LABORATORY PERFORMANCE TESTS
ON A MECHANICALLY FASTENED STONE VENEER PANEL - *VENA*

Prepared for: ***LES PIERRES ROYALES INC.***
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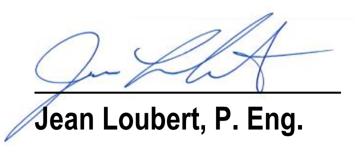
Attn. : Mr. Dominic Vézina

Report no.: AS-01644

Date: March 8th, 2023

Number of pages: 8 pages and Annexes A to D

Approved by:



Jean Loubert, P. Eng.
Assistant Manager, Materials and Systems Testing
UL Laboratory Canada Inc.

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LABORATORY PERFORMANCE TESTS
ON A MECHANICALLY FASTENED STONE VENEER PANEL - *VENA*

1.0 INTRODUCTION

This report covers the performance testing on a mechanically fastened stone veneer system - *Vena*. The tests were performed from October 18th, 2022 to November 30th, 2022. The tests were carried out in accordance with testing procedures mentioned in section 4.0 of this report.

2.0 MANUFACTURER

LES PIERRES ROYALES INC.

3.0 WITNESSES

The following witnesses were present for the entire (or a part of the) testing sequence:

Mr. Richard Arsenault	-	*Les Pierres Royales Inc.*
Mr. Dominic Vézina	-	*Les Pierres Royales Inc.*
Mrs. Karen Barrette	-	*Les Pierres Royales Inc.*
Mr. Samuel-Dominic Lortie	-	*UL Laboratory Canada Inc.*
Mr. Jean Loubert	-	*UL Laboratory Canada Inc.*
Mr. Benjamin Dalpé	-	*UL Laboratory Canada Inc.*
Mr. Patrick Fournier	-	*UL Laboratory Canada Inc.*

4.0 TEST METHODS AND REFERENCES

AAMA 501.5, "Test Method for Thermal Cycling of Exterior Walls".

AAMA 501.1, "Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure".

ASTM E283, "Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Difference Across the Specimen".

ASTM E330-02, "*Standard Test Method Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*".

ASTM E331, "*Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference*".

5.0 PROTOTYPE DESCRIPTION

Description: The sample wall was fabricated in the facilities of *UL Laboratory Canada Inc.* located in Varennes, QC, on October 18, 2022 by Mr. Richard Arseneault and Mr. Dominic Vézina from *Les Pierres Royales Inc*. Photograph 1 below shows the assembly of the prototype.

