Fire Resistance of Handcrafted Log Walls

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ABSTRACT: The objective of this paper is to study the fire resistance of the handcrafted full-scribe chink-less log wall. Log construction is growing in popularity, but knowledge of its fire performance and availability of experimental fire data are limited. Sometimes when a high fire resistance rating of a log wall is required, the application of a layer of gypsum wallboard is recommended to increase the assembly fire resistance. The experimental research of an untreated log wall proved that the wall can achieve a very high fire resistance rating by itself and additional steps to increase its fire resistance are not necessary. Use of a traditional handcrafted log system provides the comfort level of prefabricated manufacturing, and significant fire resistance without the need for increasing the assembly costs.

KEY WORDS: log wall, fire resistance, testing, load bearing capacity.

INTRODUCTION

THE TREND TOWARD building design, using objective-based or performance-based codes, has continued to increase the need for information on the performance of various traditional and innovative building systems. Such information in the technical area of performance and, specifically, structural fire resistance is sorely lacking for all types of construction, and especially wood construction.

Today's fire research is focused on the investigation of the most common building system, light wood frame. Heavy timber construction, especially log construction, is not an objective of today's science, although the log buildings are still a popular building method.

According to the Log Home Living Association [1], the log building industry is worth \$7 billion to \$8 billion. Since 1994, the North American log building industry has grown and expanded, especially in the overseas markets. In North America itself, more then 22,000 log houses are sold every year. Log homes now

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capture 6.6% of the custom-built homes market. Most of the research carried out earlier on log buildings was oriented toward thermal performances and air leakage of log wall assemblies, but several fire tests of log walls were also carried out.

In 1986, Sashco Sealants Inc. conducted a fire test at Underwriters Laboratories Inc., Northbrook, IL, to gain a fire resistance rating for its log wall joint sealant according to ASTM E119 [2]. The sealant was installed in a non-load-bearing log wall assembly made of twelve 3 m long logs averaging 220 mm in diameter. The weight of each log varied from 49.4 kg to 101.5 kg with an average of 68.27 kg. Logs were identified as lodge pole pine and had an average moisture content of 5.39% with the maximum being 5.7%. The vertical distance between adjacent logs varied from 3 to 75 mm. Wall joints were filled with foamed polyethylene backer rods. Sashco Log Jam Chinking was applied. The chinking material had cured for 41 days at room temperature. The experimental log wall assembly is shown in Figure 1 [3]. The log edges were supported with graded lumber (50 by 300 mm) from both sides of an assembly and secured with 12 × 75 mm hex head wood screws spaced approximately 300 mm off center.

The temperatures of the fire unexposed surface did not reach the limiting temperatures prescribed by ASTM E119 during the 60 min test. The maximum individual temperature on the unexposed surface reached 95.16°C with an average unexposed surface temperature of 71.5°C. The Hose Stream Test was done on a duplicate log wall constructed in the same way as described earlier. The Log Jam chinking delaminated on the exposed side of the assembly only, and no water penetrated through the exposed side of the assembly. The assembly was judged to afford a 1 hour fire rating according to ASTM E119.

The Technical Research Center of Finland (VTT) performed a fire test on log walls manufactured by Honkarakenne Oy [4]. The thickness of the rectangular logs, sealed with a polypropylene sealant, was 140 mm. The wall was vertically loaded with 6.1 kN m^{-1} on the center line. The log wall was tested following DIN 4102 Part 2 [5] and ISO 834 [6]. The integrity of the wall was proven by the cotton waste.

In this test, the cotton waste ignited after 112 min. The wall kept its load-bearing capability throughout the test and withstood the ball impact in 30, 60 and 90 min as prescribed by DIN 4102.

Various companies have conducted burn-through field tests, and small-scale tests of non-load-bearing chinked log walls, to display the fire endurance of their products. The overall results showed good fire resistance, but no serious measurements were done, and the details were not widely published.

All the previous work on the fire resistance of log walls was conducted on chinked or rectangular log walls. The Technical University of Zvolen, Slovakia, has commenced research to answer questions regarding the fire resistance of a chink-less log wall used primarily in North America, and to develop a model for estimating the fire resistance of log walls. The large-scale experiment according to

