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CERTIFICATION TESTING INSPECTION

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CLIENT: **GREENSTONE STRUCTURAL SOLUTIONS**
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Test Report No: T1090-2b	Report Date: November 30, 2016

SAMPLE ID: Greenstone Structural Solutions 191 mm (7.5 in.) 1.25 mm (18 Gauge) prefabricated steel stud panel with Type 1 Expanded Polystyrene (EPS), 13 mm (1/2 in.) Megrete magnesium oxide (MgO) board and standard 13 mm (1/2 in.) gypsum board.

SAMPLING DETAIL: Production of the panels was witnessed by Pam Sumner, P.Eng on September 22, 2016 at the Greenstone Structural Brandon, MB plant. The panels were marked and QAI Laboratories was provided with a sealed letter confirming that the steel frame and EPS insulation met the panel specifiaitons.

DATE OF RECEIPT: Production of the panels was witnessed by Pam Sumner, P.Eng on September 22, 2016 at the Greenstone Structural Solutions, Brandon, MB plant. The panels were marked by the noted Engineer, and QAI Laboratories was provided with a sealed letter confirming that the steel frame and EPS insulation met standard panel manufacturing specifications..

TESTING PERIOD: November 23, 2016.

TEST PROCEDURE: Testing to the following requirements:

- CAN/ULC S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials (CAN/ULC S101).
- ASTM E119-16a, Standard Methods for Fire Tests of Building Construction and Materials (ASTM E119).

TEST RESULTS: The Greenstone Structural Solutions prefabricated wall assembly with 1 layers of 13 mm (1/2 in.) Megrete MgO and 1 layer of 13 mm (1/2 in.) gypsum on the interior face, and 1 layer of 13 mm (1/2 in.) Megcrete MgO board on the exterior face, achieved a 55 kN/m (3,800 lbs/ft) load-bearing fire-resistance-rating of 1 hour when tested with interior face orientated to fire, classified in accordance with CAN/ULC S101 and ASTM E119.

Further details of the tested assembly can be found on subsequent pages of this report.

Prepared By

Scott Leduc, EIT
Project Manager

Signed for and on behalf of QAI Laboratories, Ltd.

Matt Lansdowne
Director of Engineering

Table of Contents

Introduction:

This report documents the fire testing conducted by QAI Laboratories Ltd. for Greenstone Structural Solutions of a 191 mm (7.5 in.) 1.25 mm (18 Gauge) prefabricated steel stud panel with Type 1 EPS, Megcrete 13 mm (1/2 in.) MgO board and 13 mm (1/2 in.) standard gypsum board. Testing was performed in accordance with CAN/ULC S101-14 and ASTM E119-16a.

The wall assembly was evaluated for a 1-hour load-bearing fire-resistance-rating with interior face of assembly facing fire on November 23, 2016.

Assembly Description:

Table 1: Wall Description

COMPONENT	DESCRIPTION	
Assembly	Size:	2.74 m (9 ft.) high by 3.66 m (12 ft.) wide by 241 mm (9-1/2 in.) thick
	Type:	Steel stud and EPS Prefabricated wall assembly with Megcrete 13 mm (1/2 in) MgO and 13 mm (1/2 in.) standard gypsum board.
Greenstone Panels	Type:	Prefabricated Wall Panels
	Wall Stud:	1.25 mm (18 Gauge) x 64 mm (2-1/2 in.) x 30 mm (1-3/16 in.) C-channel wall studs. The end studs at the joint have a 3 mm (1/8 in.) x 25 mm (1 in.) jog in the channel along the 64 mm (2-1/2 in.) dimension. There is one row of studs on each side of the panels spaced 406 mm (16 in.) on center (OC).
	Horizontal Bracing:	A 0.71 mm (22 Gauge) x 86 mm (3-3/8 in.) steel strapping spanned the panels on the interior of the stud framing on both sides of the panel. Horizontal strapping was located at 1.22 m (4 ft) and 2.44 m (8 ft) vertical heights on wall panels.
	Top Track:	The top track was replaced with a 1.65 mm (16 Gauge) x 89 mm (3-1/2 in.) x 32 mm (1-1/4 in.) J-shaped channel with a 13 mm (1/2 in.) return. Sides were fastened to the wall studs with #10 x 19 mm (3/4 in.) self-drilling pan head screws. Two screws were placed side by side at each wall stud and one screw at each joint stud.
	Bottom Track:	A 51 mm (2 in.) x 51 mm (2 in.) angle was placed over top of the bottom track on both sides of the wall and was fastened to each stud with one #10 x 19 mm (3/4 in.) self-drilling pan head screw.
	Connection Plates:	The panels were held together with 1.25 mm (18 Gauge) x 152 mm (6 in.) x 51 mm (2 in.) plates fastened using six #10 x 19 mm (3/4 in.) self-drilling pan head screws. The plates were placed every 610 mm (2 ft.) starting 152 mm (6 in.) from the bottom.
	Insulation:	Type1 EPS.

