.1	23.1	23.0	23.0	23.0	23.0	23.0	23.0	23.0
6.7	613.0	437.7	147.5	49.5	27.4	23.6	23.1	23.0	23.0	23.0	23.0	23.0
10.0	681.0	574.3	277.5	117.4	51.0	29.7	24.3	23.2	23.0	23.0	23.0	23.0
13.3	721.7	645.6	369.0	187.7	89.7	46.0	29.8	24.7	23.4	23.1	23.0	23.0
16.7	756.0	695.8	435.9	248.5	132.1	69.5	40.5	28.8	24.7	23.4	23.1	23.0
20.0	784.0	732.9	487.2	300.0	173.0	96.4	55.4	35.9	27.6	24.5	23.4	23.2
23.3	806.6	762.4	529.1	344.0	210.9	124.1	72.9	45.5	32.3	26.5	24.3	23.6
26.7	827.0	787.8	564.5	382.3	245.6	151.5	91.8	57.2	38.8	29.8	25.8	24.5
30.0	845.0	809.5	594.7	415.9	277.5	177.9	111.4	70.2	46.6	34.2	28.2	26.1
33.3	860.3	828.0	621.1	445.9	306.6	203.1	131.0	84.2	55.7	39.7	31.6	28.5
36.7	874.7	844.8	644.6	472.7	333.4	227.0	150.5	98.6	65.7	46.2	35.8	31.6
40.0	888.0	860.1	665.7	497.1	358.2	249.7	169.5	113.4	76.4	53.6	41.0	35.6
43.3	899.3	873.3	684.8	519.4	381.1	271.2	188.0	128.2	87.6	61.8	46.9	40.3
46.7	910.3	885.8	702.2	539.8	402.5	291.5	206.0	143.1	99.2	70.5	53.5	45.6
50.0	921.0	897.7	718.2	558.7	422.4	310.8	223.3	157.8	111.1	79.8	60.8	51.4
53.3	930.3	908.3	733.1	576.2	441.1	329.1	240.1	172.3	123.1	89.4	68.5	57.7
56.7	939.3	918.3	747.0	592.7	458.7	346.6	256.4	186.7	135.2	99.4	76.5	64.3
60.0	948.0	927.9	759.9	608.0	475.3	363.3	272.1	200.8	147.3	109.5	84.9	71.2

Figure 3. Print-out of program CONDUCTIVITY approximating an AS 1530.4 fire test on a 100 mm thick block of timbercrete.

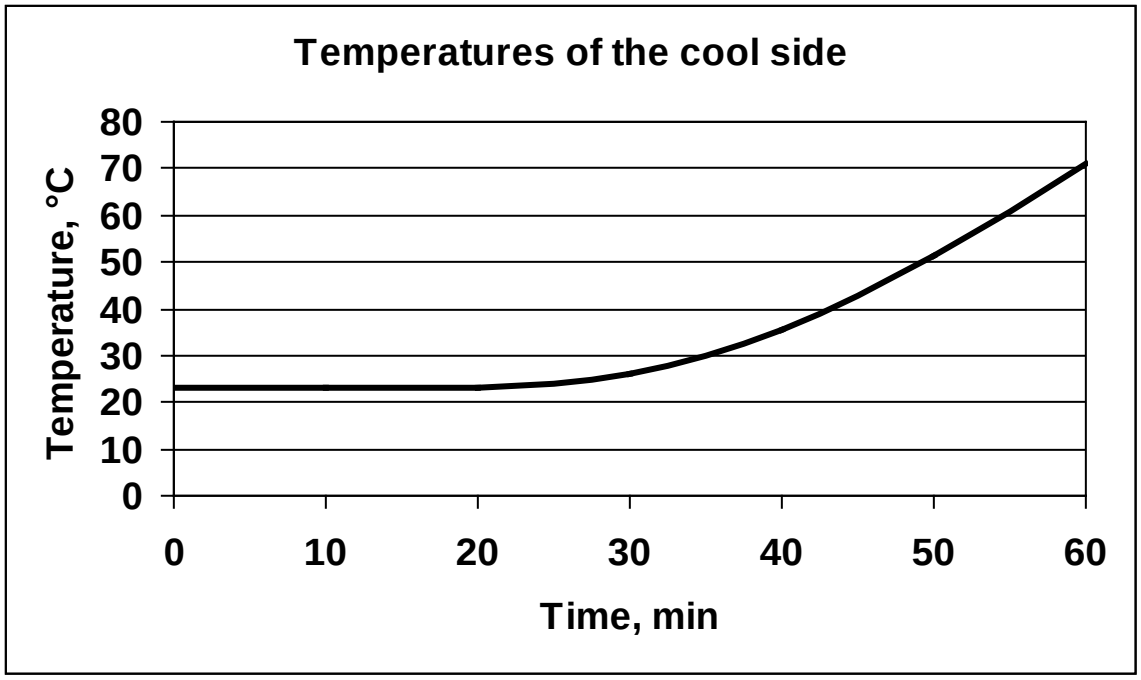

Figure 4. Temperatures on the side not exposed to fire in 1 hour of the standard fire test.