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FULL SCALE EXTERIOR WALL TEST ON THE SAGIWALL PVD BOARD

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FULL SCALE EXTERIOR WALL TEST ON
THE SAGIWALL PVC BOARD

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INTRODUCTION

This report describes a full-scale exterior wall fire test conducted on April 30, 2015 on the SAGIWALL PVC BOARD. The test was conducted in accordance with CAN/ULC-S134-13, Standard Method of Fire Test of Exterior Wall Assemblies.

TEST FACILITY

The test was conducted using the exterior wall fire test facility (see Figures 1 and 2) located in the Burn Hall of the NRC Fire Safety Laboratory, Mississippi Mills, Ontario.

The burn room portion of the apparatus consisted of a reinforced concrete floor, concrete block walls and a precast concrete panel ceiling. The walls and ceiling were covered on the room side with 25 mm thick ceramic fiber insulation. The floor was covered with 57 mm thick fired clay paving stones. The inside dimensions of the burn room were 5.95 m wide, 4.4 m deep and 2.75 m high.

The fuel source in the burn room consisted of four 3.8 m long linear propane burners spaced equally along the width of the room and mounted 0.6 m above the surface of the paving stones (see Figure 3).

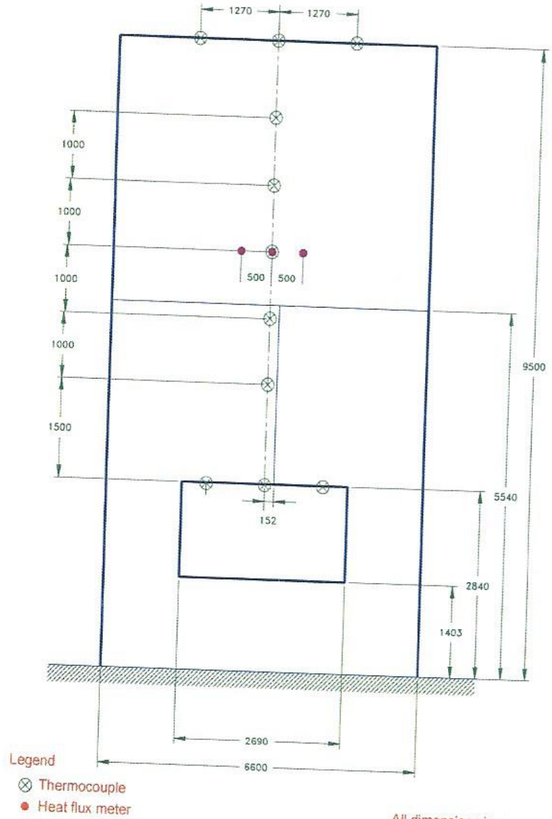


Figure 1. Test Facility (front view).

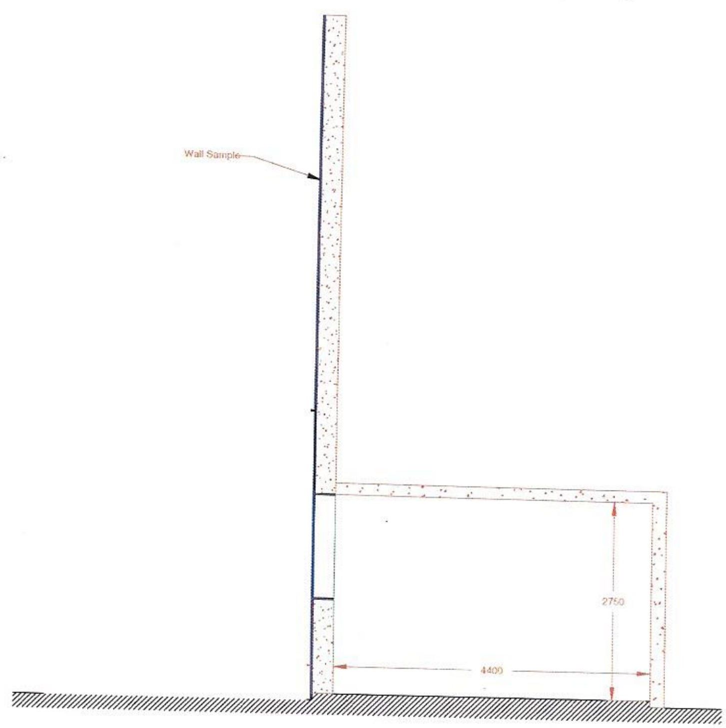


Figure 2. Test Facility (side view).

Figure 3. Propane Burners and Room Thermocouples.

DESCRIPTION OF SPECIMEN

Sagiwall is described by the manufacturer as a heavy gauge corrugated PVC tongue and groove plank used specifically for exterior siding. The planks tongue ends are predrilled for easy fastening points. All accessories are made of aluminum and are a two-piece clip system, consisting of a base and a finishing cap that snaps onto it.

Galvanized 38 mm Z type bars were fastened vertically to the structure using concrete anchors at 400 mm centers. As shown in Figure 4, the Z-bars spanned the entire height of the wall with no interruption (except for the window) allowing a 35 mm air barrier between the drywall and the test samples. Extruded aluminum channels were installed vertically at the outer edges of the assembly and at the centerline. The Sagiwall planks were mounted horizontally and fastened using self-tapping screws. The planks interlocked by using an integrated tongue and groove system. Aluminum trim caps were applied to all the edges of the assembly and in the center where the planks joined at the vertical joint. The only vertical joint of the assembly spanned the entire wall height on the centerline. The assembly incorporated four horizontal joints between 2.4 and 3.0 m.