Table 1: Wall Description - *Continued*

Interior Sheathing Layer 1	Type:	Megcrete MgO Board
	Thickness:	13 mm (1/2 in.)
	Manufacturer:	Magnum Building Products (Underwriters Laboratories Listed and Labeled).
	Product Name:	Magnum Board
	Date Stamp:	October 29, 2016
	Orientation:	One Layer was applied horizontally with the vertical joints staggered.
	Fastener Detail:	The boards were fastened using #6 x 32 mm (1-1/4 in.) Type S drywall screws spaced 203 mm (8 in.) OC.
	Joint Treatment:	A bead of Multiflex sealant manufactured by Chemtron was placed on the edges of each board prior to placing the next board.
Interior Sheathing Layer 2	Type:	Standard ASTM C1396 compliant gypsum board
	Thickness:	13 mm (1/2 in.)
	Manufacturer:	Georgia Pacific
	Product Name:	N/A
	Fastener Detail:	The boards were mounted horizontally with #6 x 32 mm (1-1/4 in.) Type S drywall screws spaced 203 mm (8 in.) OC.
	Joint Treatment:	RediFiller all-purpose drywall compound and 51 mm (2 in.) fiberglass tape.
Exterior Sheathing	Type:	Megcrete MgO Board
	Thickness:	13 mm (1/2 in.)
	Manufacturer:	Magnum Building Products (Underwriters Laboratories Listed and Labeled).
	Product Name:	Magnum Board
	Date Stamp:	October 29, 2016
	Orientation:	One Layer was applied horizontally with the vertical joints staggered.
	Fastener Detail:	The boards were fastened using #6 x 32 mm (1-1/4 in.) Type S drywall screws spaced 203 mm (8 in.) OC.
	Joint Treatment:	A bead of Multiflex sealant manufactured by Chemtron was placed on the edges of each board prior to placing the next board.

Test Apparatus:

The furnace used in the tests had dimensions of 3.96 m (13 ft.) in height, 3.96 m (13 ft.) in width, and 0.91 m (3 ft.) in depth.

Temperatures within the furnace were monitored using nine thermocouples. The temperatures are controlled by adjusting fuel to the furnace burners to conform to the time/temperature curve specified by the test standards. Temperature measurements are recorded by a Keithley 2750 data acquisition unit (ID# DMM1) which passes the readings to a computer for graphical display and storage.

Unexposed wall surface temperatures were monitored by thermocouples (TCs) placed at nine locations. Five of these were symmetrically disposed, one to be at the center of the assembly, and four at the center of each quarter section. Detailed locations are shown in Figure 3 in Appendix A. The temperatures were recorded continuously for the duration of the test. The temperature rise data are provided graphically in Figure 4 in Appendix A.

The wall assembly was mounted vertically into a steel frame specimen holder with a movable lower beam. Vertical loading was applied to the lower beam using three hydraulic rams monitored using a verified pressure gauge.

Two pressure taps are installed along the longitudinal center line of the test assembly. The pressure taps are each attached and monitored by Setra model 264 pressure transducers (ID# Pressure T1 and Pressure T2). The furnace pressure is controlled by adjusting a damper in the furnace exhaust stack.

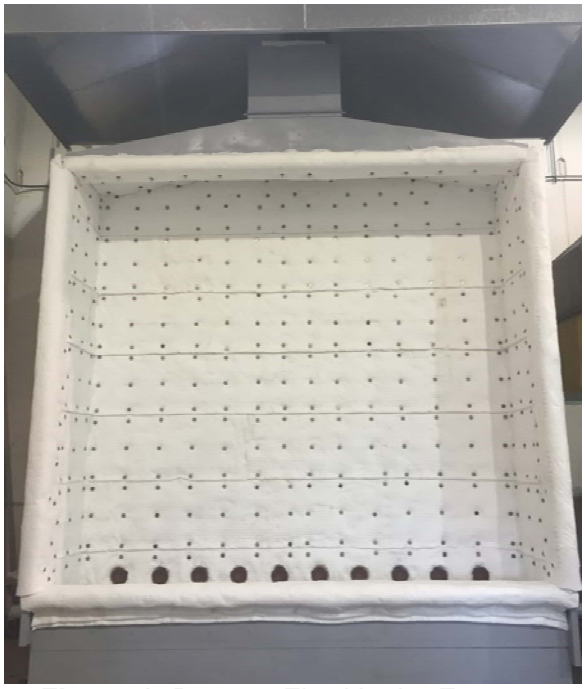


Figure 1: Burners Fired in the Furnace

Test Conditions:

The Greenstone Structural assembly was constructed in a full-scale moveable steel restraint frame. Side walls were constructed using wood stud and 3 layers of 16 mm (5/8 in.) Type X gypsum board. The wall was initially held in place with two screw jacks which clamped the wall into place between the lower and upper steel beams. The screw jacks were backed off once the load was applied by the hydraulic rams. The space between the test frame and the wall assembly was filled with ceramic fiber batt to prevent air movement between the frame and wall.

The vertical load that was applied to the wall assembly at client specified load of 55 kN/m (3,800 lbs/ft). The load was induced uniformly across a loading beam with three hydraulic rams. The load was applied in 25% increments prior to testing. The weight of the wall and loading beam were accounted for when calculating the applied force to achieve the correct load.

Prior to the fire endurance test the test assembly was moved into place, the load was applied and the pilot burners were ignited. The fire endurance test was initiated after igniting the burners. The temperature inside the furnace was controlled to follow the time/temperature curve within the limits described in the test standards.

After the fire endurance test, the assembly was subjected to the impact, erosion, and cooling effects of a hose stream as described in the test standard. The pressure and duration of the hose stream test were 205 kPa (30 psi) and 6.5 sec/m^2 (0.6 sec/ft^2).

Test Requirements

Per CAN/ULC S101 and ASTM E119, the following requirements were followed for testing:

1. No individual thermocouple cannot exceed 180°C above 11°C ambient for CAN/ULC S101, and 325°F above 52°F ambient for ASTM E119:
   $T_{Indivual} \leq 191°C$ CAN/ULC S101 or $T_{Indivual} \leq 377°F$ ASTM E119

2. The average of thermocouples cannot exceed 140°C above 11°C ambient for CAN/ULC S101 and 250°F above ambient 52°F for ASTM E119:
   $T_{AVE} \leq 151°C$ CAN/ULC S101 or $T_{AVE} \leq 302°F$ ASTM E119

3. The test specimen shall have sustained the applied load throughout the fire endurance test without passage of flame or passage of gases hot enough to ignite cotton pads.

4. The test specimen shall have sustained the applied load during the fire and hose stream tests without passage of flame, gases hot enough to ignite cotton pads and passage of the hose stream.

Test Results:

Observations

Table 3: Test Observations

Test Time (min)	Unexposed	Exposed
1:30		Ignition of the surface.
2:45		Surface flaming has self-extinguished.
8:00		The joint tape is beginning to fall off.
13:25		60% of the joint tape remains on the wall.
17:00		90% of the joint tape has fallen off.
22:00		Cracks have formed on the gypsum board.
30:00		More cracks have formed in the gypsum board. No board has fallen from the wall yet.
44:30	Light venting from the vertical MgO joints.	
46:30		Large curvature in the right side gypsum.
49:43		Light flaming at the cracks of the gypsum. Gypsum sections are peeling away from the wall.
57:00	Right side is bowing into the furnace.	
58:42		Heavier flaming at gypsum joints.
60:00	Test discontinued.	

Flaming and Penetration

No flaming occurred on the unexposed face of the test assemblies, and no through penetrations or openings were observed during the fire test.

Unexposed Temperature Rise

During the fire endurance test the average temperature measured by the unexposed thermocouples did not rise more than 140°C above its initial average temperature for CAN/ULC S101 or 250°F for ASTM E119; and none of the temperatures at any individual point exceeded 180°C above its initial temperature for CAN/ULC S101 or 325°F for ASTM E119.

Hose Stream Test

Immediately after the fire test, a hose stream test was conducted for 65 seconds. The wall assembly successfully met the conditions of acceptance for the hose stream test: no through openings were developed that would allow a projection of water from the stream beyond the unexposed face during the time of the hose stream test.