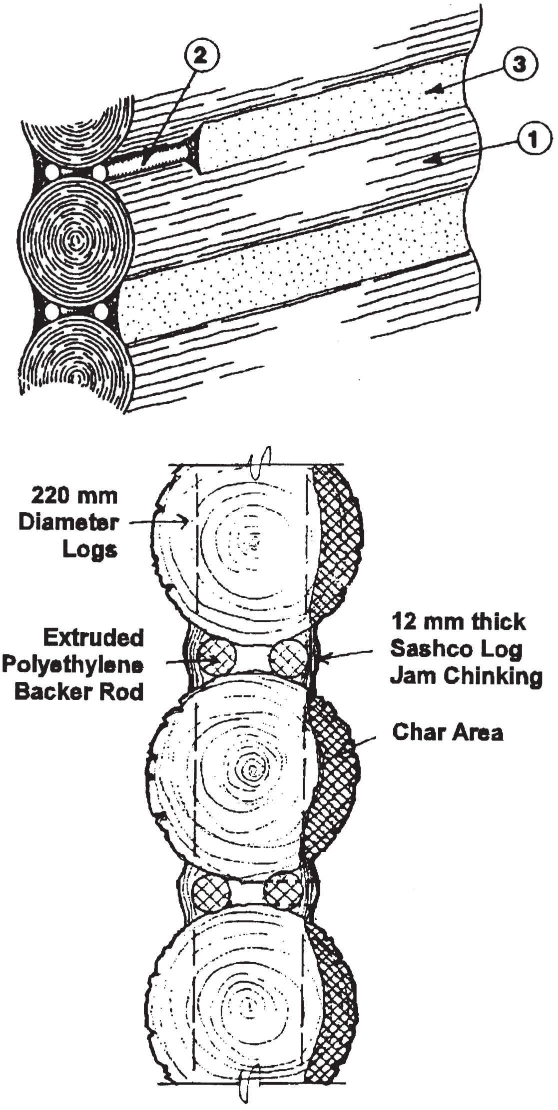

Figure 1. *Chinked log wall tested by Sashco Sealants Inc. at Underwriters Laboratories Inc., Illinois. (1—Wall log; 2—Polyethylene backer rod; 3—Sashco log jam chinking.)*

ISO 834 and CSN 73 0855 [7] (Czech fire standard corresponding to ISO 834) was undertaken at the PAVUS-Fire Research Institute, Czech Republic.

EXPERIMENTAL

The test sample consisted of twelve spruce logs ranging from 237 mm to 300 mm in diameter with an average diameter of 257.1 mm, stacked horizontally. A log wall joint was made in the traditional chink-less style (see Figure 2 [8]), following North American log building industry recommendations [9,10]. In the traditional chink-less style, each log is precisely scribed to fit into the log above. The proficiency of this operation makes the building envelope sealed and weather tight. The cupped lateral groove (a wall cavity) is approximately 15 mm deeper than necessary to accommodate additional mineral insulation. The wall sample was 3250 mm long, and 2800 mm high. Characteristic details of the log wall are shown in Figure 3.

Eleven logs were kiln-dried to 18% of moisture content (MC) ranging from 17.7% to 21.6% with an actual average of 19.5% and one log was conditioned to 36% with an actual average of five moisture readings of 36.8%. The MC figures used for this test were derived from experimental measurements on existing log structures in Slovakia. According to the measurements summarized in Reference [11], the average MC of wall logs depends on the position of the log in the building and can range between 15% and 40%. Most of the measurements ranged between

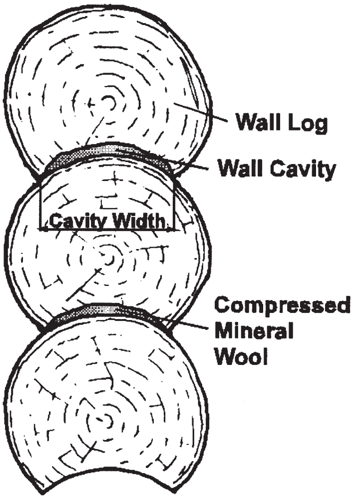

***Figure 2.** Chink-less log wall. Wall cavity is filled with compressed mineral insulation. Weather tightness of such a wall is provided by precise scribing of the bottom log into the log above.*