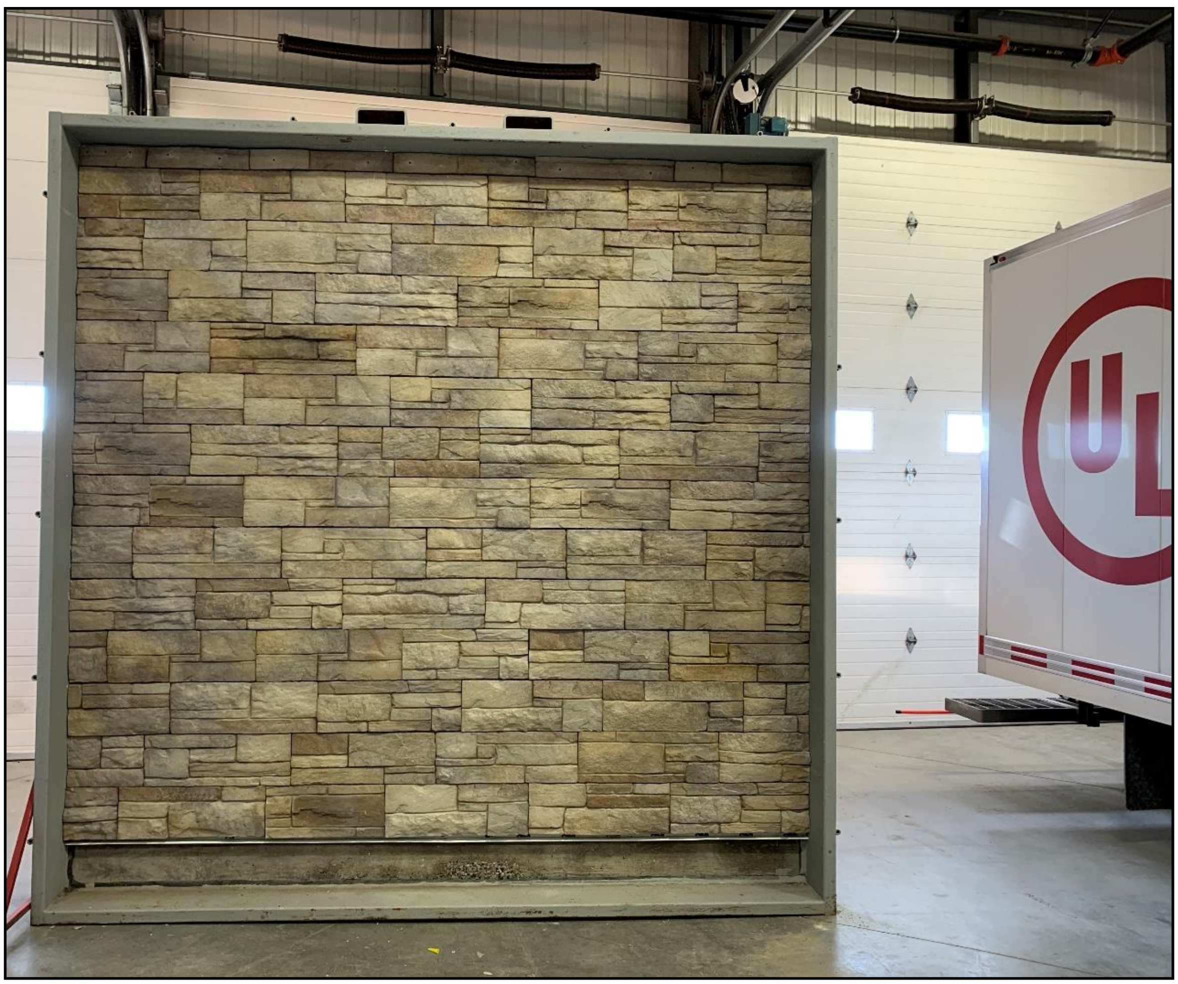
Dimensions: 3048 mm (10 ft) wide x 3048 mm (10 ft) high.

Test Frame: The rigid perimeter test frame consists of two 2" x 10" rectangular steel HSS tubes adjacent and welded together.

Composition of the wall framing:

Frame made with 2x6 20 gage metal studs spaced at 16" on center. An intermediate support made up of a 5/8" thick plywood panel sheathing covered with a flexible non-woven polyefin membrane of the *BP Air Lock* type.

Drawings: The prototype components and fabrication details are described in drawings provided by *Les Pierres Royales Inc.* (Included in Appendix A).



Photograph 1 : Prototype Assembly - Elevation View

6.0 ALTERATION(S)

Alteration(s) performed in the laboratory on tested prototype to meet the reported performances:

- None

7.0 TEST PROCEDURES

7.1 WIND PRESSURE CONDITIONING

The prototype was exposed to the pressure conditioning at a pressure of 800 Pa for cyclic loads and 1200 Pa for gust loads. After each loading stage (cyclic and gust loading), the prototype was inspected for signs of fracture, delamination, loosening of fasteners, and so forth.

7.1.1 CYCLIC WIND PRESSURE LOADING

Appropriate apparatus was used to perform the pressure cycling test. A typical cycle consists of the following steps:

1) From atmospheric pressure, increase (or decrease) the pressure difference across the specimen until it reaches the set-point within a period higher than one (1) second;
2) Maintain the set-point for a period of three (3) seconds;
3) Return to atmospheric pressure within a period of one (1) second.

The prototype was subjected to tow (2) stages of 1000 cycles reversing from positive to negative pressure at room temperature. The set-point pressures were +800 Pa (inward) and -800 Pa (outward).

7.1.2 GUST LOADING

The prototype was subjected to a pressure difference of +1200 Pa and -1200 Pa for a period of three (3) seconds.

7.2 WATER RESISTANCE UNDER DYNAMIC PRESSURE

The dynamic water penetration test was conducted as per *AAMA 501.1* under a dynamic pressure differential of 720 Pa maintained for a time period of 15 minutes. The prototype was subjected to a uniform water spray of 3.4 L/min·m² (5 U.S. gal/ ft^2·hour) during the entire static water penetration test.