Conclusion

QAI performed testing in accordance with CAN/ULC S101-14 *Standard Methods of Fire Endurance Tests of Building Construction and Materials* and ASTM E119-14 *Standard Test Methods for Fire Tests of Building Construction and Materials* on a representative Greenstone Structural Solutions 191 mm (7.5 in.) 1.25 mm (18 Gauge) prefabricated steel stud panel with Type 1 Expanded Polystyrene (EPS), with 13 mm (1/2 inch) Megcrete MgO board with 13 mm (1/2 in.) gypsum board interior face, and 13 mm (1/2 in.) Megcrete MgO board exterior face.

The noted testing showed Greenstone Structural Solutions prefabricated wall assembly achieved a 55 kN/m (3,800 lbs/ft) load-bearing fire-resistance-rating of 1 hour when tested with interior face orientated to fire per CAN/ULC S101-14 and ASTM E119-16a.

APPENDIX A

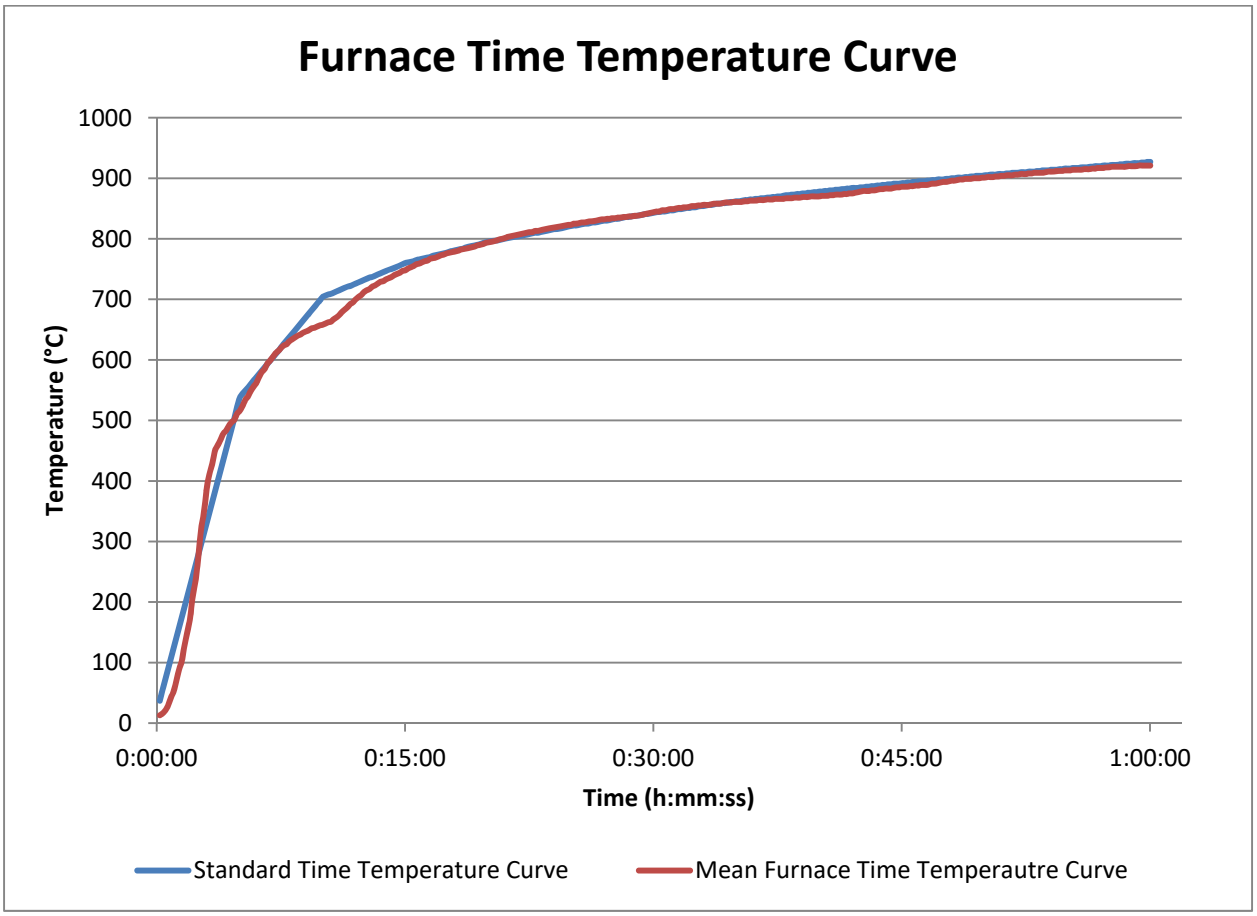