The full test specimen was 10 m high and 6.1 m wide, with a window opening 2.51 m wide and 1.42 m high (see Figure 5). The edges of the wall assembly at the window opening were covered with galvanized steel flashing followed by a layer of 25 mm thick ceramic fiber insulation.

Figure 4. Wall System Under Construction.

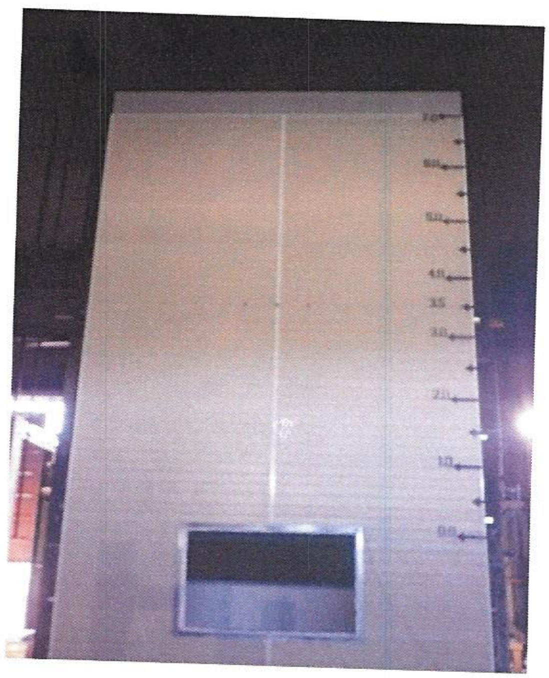


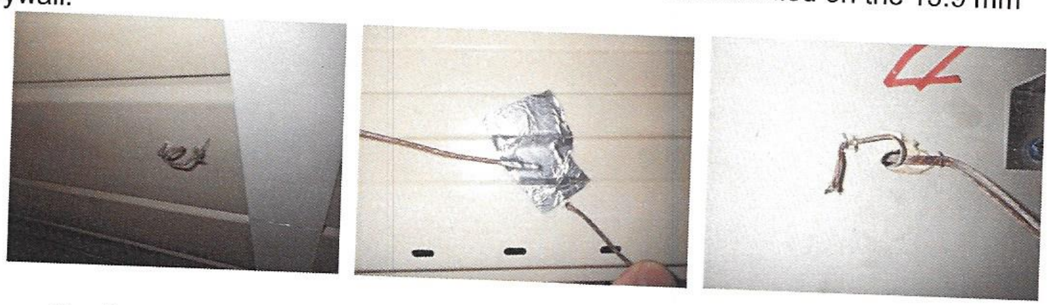
Figure 5. Wall System Layout Front View.

INSTRUMENTATION

Room Temperatures – The burn room air temperature was monitored by six Type K thermocouples, enclosed in 6 mm outside diameter Inconel sheaths. The thermocouples were introduced through the side walls with the measuring tips 0.6 m from the inner surface of the wall. All room thermocouples were located on the vertical centerlines of the side walls (see Figure 3).

Window Temperatures – The temperature of the flames emerging from the window was measured with three Type K, bare-beaded thermocouples installed 0.15 m below the top of the window opening, on the vertical centerline of the opening and 0.4 m from the sides of the opening (see Figure 1).

Wall Temperatures – The wall temperatures were monitored using Type K bare-beaded thermocouples on the vertical centerline of the wall. They were located five levels above the top of the window at 1.0 m intervals, starting at 1.5 m above the window opening (see Figures 1 and 6). Three thermocouples were used at each level, one was tension mounted on the exterior surface of the wall samples, the second was held on the back of the sample using aluminum tape and the third was installed on the 15.9 mm drywall.



Tension mounted TC **Back of the sample** **On 15.9 mm drywall**

Figure 6. Wall Thermocouple Installation.

The temperature at the top of the test assembly was monitored by three Type K bare-beaded thermocouples located 0.1 m out from the exterior surface of the wall, one on the centerline of the wall, and the other two at a distance of 1.3 m from both edges of the wall (see Figure 1).

Heat Flow – The total heat flux density to the wall above the window was monitored by three water-cooled heat flux transducers (Medtherm Corp. Series 64) installed in the test wall, 3.5 m above the top of the window, one on the centerline of the wall and one on each side, 0.5 m from the centerline (see Figures 1 and 7).

Figure 7. Heat-Flux transducers.

Propane – The propane gas flow rate to the burners was monitored with a mass flow meter.

Visual Records – Video records of the front and side views were made during the test and digital photos were taken before, during and after the test.

Data Acquisition – All thermocouples, as well as the heat flux transducers, were connected to a data acquisition system and readings were recorded at 5 s intervals.

ATMOSPHERIC CONDITIONS

At the time of the test, the ambient temperature in the Burn Hall was 17.0°C and the relative humidity was 43%.

TEST PROCEDURE

The test procedure was in accordance with CAN/ULC-S134-13, Standard Method of Fire Test of Exterior Wall Assemblies. The pilot burners were lit prior to the commencement of the test. Gas flow to the burners was manually adjusted to follow the prescribed heat input required by the standard.