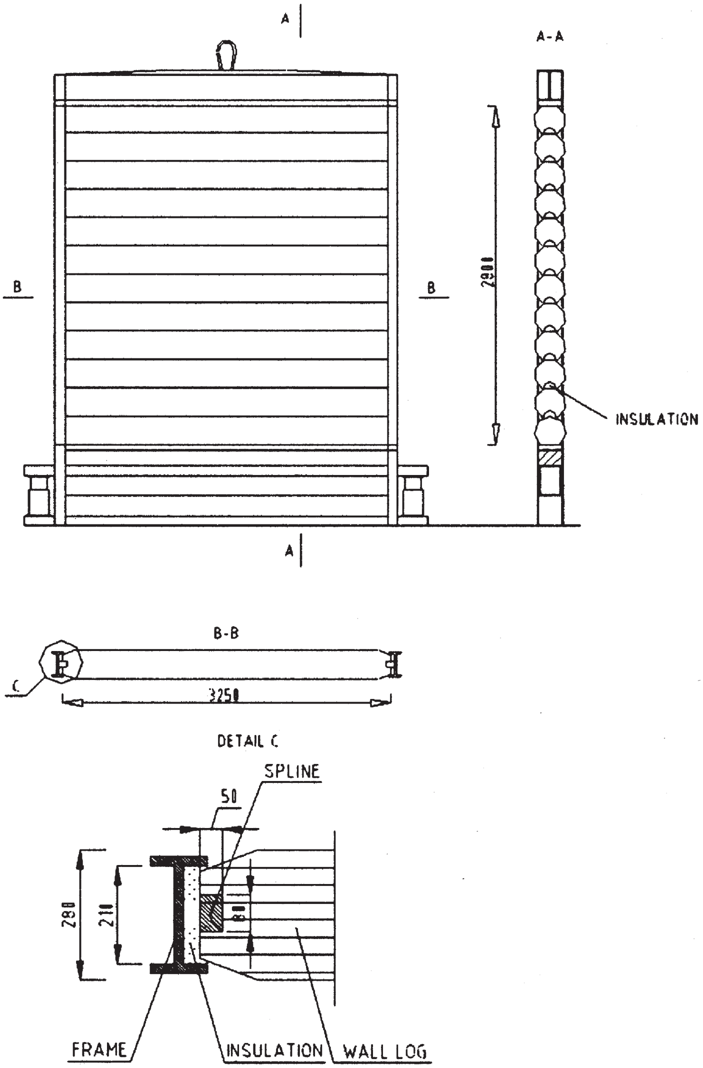

Figure 3. *Sample of the log wall installed in the testing frame.*

16% and 25%, therefore, an 18% MC was selected for the tested log wall. The log with the 36% MC was an extreme value included in the test to investigate the influence of the logs' initial MC on the heat transfer for further modeling.

The log wall was placed in the loading frame one day before the test. All moisture readings were taken one day prior to the test. The wall cavity was filled with mineral wool insulation (rock wool type) during the assembly. The density of the mineral insulation was 50 kg m^{-3} and the initial thickness of the insulation strips was 50 mm. Due to the natural irregularities of each log, the width of the wall cavity varied between 89 and 130 mm with an average of 105.2 mm.

Log edges were structurally supported on both ends by full-length 50 × 80 mm rectangular splines smoothly inserted into the groove made in the log ends with appropriate provision for settling of the wall during the fire test. Splined log edges were outside the furnace chamber, therefore, they were not subjected to fire exposure. In real situations, each wall log would be supported by interlocking corners or interior partitions, but the spline technique is commonly used at window and door openings. The spruce pegs, 30 mm in diameter, were driven throughout the log length approximately 800 mm apart (always three per log) to support the position of the wall logs. They were driven only through two vertically adjacent logs. Both edge support and wood pegs techniques are commonly used in log construction for securing a log's position.

Thermocouples were placed throughout the log wall as shown in Figure 4. They were placed inside the logs at 10, 30, 50, 70, 90, 110 and 200 mm from the fire-exposed surface (FES). Inside the wall cavity, thermocouples were placed 15, 30, 45, 60, 75, 90 and 105 mm from the FES. On the unexposed side, the thermocouples were placed over the joint of two vertically adjacent logs. In handcrafted log walls, the width of the wall cavity varies throughout each log. Therefore, the initial distance of each thermocouple placed over the fire unexposed log wall joint varied between 92 and 125 mm.

The log wall sample was subjected to fire exposure prescribed by ISO 834 and CSN 73 0855. Temperatures inside the logs, inside the lateral wall cavity and on the unexposed side were continuously monitored and recorded.

The log wall was continuously vertically loaded on the centerline with 15 kN m^{-1} using a hydraulic loading system built in the furnace loading frame. The load was applied 30 min before the commencement of the test to accommodate the settling of the wall, and was maintained throughout the test at a constant value. The load figure derived from the calculation of a one-and-a half story log house of the size of 10 by 10 m (measured from the wall axis to the wall axis on the opposite side). The reference log house was designed with heavy roofing laid on a heavy timber roof at an angle of 45°, placed in the average snow and wind area of the Czech Republic. It was not estimated as to how many percent the 15 kN m^{-1} represents of the maximum designed load of such a wall.

Compression of the log wall was continuously measured on both ends of the log

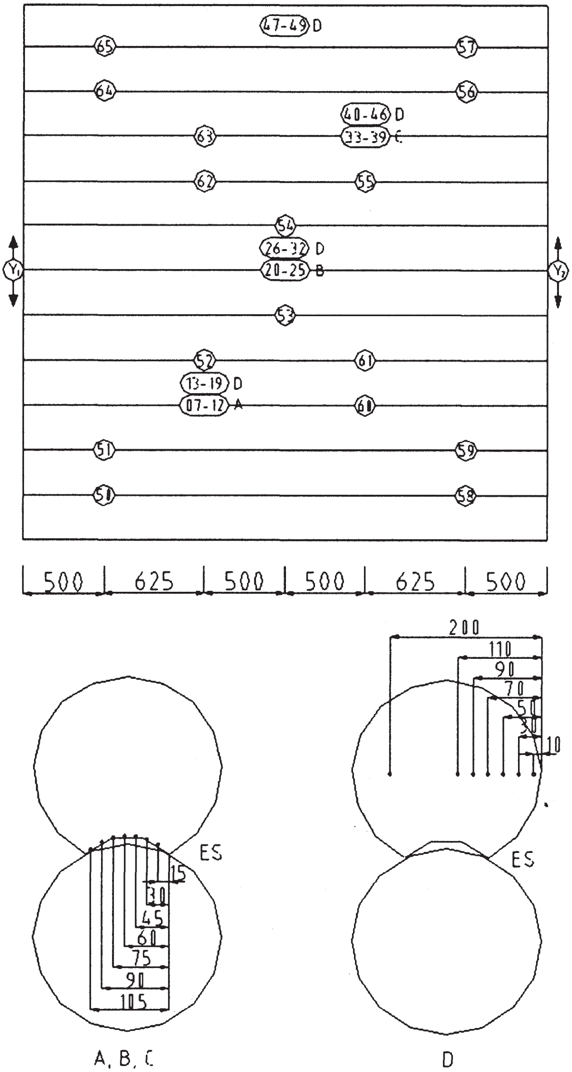

Figure 4. *Thermocouples' position. (Areas A, B, and C represent thermocouples inside the wall cavity and Area D represents thermocouples inside the log. Y1 and Y2 show where the wall compression was measured. ES is the fire exposed side.)*

wall sample (see Figure 4) using the Huggenberger measuring device operated according to CSN 73 0855.