Figure 2: Time Temperature Curve

Thermocouple Locations

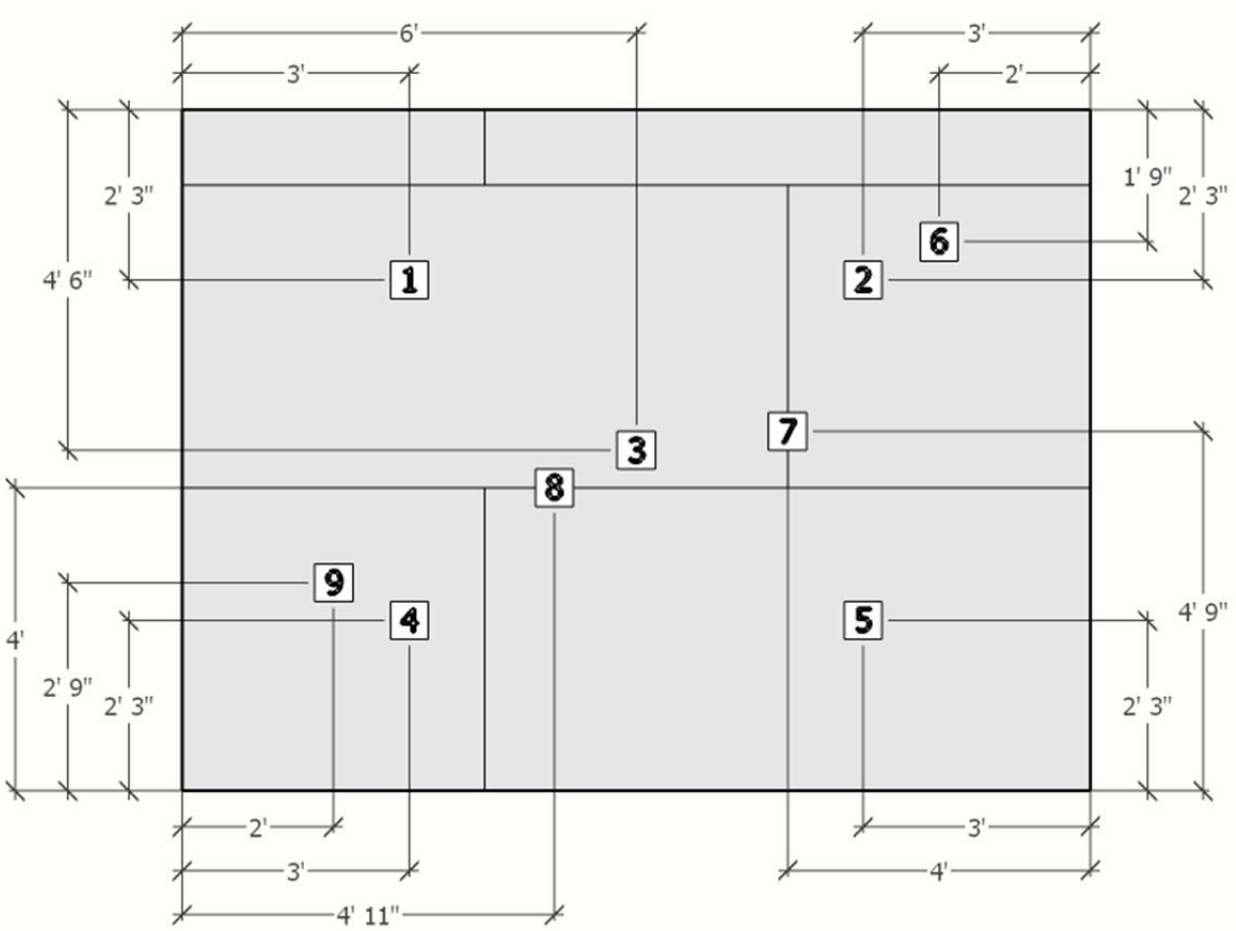


Figure 3: Unexposed Thermocouple Locations

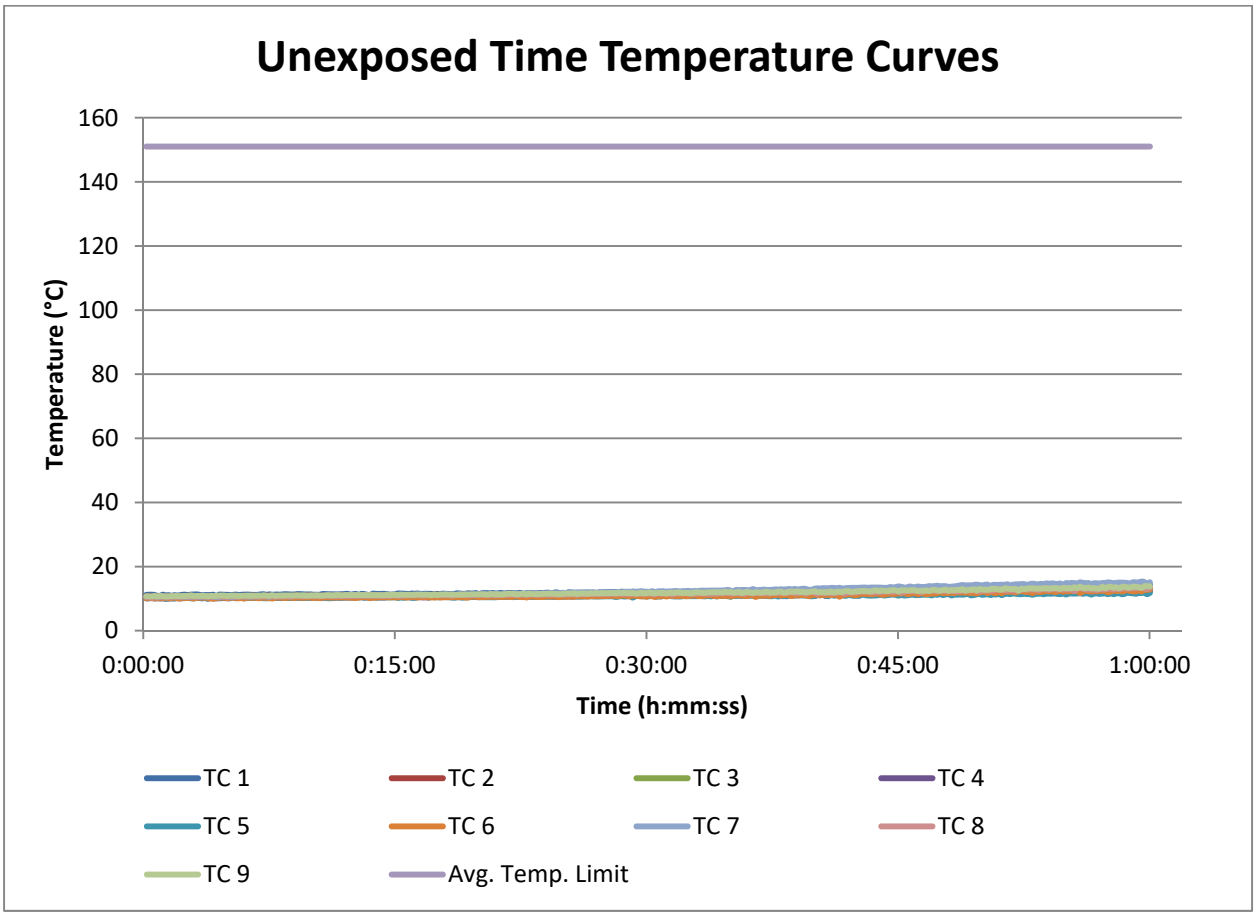
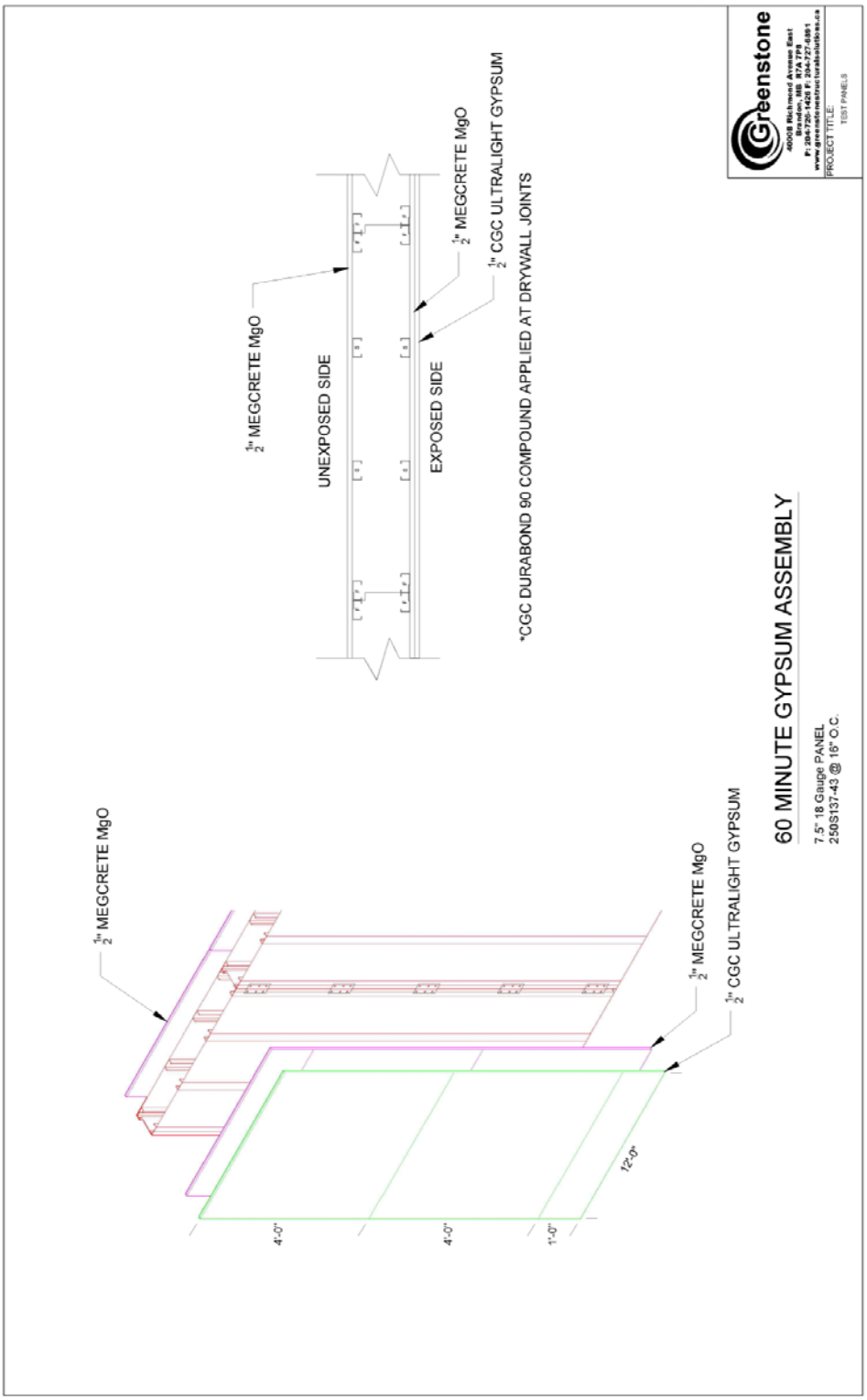
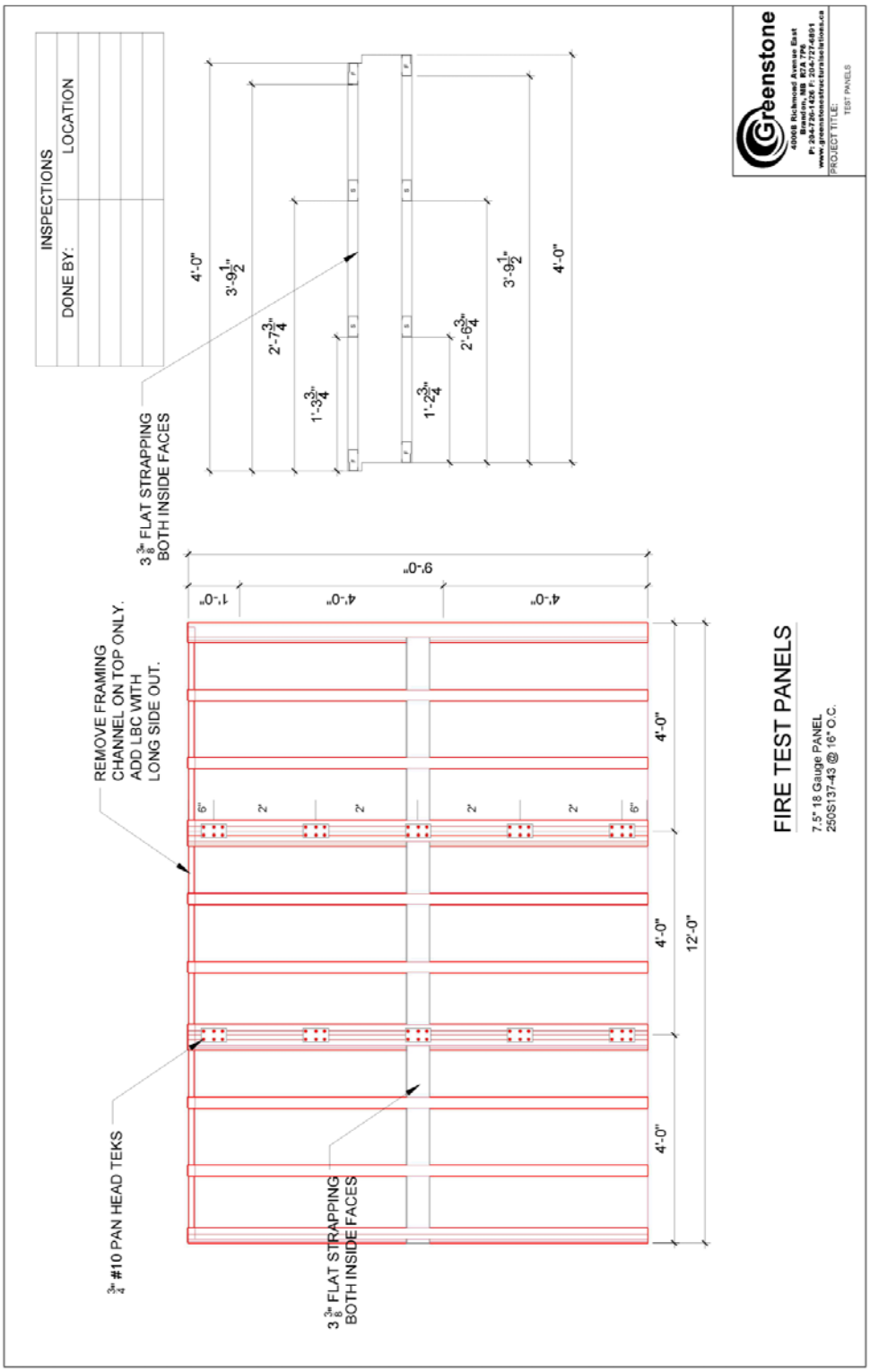