VISUAL OBSERVATIONS

(min:sec)
00:00 Ignition
04:07 Flames are exiting the room, reaching 1.0 m
05:00 Steady state gas flow begins
05:10 Planks beginning to char
06:28 Flare up reaching 3.0 m
06:59 Flare up has receded below 1.0 m, plume is reaching 2.5 m
07:46 Debris is falling from above the window, south of center
08:20 More debris falling
09:25 Planks are melting/sagging near 2.0 m
09:49 More debris falling
10:37 The melting extends to at least 4.0 m
14:37 The melting is observable up to 5.0 m
15:45 Flames are reaching 2.5 m, small fire above the window
20:00 Decreasing gas flow begins
21:35 The planks have melted away from the center up to the top of the wall
22:14 Small fire above the window
24:00 No flames present on the wall
25:00 End of gas flow
60:00 End of test

RESULTS

Room Temperatures – Figure 8 shows the average gas temperature in the burn room (average of six thermocouples).

Window Temperatures – Figure 8 shows the average temperature of the fire gases emerging from the window.

Wall Temperatures – The temperatures recorded on the outer surface of the test assembly are shown in Figure 9. A maximum temperature of 653°C was recorded at 1.5 m above the window opening. The maximum temperatures at 2.5 m, 3.5 m, 4.5 m and 5.5 m above the window opening were 584°C, 489°C, 371°C and 323°C, respectively.

The temperatures recorded by the thermocouples installed behind the exposed layer are shown in Figure 10. The maximum temperatures at 1.5 m, 2.5 m, 3.5 m, 4.5 m and 5.5 m above the window opening were 640°C, 537°C, 480°C, 326°C and 326°C, respectively.

Temperatures recorded by the thermocouples fastened to the 15.9 mm drywall are shown in Figure 11. A maximum temperature of 594°C was recorded at 1.5 m above the window opening. The maximum temperatures at 2.5 m, 3.5 m, 4.5 m and 5.5 m above the window opening were 512°C, 425°C, 372°C and 233°C, respectively.

The temperatures measured at the top of the wall are shown in Figure 12. The temperatures at the top of the wall reached a maximum of 232°C.

Heat Flux – The total heat flux density to the wall, as measured 3.5 m above the top of the window, is shown in Figure 13. The data shown in this figure has been smoothed using the procedure of a running average over one minute.

The maximum one-minute averaged values recorded at the 3 locations: the center, the south, and the north were 27.9 kW/m^2, 19.5 kW/m^2 and 27.1 kW/m^2, respectively.

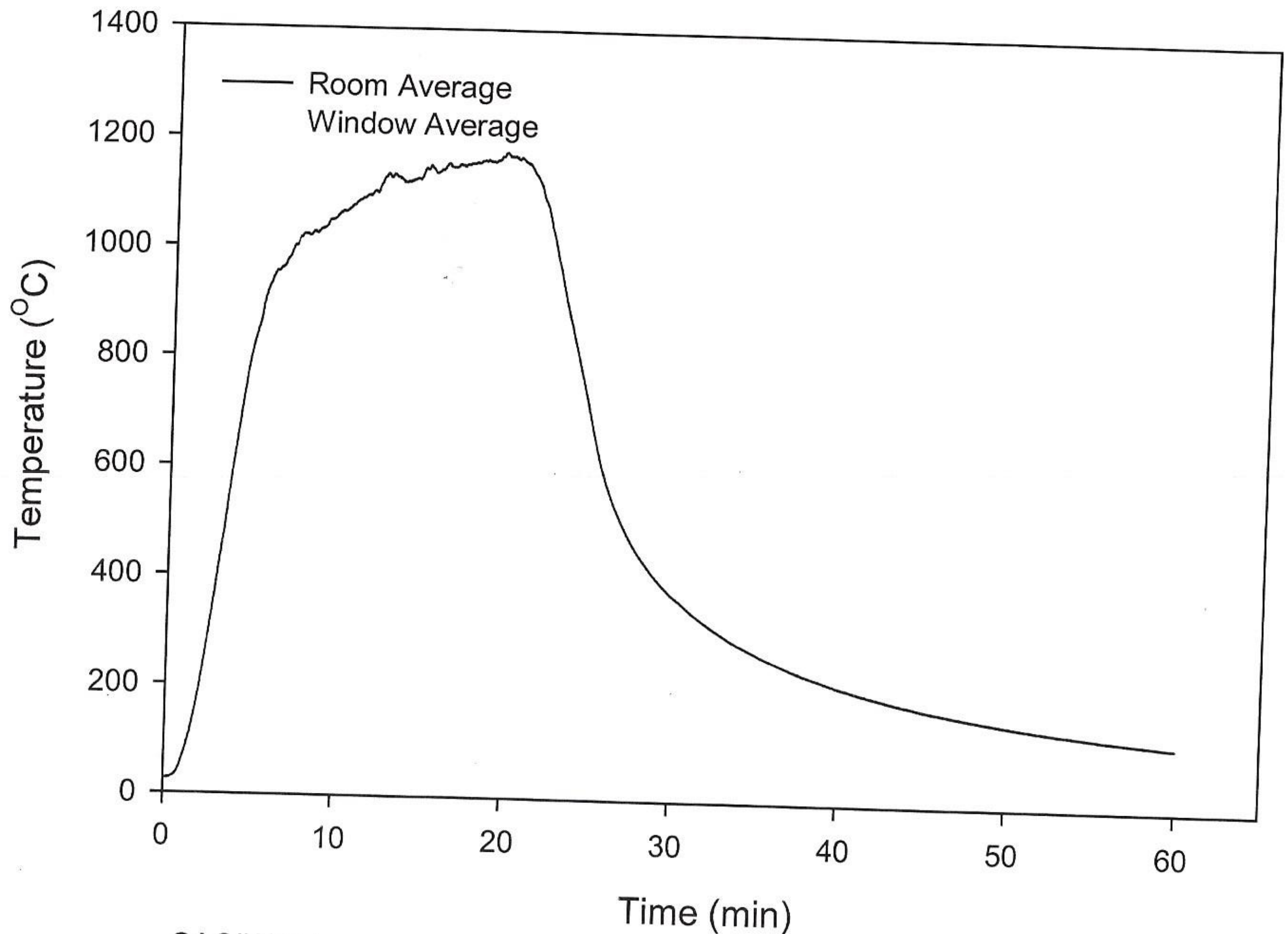


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Figure 8. Average Room and Window Temperatures.