EXPERIMENTAL RESULTS AND DISCUSSION

According to ISO 834, three criteria for failure of fire resistance tests are applicable to structural walls. These are failure of

- integrity, causing ignition of a cotton pad, permitting the penetration of a gap gauge, or penetration of flames resulting in sustained flaming,
- insulation, causing an increase of the average temperature above the initial average temperature by more than 140 K or an increase above the initial temperature at any location by more than 180 K,
- load-bearing capacity by reaching the limiting axial contraction of $C = h/100$ (mm) and exceeding the limiting rate of axial contraction $dC/dt = 3h/1000$ (mm min^{-1}) where C is contraction, t is time, and h is the initial height in mm.

A visual observation of the tested wall was conducted throughout the test. Inside the furnace, the wall surface turned black in the 3rd minute of the test. In the 5th minute, the surface ignited and continued to burn for the duration of the test. The surface was evenly charred with small and shallow cracks. The large deep cracks developed around the 11th minute. From about the 30th minute, the surface remained red charred with large deep cracks for the rest of the test procedure. It was observed that when the fire-exposed edge of the lateral groove burned off, the mineral insulation compressed inside the wall cavity protruded from the cavity and expanded to about its initial thickness of 50 mm (see Figure 5). No flame penetration through the wall was observed during the test. An unexposed side showed no visible changes; smoke penetration was not observed through any of the unexposed wall joint. After the test was terminated, the char development through the log wall could not be investigated. Due to the long test duration, the ceramic tiles inside the furnace became red hot, and if the wall were taken from the furnace, the ceramic furnace tiles could be damaged due to the thermal shock.

Figure 6 shows the temperature rise on the unexposed side at all measured locations of the log wall. Each measurement represents the reading from one thermocouple. The temperature rise of the unexposed surface was slow and uniform. After 180 min, the average temperature of 16 measurements over the weakest areas of the log wall (wall joints) reached 32°C from the initial 11°C, meaning that the average increase in temperature was 21°C. The maximum temperature increase was 37°C (the maximum unexposed surface temperature was 48°C).

Comparing the results of chink-less log wall joint with the chinked wall joint

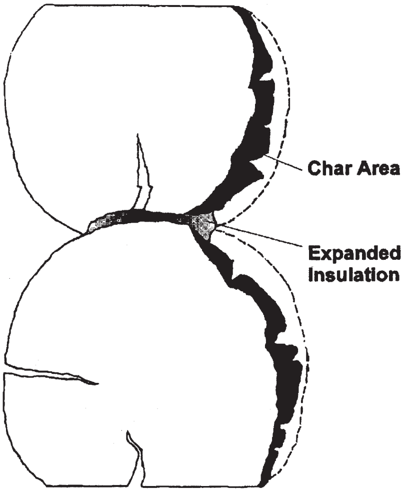

Figure 5. *Expansion of mineral insulation after the wall cavity edge burns off. (Mineral insulation filled the area of the cavity edge and created a protective shield against the heat penetration through the wall joint.)*

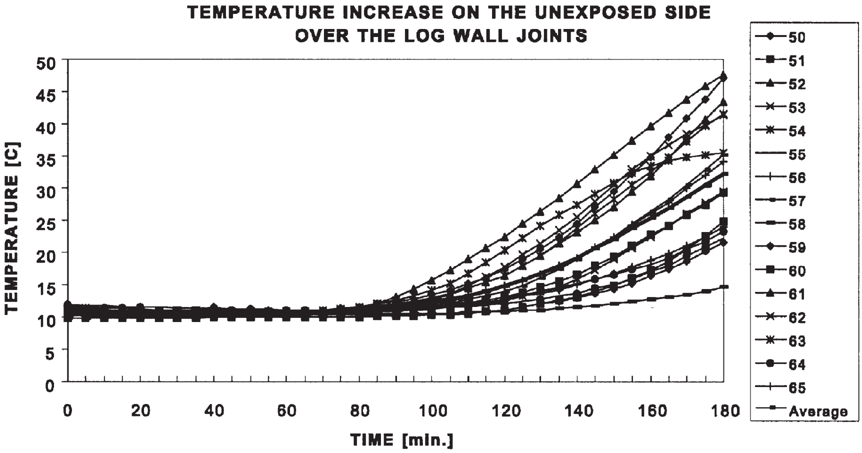

Figure 6. *Temperature development on the unexposed side of the wall. (Numerical sequence in the legend corresponds with Figure 4.)*

tested at Underwriters Laboratories Inc. by Sashco Sealants Inc., the chink-less log wall has a much higher insulation value. At 60 min of the test duration, the chink-less log wall showed absolutely no increase in surface temperature, compared to an average 71.16°C temperature increase of the chinked log wall tested by Sashco Sealants Inc. In the fire test conducted at VTT in Finland, using the wall made of rectangular lumber of 140 mm in thickness manufactured by Honkarakenne Oy, the cotton pad was ignited at 112 min. The width of the chink-less log wall joints varied only between 89 and 130 mm and the cotton pad was not ignited throughout the 180 min.