7.3 WATER RESISTANCE UNDER STATIC PRESSURE

The static water penetration test was conducted as per *ASTM E331* under static pressure differential of 720 Pa. Pressure was maintained for a period of 15 minutes. The prototype was subjected to a uniform water spray of 3.4 L/min·m² (5 U.S. gal/ ft^2·hour) during the entire static water penetration test.

7.4 THERMAL CYCLIC

The prototype was subjected to 6 cycles of thermal variation of 8 hours each. One cycle consists of the following: starting at 24°C, 1 hour to increase the temperature up to 82°C, 2 hours at 82°C, 2 hours to decrease the temperature down to -30°C, 2 hours at -30°C, 1 hour to increase the temperature up to 24°C.

7.5 INFILTRATION / EXFILTRATION AIR LEAKAGE

The air leakage rate of the prototype, for both positive and negative cases, was determined at a pressure differential of 75 Pa.

7.6 STRUCTURAL PERFORMANCE

The structural performance test was carried out according to the ASTM E330 standard. The absolute displacement of the wall system was taken under negative pressure (pullout). The tests were carried out by first applying a pressure of 0 Pa to 4450 Pa and then from 0 Pa to 6500 Pa. The structural resistance report including the graphs of displacement as a function of pressures is presented in Appendix D for reference.

7.7 DURABILITY – BEHAVIOR UNDER FREEZE/THAW CYCLES

The freeze-thaw conditioning test consists of subjecting the prototype to 50 cycles of temperature variation lasting 8 hours each. A freeze-thaw cycle takes place as follows: one hour at 24°C with exposure to water, one hour transition to lower the temperature to -10°C, two hours at a maintained temperature of -10° C, one hour transition to increase the temperature to 70°C, two hours at a maintained temperature of 60°C, one hour transition to decrease the temperature to 24°C.

8.0 RESULTS SUMMARY

TEST	EVALUATION CRITERIA	TEST RESULTS / COMMENTS
Water Resistance Under Static Pressure (Initial) *ASTM E331* 11/01/2022	No water leakage allowed on the interior side when the prototype is subjected to a uniform water spray of 3.4 L/min·m² (5 U.S. gal/ ft²·hour) during 15 continuous minutes at targeted static pressure level.	No water penetration was observed under static pressure differentials of 75, 360 et 720 Pa.
Wind Pressure Conditioning (cyclic and gust loads) 11/10/2022 au 11/11/2022	Cyclic Load = 800 Pa Gust Load = 1200 Pa For the cyclic stage, 2000 cycles at 2560 Pa were applied in 2 stages of 1000 cycles reversing from positive to negative pressures. After each loading stage (cyclic and gust loading), the prototype shall not demonstrate any change in structure and all elements shall remain intact during loading and after load removal.	No loss of structural integrity was observed during the wind pressure loading and all elements remained intact during the entire structural wind loading schedule.
Thermal Cycling 6 cycles of thermal variation of -30oC to 82oC in 8 hours per cycle *AAMA 501.5* 11/14/2022 au 11/16/2022	All wall system elements shall remain intact during the thermal cycling test.	No loss of structural integrity was observed during the thermal cycling test.
Freeze / Thaw Cycling Behavior (50 cycles) 11/16/2022 au 11/22/2022	During and after the freeze/thaw cycling test, the prototype must not demonstrate any changes that could compromise the integrity of the system.	The integrity of the system remained intact throughout the freeze/thaw test. No anomaly or visual cracking, permanent deformation or element tearing was observed.