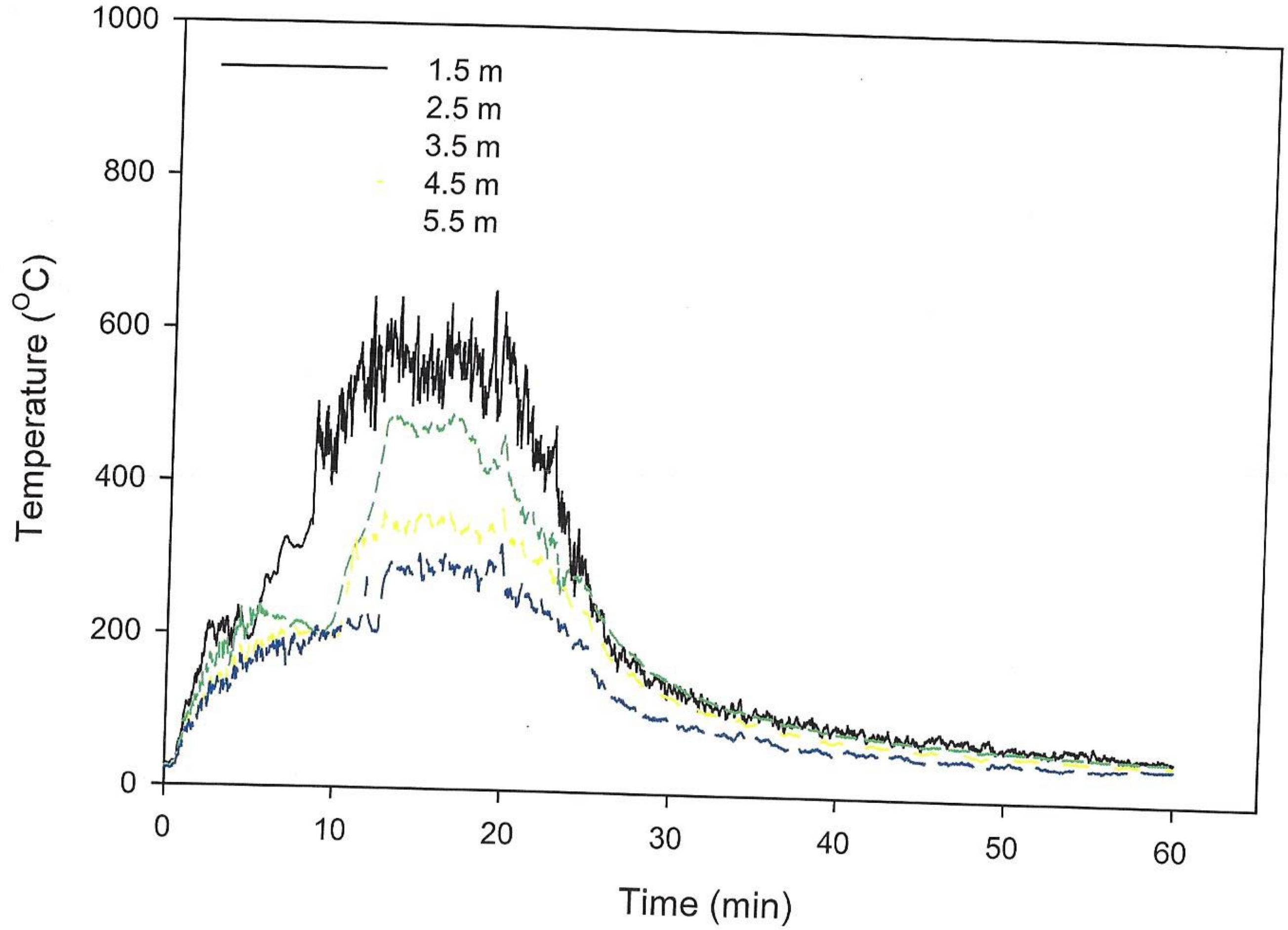

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Figure 9. Temperatures on the Surface of the Wall Panels.