Figure 4: Unexposed Time Temperature Curves

APPENDIX B





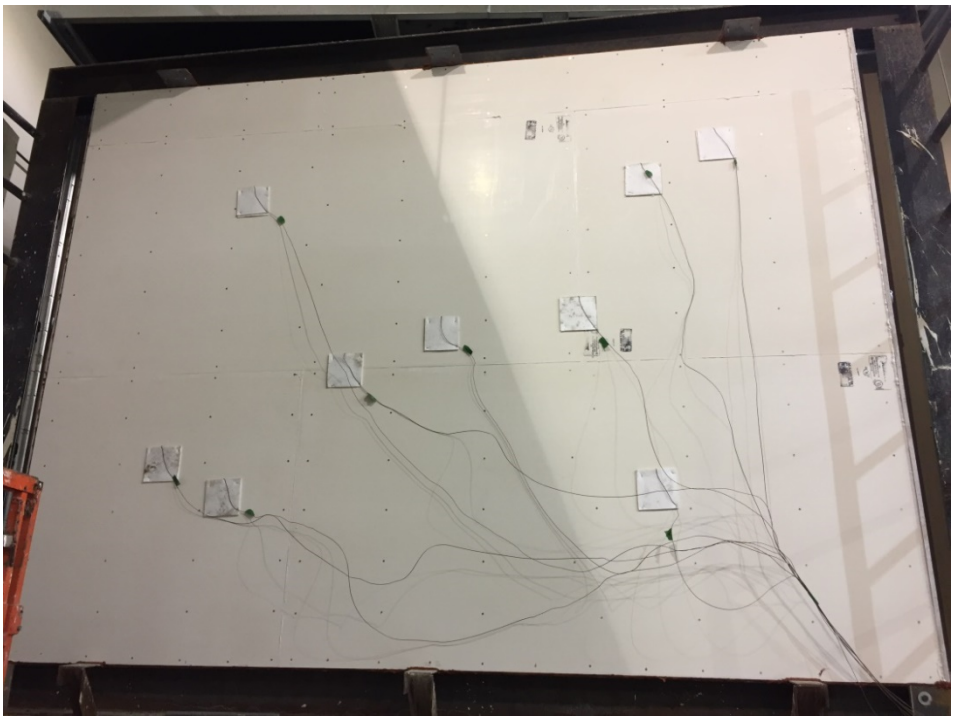


Figure 5: The unexposed face prior to the fire test.

Figure 6: The exposed face prior to the fire test.

Figure 7: The exposed face after the fire test.

Figure 8: The exposed face after the hose stream test.

Figure 9: The unexposed face after the hose stream test.