The joint width represents approximately 1/3 to 1/2 of the log diameter and consists of the mineral wool insulation, compressed in the wall cavity cut in the upper log. Therefore, the difference in the temperature development through the wall cavity and solid log was anticipated. Figure 7 shows the comparison of the temperature development inside the wall cavity and inside the solid log at a distance of 30 mm and 90 mm from the FES. The diagram shows average temperatures of three independent readings inside three different logs.

The curves for thermocouples at the initial distance of 30 mm from the FES at the 60th minute of the test duration show that the temperature inside the log started to rise faster than the temperature inside the wall cavity. It was represented by temperatures around 300°C, when charring occurs and exothermic reactions progress. In other words, the thermocouple inside the log was already close/inside the char zone. Obviously, the log was burning off, and the thermocouples inside the logs were becoming closer to the FES. On the

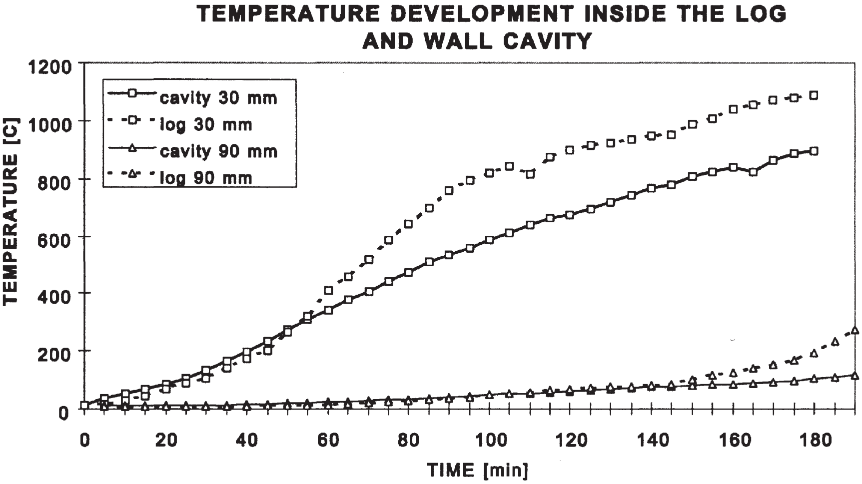

Figure 7. *Temperature increase inside the log and inside the wall cavity at the same initial distance from the exposed surface.*

other hand, thermocouples inside the wall cavity, embedded in the mineral insulation, remained at the same distance, and were protected by the expanded insulation, when the cavity edge burned away.

At a distance of 90 mm from the FES, the temperature inside the cavity rose faster to about the 100th minute when it reached approximately 50°C. Then the temperature inside the log started to increase faster than inside the wall cavity. It can be assumed that the decreasing distance of the thermocouples inside the log from the FES affected the temperature rise.

Average temperature readings inside the wall cavity calculated from three independent measurements are shown in Table 1.

Figures 8 and 9 show the average temperature increase inside the wall log based on three independent measurements. Temperatures inside the moist log were measured by only one thermocouple at each location.

As can be seen from the curves representing a distance of 10 mm from the FES inside the log with an initial MC of 18% and 36%, moisture plays a tremendous role in the temperature development. The temperature rise inside the moist log leveled off slightly above 100°C and remained almost unchanged for more than 25 min. Simultaneously, temperatures inside the log with 18% MC rose to 860°C, creating a temperature gradient of 754°C. Another slowdown in a temperature rise inside the moist log can be observed at 300°C. At the 85th minute, the temperature even drops about 26°C. It is assumed to be a contribution of char development and transfer of water vapor from the deep layers of wood.

A similar scenario can be observed at a distance of 30 mm from the FES. The temperature inside the moist log reached 310°C and then dropped to less than 200°C. Such could possibly be caused by escaping water vapor from the center layer of the wall log as deep cracks occur and the central zone dries out. The moisture distribution across the log diameter was not investigated before the test, but higher MC in the center part compared to the surface of the log can be expected. It might explain the greater decrease in the temperature at 30 mm from the FES.

In deeper layers of the log, at 70, 90, 110 and 200 mm from the FES, the temperature rises slowly and the effect of the log's drying can be observed around 100°C. The average temperature values inside the log are recorded in Table 2.

Figure 10 [8] shows the deformation at both ends of the log wall along with the average of the two readings. A load applied to the wall assembly exposed to fire always decreases the load-bearing capacity during the fire resistance test, and the same can be applied to the log walls. On the other hand, when thermal properties, air infiltration and water penetration properties of the log walls are investigated, the loaded walls show better results. The reason is that the load causes compression of the lateral groove edges, and creates tighter joints of adjacent logs.

The deformation during the first 10 min rose faster than in later stages. When the

Table 1. Average temperature inside the wall cavity.