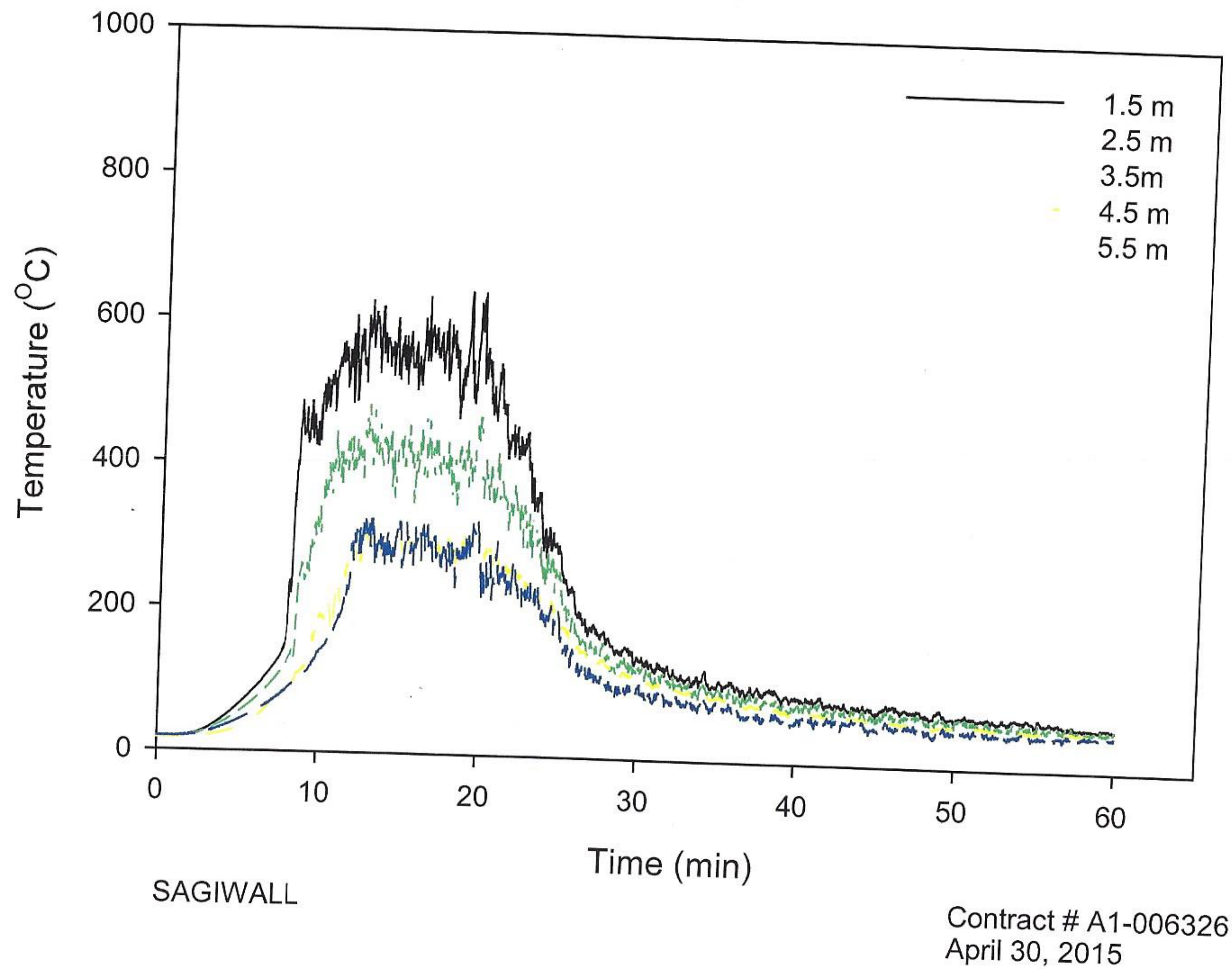

Figure 10. Temperatures behind the exposed panels.