TEST	EVALUATION CRITERIA	TEST RESULTS / COMMENTS
Water Resistance Under Dynamic Pressure AAMA *501.1* 11/24/2022	No water leakage allowed on the interior side when the prototype is subjected to a uniform water spray of 3.4 L/min·m² (5 U.S. gal/ ft²·hour) during 15 continuous minutes at targeted dynamic pressure level.	No water penetration was observed after 15 minutes under a dynamic pressure differential of 720 Pa.
Water Resistance Under Static Pressure (Post Cyclic Durability) *ASTM E331* 11/24/2022	No water leakage allowed on the interior side when the prototype is subjected to a uniform water spray of 3.4 L/min·m² (5 U.S. gal/ ft²·hour) during 15 continuous minutes at targeted static pressure level.	No water penetration was observed under static pressure differentials of 75, 360 et 720 Pa.
Infiltration / Exfiltration Air Leakage *ASTM-E283* 11/29/2022 au 11/30/2022	Recommendations of Appendix note A-5.4.1.2. 1) and 2), and Table A-5.4.1.2. of *NBC 2010,* maximum recommended air leakage rates (at 75 Pa) for air barrier systems: <27% RH : 0.15 L/s·m² 27% to 55% RH : 0.10 L/s·m² >55% RH : 0.05 L/s·m² *ABAA* requirement for air leakage of air barrier assemblies, air leakage not greater than 0.20 L/s·m² at a pressure difference of 75 Pa for both positive and negative directions.	Q_{inf} = 0.08 L/s·m² @ 75 Pa Q_{exf} = 0.09 L/s·m² @ 75 Pa Meets the recommendations of *NBC 2010* and *NBC 2015* for relative humidity level below 55% and meets the *ABAA* requirements.

9.0 CONCLUSION

Based on the results of water penetration resistance tests, the mechanically fastened veneer panel system *Vena*, as tested, resists water penetration under a static pressure difference of 720 Pa when subjected to a uniform watering of 3 .4 L/min·m² for a period of 15 minutes. No water penetration was observed following the water penetration resistance test under a dynamic pressure differential of 720 Pa (equivalent to 110 km/h). Thus, the Vena system has demonstrated its ability to manage the water that migrates inside it by evacuating it through the drainage devices provided for this purpose.

The tested prototype shows no signs of deterioration or failure under wind and thermal cycling conditioning. The integrity of the system remained intact throughout the freeze/thaw test. No anomaly or visual cracking, permanent deformation or element tearing was observed. In addition, no visual anomaly, permanent deformation or tearing of any element of the *Vena* system was observed during the resistance test to dynamic wind loads over a period of 15 minutes.

Finally, the assembly of the prototype of *Vena* system with reference to the attached drawings, in addition to the aforementioned performances, meets the recommendations of the *National Building Code CNB 2010* and *CNB 2015* for a relative humidity of less than 55% as mentioned in Table A-5.4.1.2.(1)(2) and meets the requirements of the *ABAA Air Barrier Association of America*. Air leakage measured in infiltration and exfiltration is less than 0.10 L/s·m^2 under a pressure differential of 75 Pa

Note sur la limitation de la responsabilité:

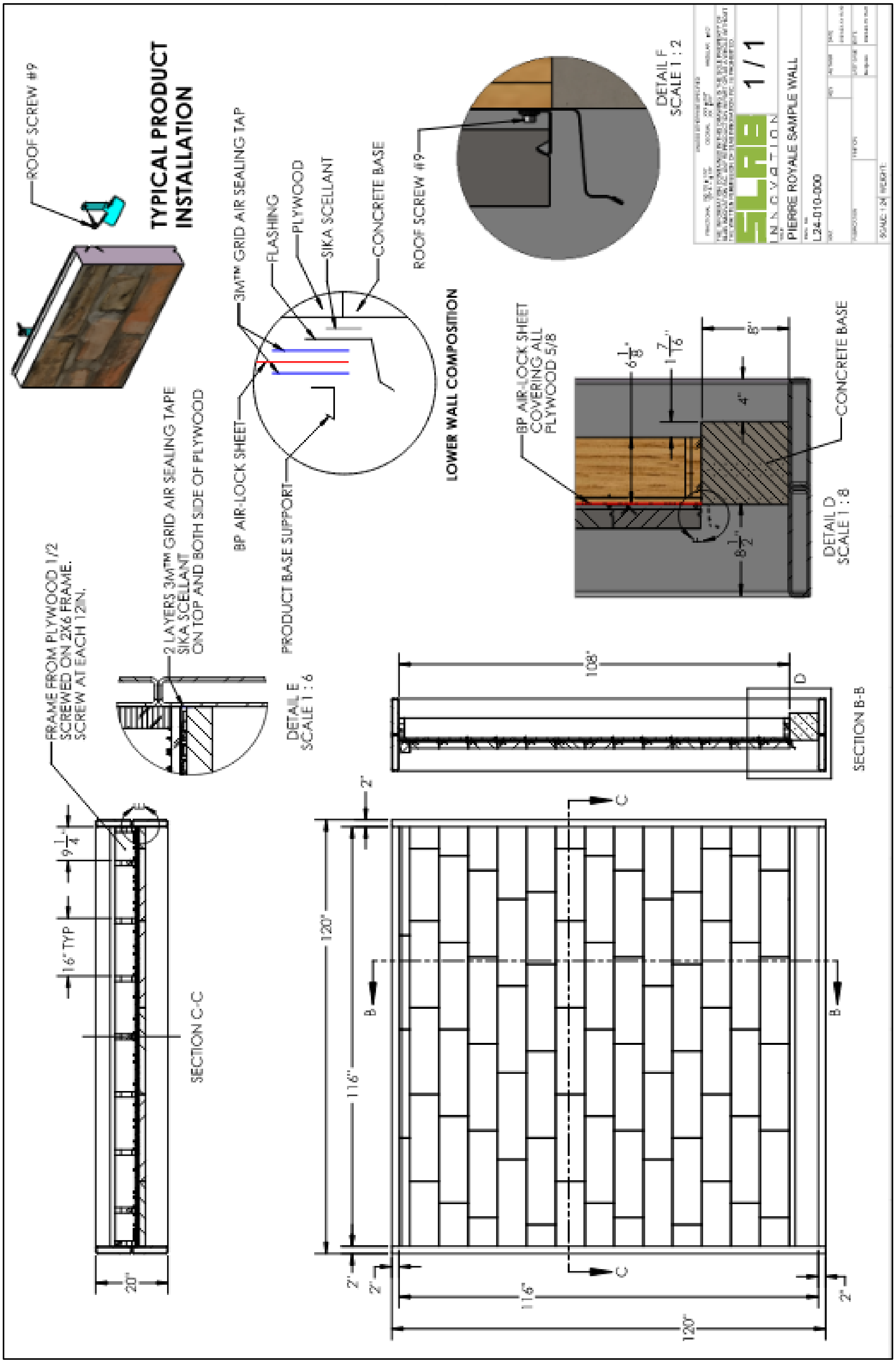
This report is for the exclusive usage and distribution by *Les Pierres Royales Inc.*. The test results presented in this report refer only to the performance tests of the specimens tested at *UL Laboratory Canada Inc.*. The tests results obtained, and the recorded values are objectively based on the fulfilment of the described test procedures. *UL Laboratory Canada Inc.* does not offer an opinion on the product's performance nor does this report constitute an endorsement of the product. The Decision Rule is based on Simple Acceptance (Measurement Uncertainty is not considered when making a statement of conformity)