Time (min)	Initial Distance from the Exposed Surface						
	105 mm	**90 mm**	**75 mm**	**60 mm**	**45 mm**	**30 mm**	**15 mm**
	Measuring Point						
	33	**7,20,34**	**8,21,35**	**9,22,36**	**10,23,37**	**11,24,38**	**12,25,39**
0	11	11	10	10	10	10	11
5	10	10	10	10	11	14	32
10	10	10	10	12	17	34	72
15	10	11	11	14	26	54	100
20	11	11	13	18	35	70	130
25	11	12	14	22	47	86	178
30	11	13	17	28	59	106	231
35	12	15	20	35	69	132	292
40	12	17	24	42	80	164	367
45	13	19	28	48	93	196	415
50	13	21	31	55	107	233	473
55	14	23	35	62	125	272	527
60	15	25	40	69	143	309	573
65	16	28	44	76	160	342	609
70	17	31	48	82	178	375	642
75	18	34	53	89	196	405	666
80	20	37	59	96	317	442	705
85	21	41	64	105	237	474	730
90	23	44	69	114	260	509	755
95	25	47	73	125	280	533	775

(continued)

Table 1. (continued).

	Initial Distance from the Exposed Surface						
	105 mm	90 mm	75 mm	60 mm	45 mm	30 mm	15 mm
	Measuring Point						
Time (min)	33	7,20,34	8,21,35	9,22,36	10,23,37	11,24,38	12,25,39
100	27	50	78	135	296	559	786
105	29	54	83	145	318	585	801
110	31	57	87	154	339	611	816
115	34	60	92	166	362	640	833
120	36	64	97	176	382	660	836
125	39	68	101	190	396	674	848
130	42	72	106	202	416	695	858
135	45	75	112	216	441	717	871
140	48	78	117	232	467	742	887
145	51	81	124	248	492	768	899
150	54	83	131	264	512	779	899
155	57	86	139	280	536	806	924
160	60	88	147	296	565	824	935
165	63	93	157	316	595	837	956
170	66	98	168	342	621	822	972
175	68	104	181	366	650	863	993
180	70	110	193	391	679	886	999
185	72	116	206	412	702	896	1003
190	74	124	222	438	733	922	1009
195	75	130	235	459	753	932	1012
200	77	139	254	491	778	960	1018
205	79	149	275	516	782	975	1015
210	81	157	286	524	787	982	1012

Displayed values were calculated from three independent measurements. Temperature readings at a distance of 105 mm derive from only one measurement.

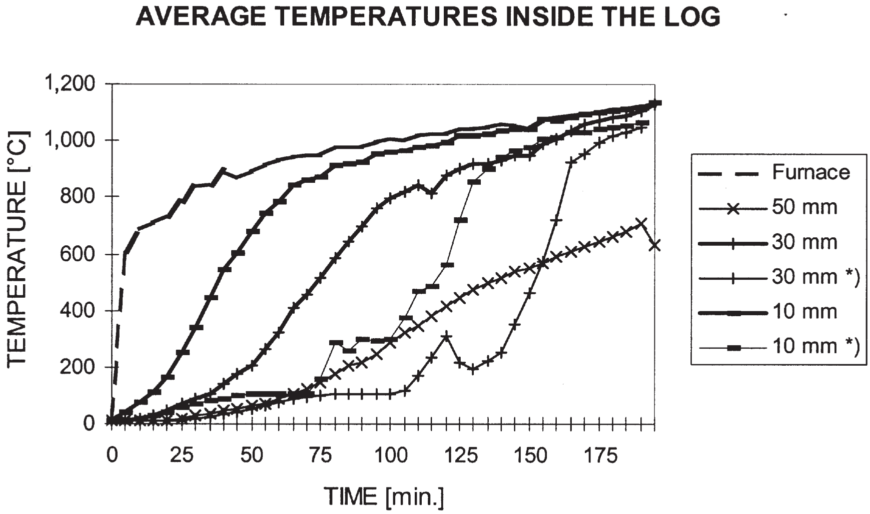

*Figure 8. Temperature development inside the wall logs. (Note the temperature gradient between the log with 18% and 36% of moisture content.) *) Temperature inside the log with moisture content of 36%.*

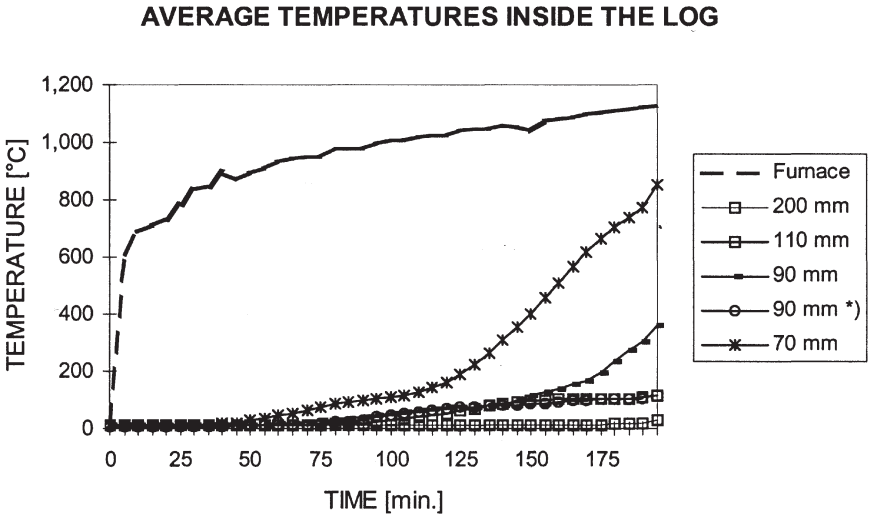

*Figure 9. Temperature development inside the wall logs. (Note the temperature gradient between the log with 18% and 36% of moisture content.) *) Temperature inside the log with moisture content of 36%.*

Table 2. Average temperature inside the wall logs.