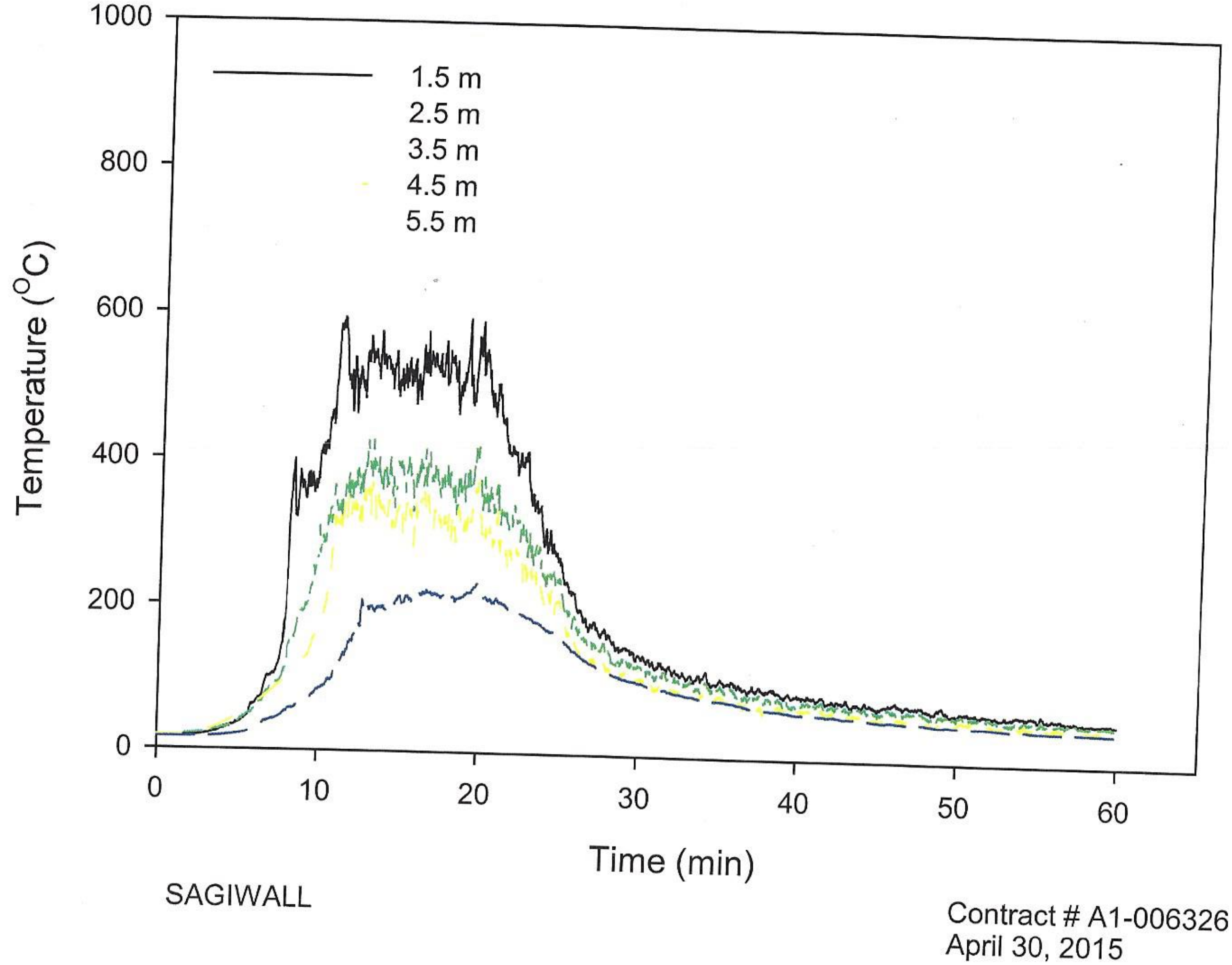

Figure 11. Temperatures on the 15.9 mm drywall.

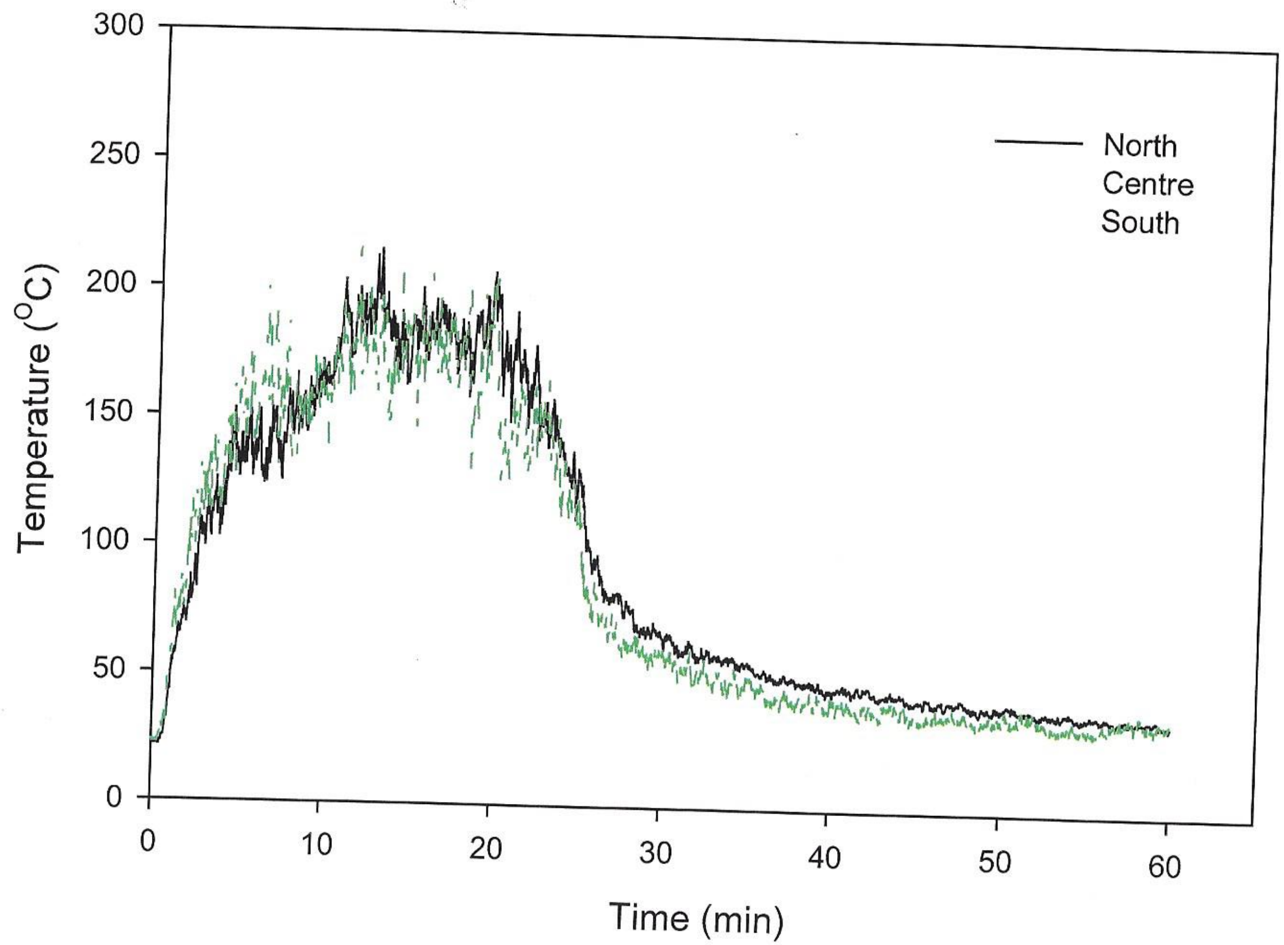

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Figure 12. Temperatures at the Top of the Wall.