10.0 REVISION LOG

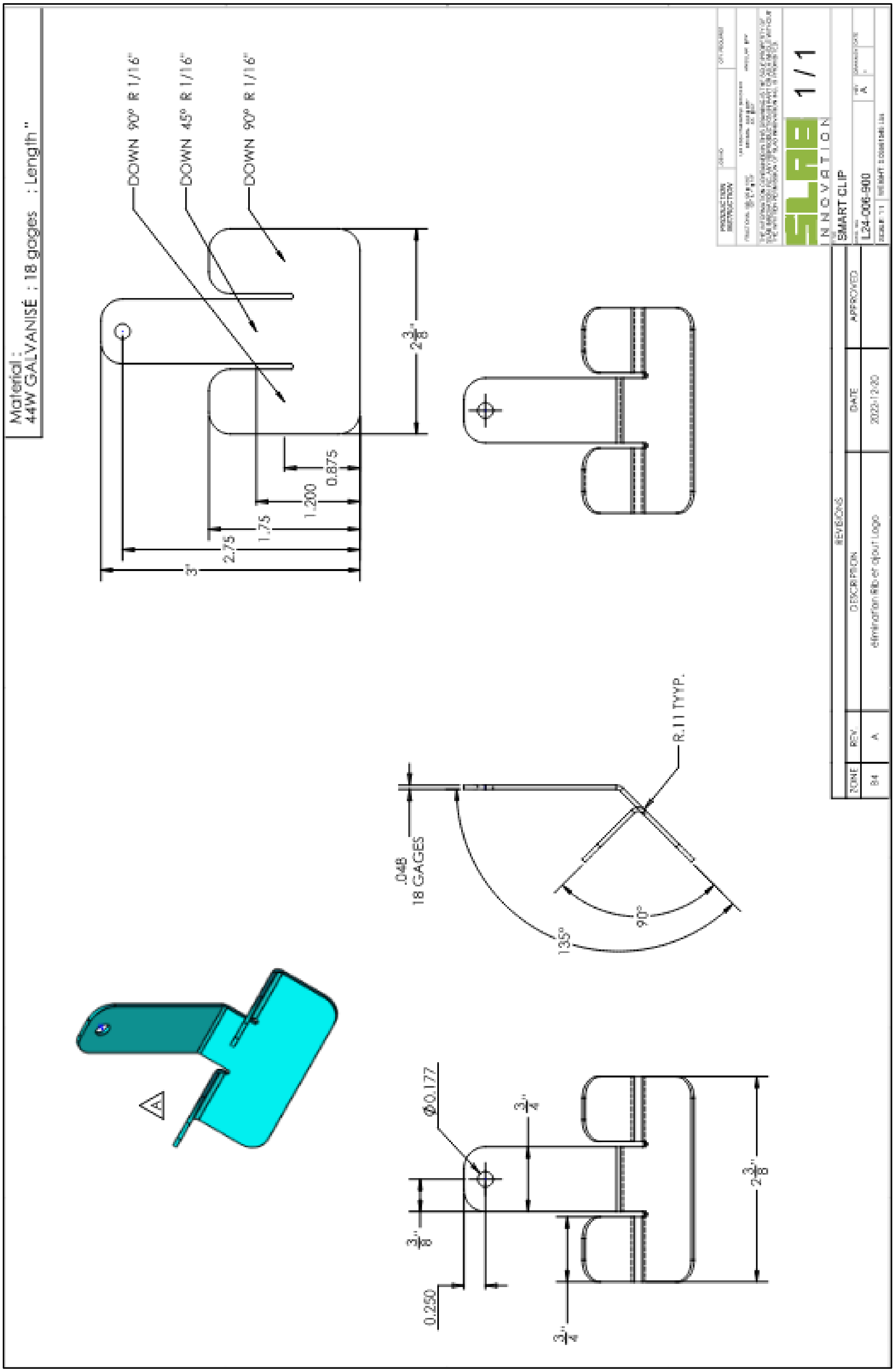
Rev. #	Date	Page(s)	Revision(s)