	Initial Distance of the Thermocouple from the Fire Exposed Surface									
	200 mm	**110 mm**	**90 mm**		**70 mm**	**50 mm**	**30 mm**		**10 mm**	
	Measuring Point									
Time (min)	**13,26,40 ***	**14,27,41 ***	**15,28,42 ***	**47 ****	**16,29,43 ***	**17,30,44 ***	**18,31,45 ***	**48 ****	**19,32,46 ***	**49 ****
0	11	10	10	9	10	10	10	9	11	10
5	11	10	10	9	10	10	10	9	43	11
10	11	10	10	9	10	10	16	9	75	16
15	11	10	10	9	11	11	30	9	108	28
20	11	10	10	9	14	14	45	11	166	43
25	11	10	10	9	18	18	69	14	249	58
30	11	10	10	9	27	27	89	20	338	70
35	11	10	10	9	36	36	105	26	446	80
40	11	10	10	9	45	45	141	34	547	90
45	11	10	11	9	54	54	174	42	605	102
50	11	10	12	9	62	62	202	52	680	105
55	10	10	13	9	72	72	266	65	743	105
60	10	10	16	9	87	87	322	78	787	105
65	10	11	19	10	103	103	410	87	841	106
70	10	12	22	13	125	125	459	94	860	106
75	10	13	26	17	148	148	516	100	874	158
80	10	15	31	21	177	177	586	103	911	285
85	10	17	36	26	204	204	643	104	921	259
90	10	19	42	30	219	219	699	104	925	297
95	10	23	48	38	246	246	759	106	954	295

(continued)

Table 2. (continued).

	Initial Distance of the Thermocouple from the Fire Exposed Surface									
	200 mm	**110 mm**	**90 mm**		**70 mm**	**50 mm**	**30 mm**		**10 mm**	
	Measuring Point									
Time (min)	**13,26,40 ***	**14,27,41 ***	**15,28,42 ***	**47 ****	**16,29,43 ***	**17,30,44 ***	**18,31,45 ***	**48 ****	**19,32,46 ***	**49 ****
100	10	27	53	47	286	286	795	106	962	297
105	10	32	58	54	322	322	820	115	968	376
110	11	39	64	59	347	347	841	169	979	465
115	11	46	68	64	380	380	815	235	986	488
120	11	54	72	69	416	416	876	310	996	560
125	11	62	74	74	445	445	901	215	1016	722
130	11	70	77	76	475	475	917	193	1019	852
135	11	77	79	78	499	499	922	223	1023	903
140	11	84	83	79	516	516	933	253	1038	940
145	11	90	100	81	537	537	946	349	1042	965
150	11	95	115	84	548	548	950	462	1039	975
155	12	99	126	87	567	567	988	571	1076	1004
160	12	101	139	91	590	590	1008	717	1073	1012
165	12	103	152	95	611	611	1038	924	1083	1029
170	13	104	167	98	627	627	1057	957	1094	1032
175	14	104	194	100	643	643	1070	994	1100	1043
180	15	105	234	102	661	661	1080	1016	1108	1050
185	16	105	273	103	679	679	1089	1032	1112	1056
190	19	107	304	104	706	706	1104	1046	1121	1063

*Average value of three temperature readings.
**Temperature reading inside the log with 36% moisture content.
Displayed values were calculated from three independent measurements. Temperature inside the moist log derives from only one temperature reading.

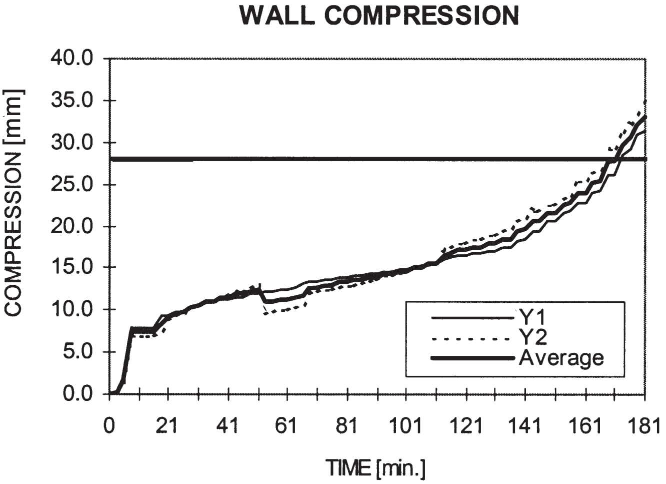

Figure 10. *Compression of the chink-less log wall measured at both ends of the log wall. (The solid line at 28 mm shows the limiting compression according to ISO 834.)*

wood is heated, it becomes more plastic, resulting in a higher rate of its compression. The lateral groove edge is very thin compared to the log diameter. Therefore, it heated quickly, and caused the faster compression at the beginning of the test, but without exceeding the limiting rate of axial contraction prescribed by ISO 834. The limiting axial compression according to the equation $C = h/100$ was 28 mm (the initial height of the log wall was 2800 mm), and this limit was reached at the 172nd minute of the test duration. Compression of the log wall during the fire test is displayed in Table 3.