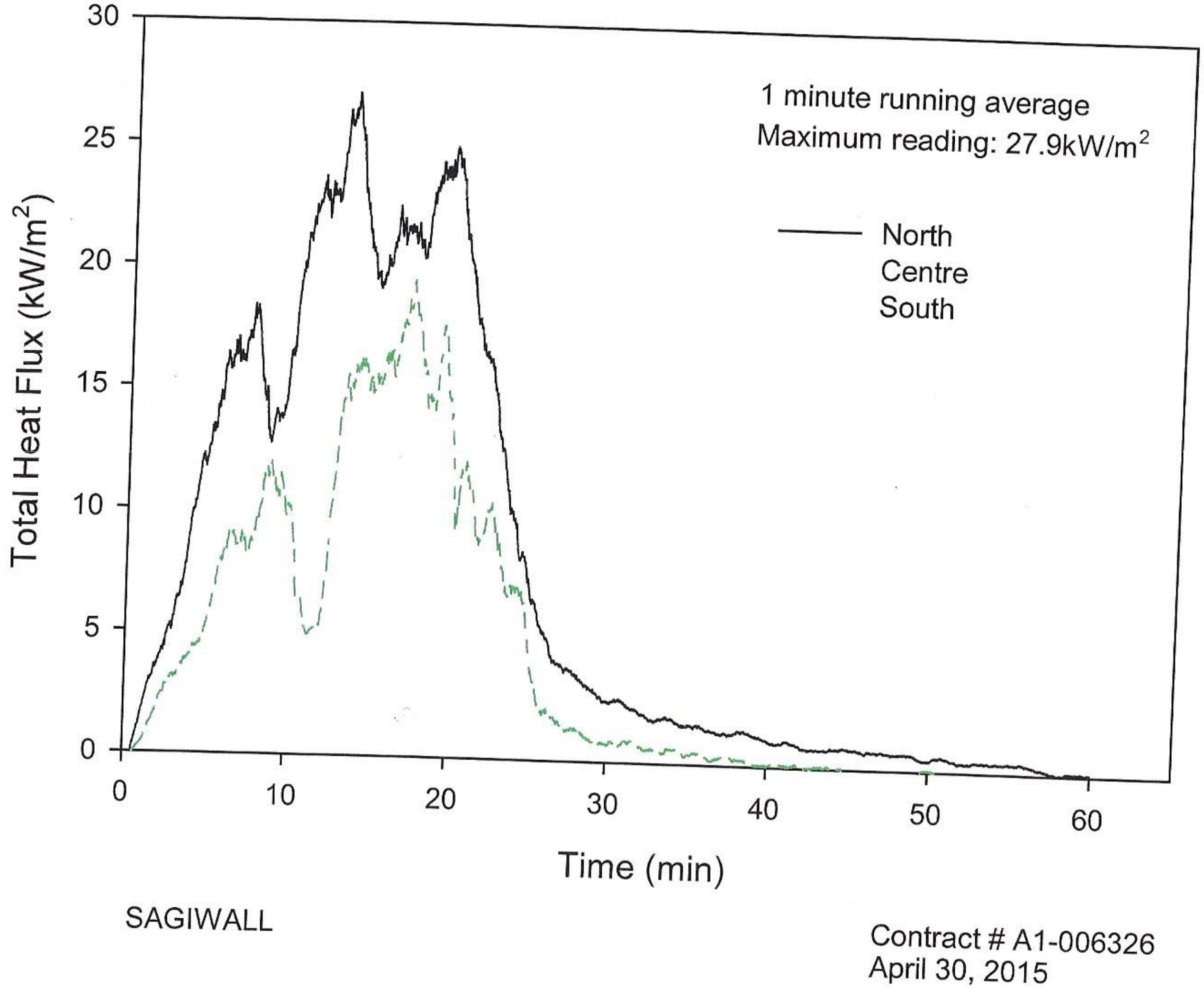


Figure 13. Heat Flux on the Wall.

PERFORMANCE OF THE WALL ASSEMBLY

A) Flame Spread over Exterior Face

The Sagiwall planks started to char at five minutes from ignition. After a brief flare-up at 6:28, the fire remained stable and burned in a typical manner. Debris fell to the floor until the planks immediately above the window were completely consumed. The planks that were not consumed by the flames ended up melting away from the heat source and drooping down (see Figure 14).

Figure 14. Melted and charred Sagiwall Planks.

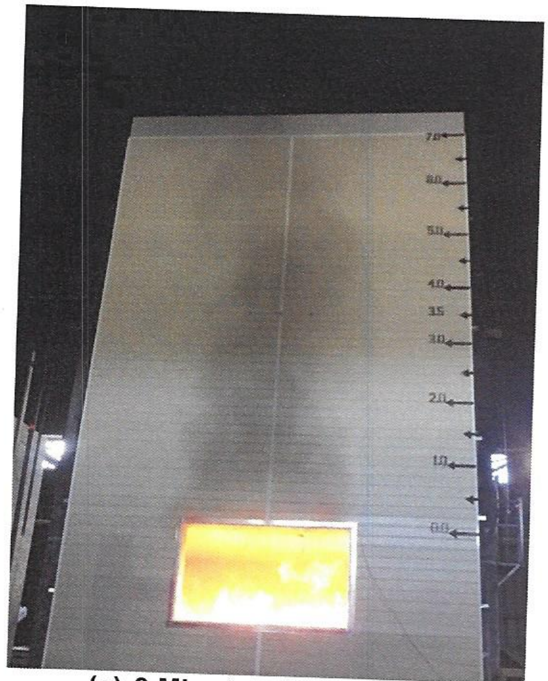
B) Incremental Radiant Heat Flow to the Wall above the Window Opening

The maximum one-minute averaged value of the total heat flux density on the test wall, at 3.5 m above the top of the window, was 27.9 kW/m^2 compared to 16 kW/m^2 for a non-combustible wall (Marinite). This is less than the 35 kW/m^2 specified in Sentence 3.1.5.5.(4) of the National Building Code of Canada (2010 Edition).