Annex A

Prototype Drawings



ROOF SCREW #9
TYPICAL PRODUCT INSTALLATION
3M™ GRID AIR SEALING TAP
FLASHING
PLYWOOD
SIKA SCELLANT
CONCRETE BASE
ROOF SCREW #9
DETAIL F SCALE 1 : 2
1 / 1
PIERRE ROYALE SAMPLE WALL
L24-010-000
FRAME FROM PLYWOOD 1/2 SCREWED ON 2X6 FRAME. SCREW AT EACH 12IN.
2 LAYERS 3M™ GRID AIR SEALING TAPE SIKA SCELLANT ON TOP AND BOTH SIDE OF PLYWOOD
BP AIR-LOCK SHEET
PRODUCT BASE SUPPORT
LOWER WALL COMPOSITION
BP AIR-LOCK SHEET COVERING ALL PLYWOOD 5/8
CONCRETE BASE
DETAIL D SCALE 1 : 8
DETAIL E SCALE 1 : 6
108"
SECTION B-B
16" TYP
SECTION C-C
20"
120"
116"
2"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DOWN 90° R 1/16"
DOWN 45° R 1/16"
DOWN 90° R 1/16"
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1.200
1.75
2.75
3"
R.11 TYP.
.048
18 GAGES
135°
90°
Ø0.177
0.250
REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
B4
A
2022-12-20
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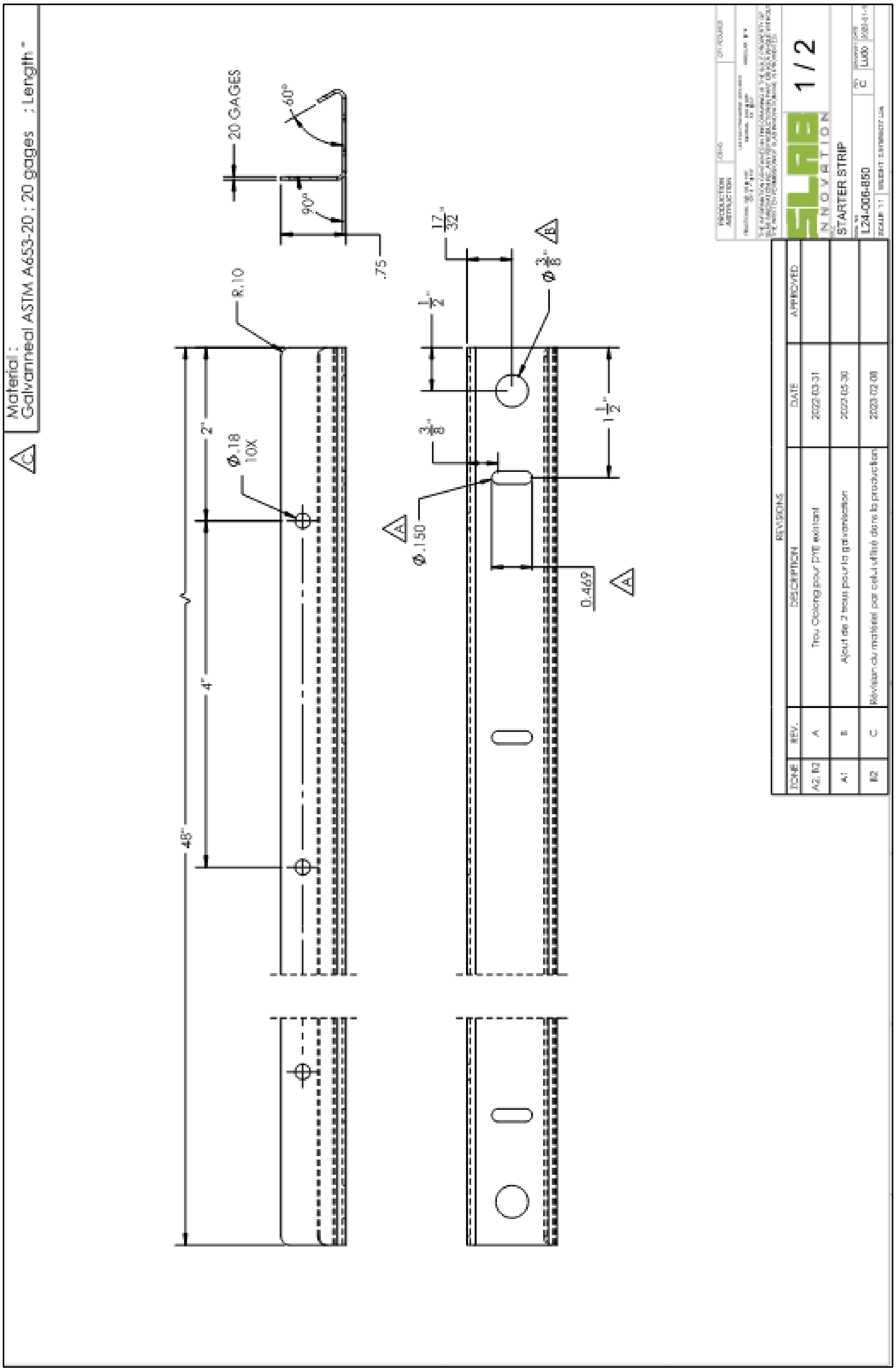