In the case of a log wall, the shrinkage of the wall logs due to the moisture content changes contributes to the resulting amount of the compression. When the moist logs are used for the test sample, it can discredit the wall load-bearing capacity during the fire resistance test. For instance, when the load-bearing light wood frame wall is subjected to fire, there is no contribution of the wall studs' shrinking on the amount of the walls' resulting compression, because shrinkage of wood lengthwise is negligible. In the case of the log wall, the shrinking of wood (the difference between the moist wood and wood with a moisture content of 0%) in the radial direction (perpendicularly to the wood grain) can reach up to 6% depending on the wood species. The shrinkage, a natural feature of wood, itself does not decrease the load-bearing capacity.

All professionally manufactured log buildings are fully engineered to account for shrinking and settling. On the other hand, no fire standard counts with this woods' natural property (shrinking due to moisture content changes), when the load-bearing capacity during the fire test of log walls is evaluated.

Table 3. Compression of the log wall.

Time (min)	Compression [mm]			Time (min)	Compression [mm]		
	Y1	Y2	Average		Y1	Y2	Average
0	0.0	0.0	0.0	95	14.6	14.1	14.4
5	0.1	0.6	0.4	96	14.6	14.1	14.4
6	1.8	1.4	1.6	100	14.8	14.4	14.6
10	8.0	7.0	7.5	101	14.8	14.6	14.7
11	7.9	7.0	7.5	105	15.1	15.0	15.1
15	7.9	7.0	7.5	106	15.4	15.0	15.2
16	8.0	7.0	7.5	110	15.4	15.5	15.5
20	9.3	7.4	8.4	111	15.5	15.6	15.8
21	9.4	8.9	9.2	115	16.0	17.0	16.5
25	9.8	9.4	9.6	116	16.3	17.4	16.9
26	9.9	9.6	9.8	120	16.5	18.0	17.3
30	10.4	10.4	10.4	121	16.6	18.0	17.3
31	10.5	10.5	10.5	125	16.8	18.4	17.6
35	10.9	11.0	11.0	126	16.8	18.4	17.6
36	10.9	11.1	11.0	130	17.0	18.9	18.0
40	11.3	11.7	11.5	131	17.1	19.0	18.1
41	11.3	11.8	11.8	135	17.4	19.4	18.4
45	11.5	12.5	12.0	136	17.5	19.6	18.6
46	11.6	12.3	12.0	140	18.1	20.6	19.4
50	11.9	12.7	12.3	141	18.5	20.8	19.7
51	12.0	12.9	12.5	145	19.3	21.7	20.5
55	12.2	9.7	11.0	146	19.5	21.9	20.7
56	12.2	9.8	11.0	150	20.6	22.5	21.6
60	12.4	10.0	11.2	151	20.6	22.6	21.6
61	12.5	10.0	11.3	155	21.6	23.2	22.4
65	12.6	10.4	11.5	156	21.9	23.4	22.7
66	13.1	10.5	11.8	160	22.7	25.3	24.0
70	13.4	12.0	12.7	161	22.7	25.3	24.0
71	13.5	12.1	12.8	165	24.0	26.4	25.2
75	13.6	12.4	13.0	166	24.3	26.7	25.5
76	13.7	12.4	13.1	170	26.2	29.2	27.7
80	13.9	12.7	13.3	171	26.2	29.2	27.7
81	14.0	12.9	13.5	175	28.4	31.2	29.8
85	14.1	13.0	13.6	176	29.3	32.0	30.7
86	14.2	13.2	13.7	180	31.0	33.4	32.2
90	14.4	13.5	14.0	181	31.4	34.9	33.2
91	14.4	13.6	14.0	Yi—Compression at i			

CONCLUSIONS

Knowing how log walls react to fire exposure is important for evaluating newly constructed buildings and existing log structures. A large-scale laboratory test showed that a massive wooden wall with a considerable number of lateral wood to wood joints can maintain the fire safety requirements prescribed by ISO 834 for as long as 172 min. The log wall withstood 180 min from its integrity and insulation viewpoint, and 172 min from the point of its load-bearing capacity. It must be noted, however, that only one large-scale test of the chink-less log wall was performed. When the results are compared to the chinked log wall tested by Sashco Sealants Inc., and a log wall made of the rectangular timber manufactured by Honkarakenne Oy, the hand-crafted chink-less log wall shows the best integrity, insulation and load-bearing capacity. Employing the traditional log style in residential and commercial construction offers an advantage of prefabrication of log home kits, and its other properties provide significant fire resistance.

Modeling of the fire resistance of log walls is to be continued based on the data obtained from the large-scale experiments discussed in this paper.

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