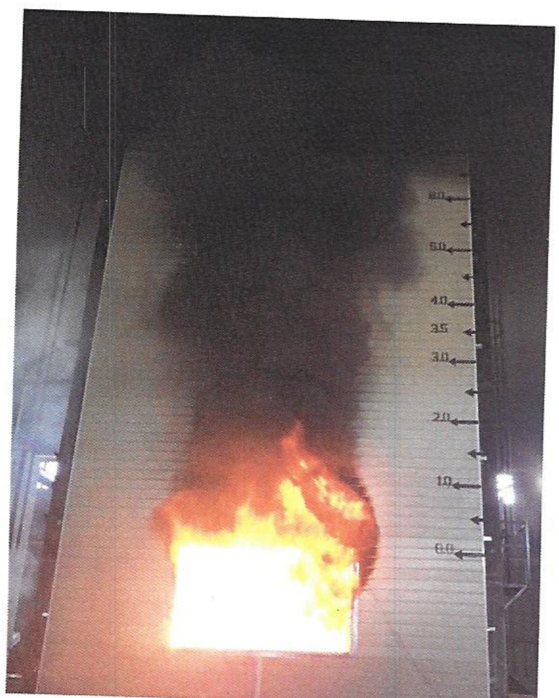
C) Damage to the Wall Assembly

Figure 15 shows the wall assembly during the fire exposure.

Figure 16 shows the extent of the damage to the wall sample after the test.



(a) 3 Minutes after Ignition



(b) 10 Minutes after Ignition

Figure 15. Wall Sample during the Fire Exposure.

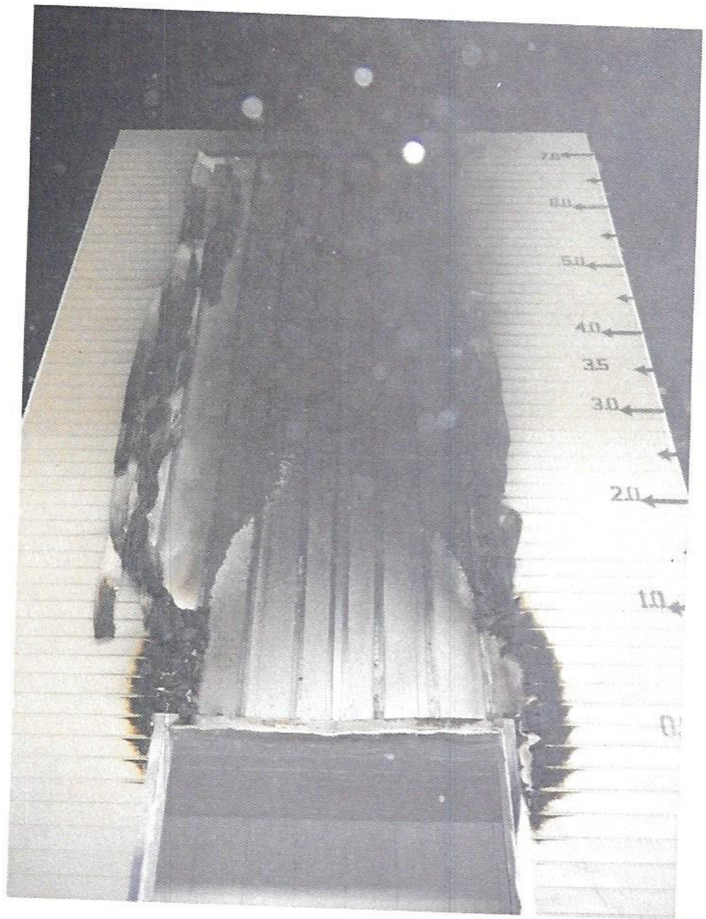


Figure 16. Wall Sample after Fire Exposure.

REMARKS

1. The test facility and test method, as described in this report, conform to the requirements of Article 3.1.5.5 of the 2010 edition of the National Building Code of Canada. The test was conducted in accordance with CAN/ULC S134-13, Standard Method of Fire Test of Exterior Wall Assemblies.
2. The damage on the specimen extended to the top of the wall assembly (7 meters above the window).
3. During the fire exposure, there were flames up to the 3.0 m mark. This is less than the 5 m limit for flame spread distance specified in Sentence 3.1.5.5.(3) and defined in Appendix A (A-3.1.5.5.(3)) of the 2010 edition of the National Building Code of Canada.
4. The maximum one-minute averaged value of the total heat flux density on the test wall, at 3.5 m above the top of the opening during the fire exposure, was 27.9 kW/m^2. This is less than the 35 kW/m^2 specified in Sentence 3.1.5.5.(4) of the 2010 edition of the National Building Code of Canada.

REFERENCE

1. CAN/ULC S134-13, Standard Method of Fire Test of Exterior Wall Assemblies, Underwriters' Laboratories of Canada, Scarborough, ON, 2013.
2. National Building Code of Canada, National Research Council Canada, Ottawa, ON, 2010.