INNOVATION
SMART CLIP
L24-006-900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Galvanneal ASTM A653-20 ; 20 gages ; Length "
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R.10
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90°
Ø.18
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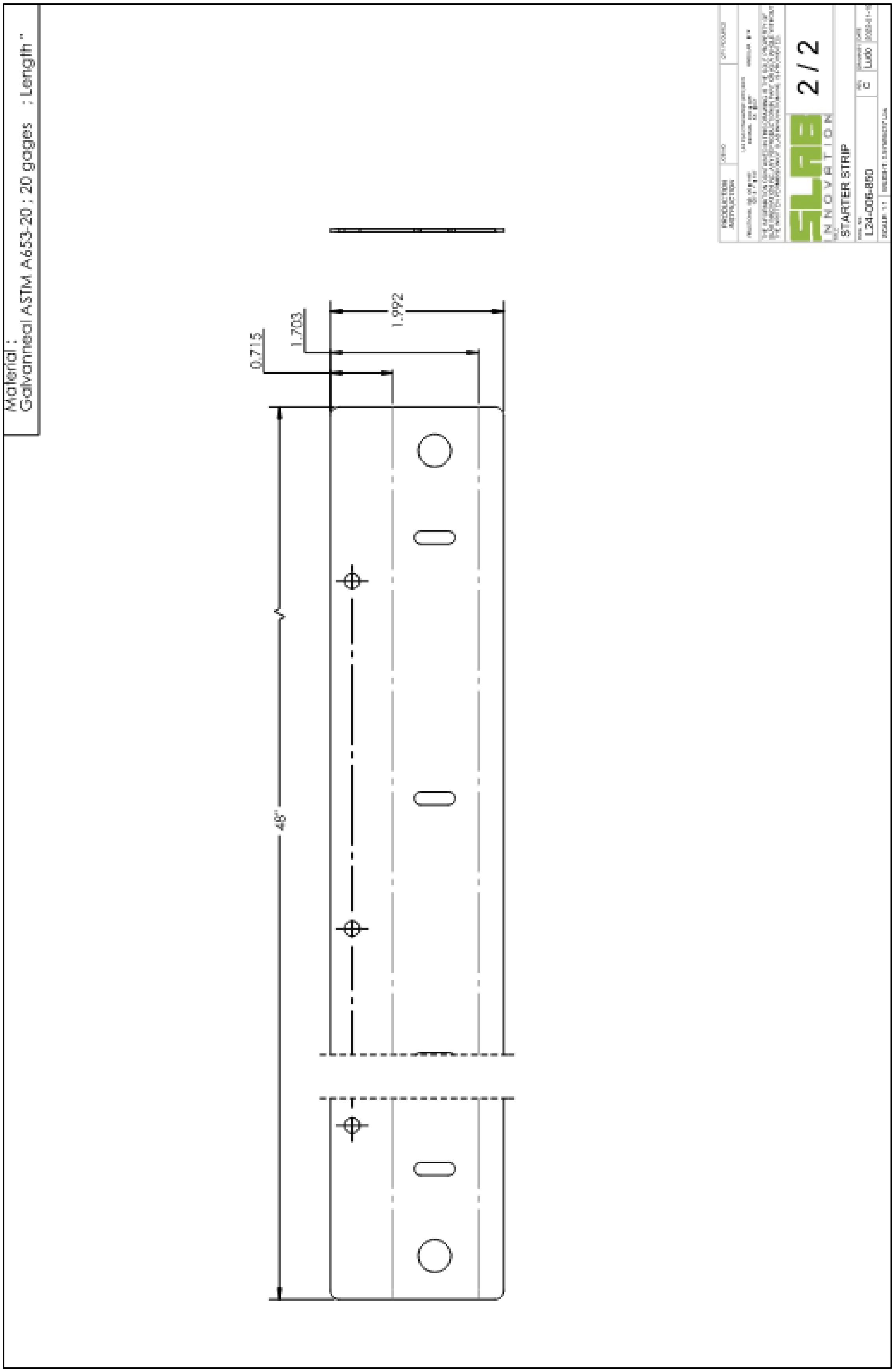
2"
4"
48"
Ø.150
0.469
STARTER STRIP
L34-008-850
1 / 2
REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
A2, B2
A
Trou Oblong pour DYE existant
2022-03-31
A1
B
Ajout de 2 trous pour la galvanisation
2022-05-30
B2
C
Révision du matériel par celui utilisé dans la production
2023-02-08


Material :
Galvanneal ASTM A653-20 ; 20 gages ; Length "
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1.703
1.992
48"
2 / 2
INNOVATION
STARTER STRIP
L34-006-850
C
Ludo

Annex B

Photographs of the Prototype Construction

B-01

B-02


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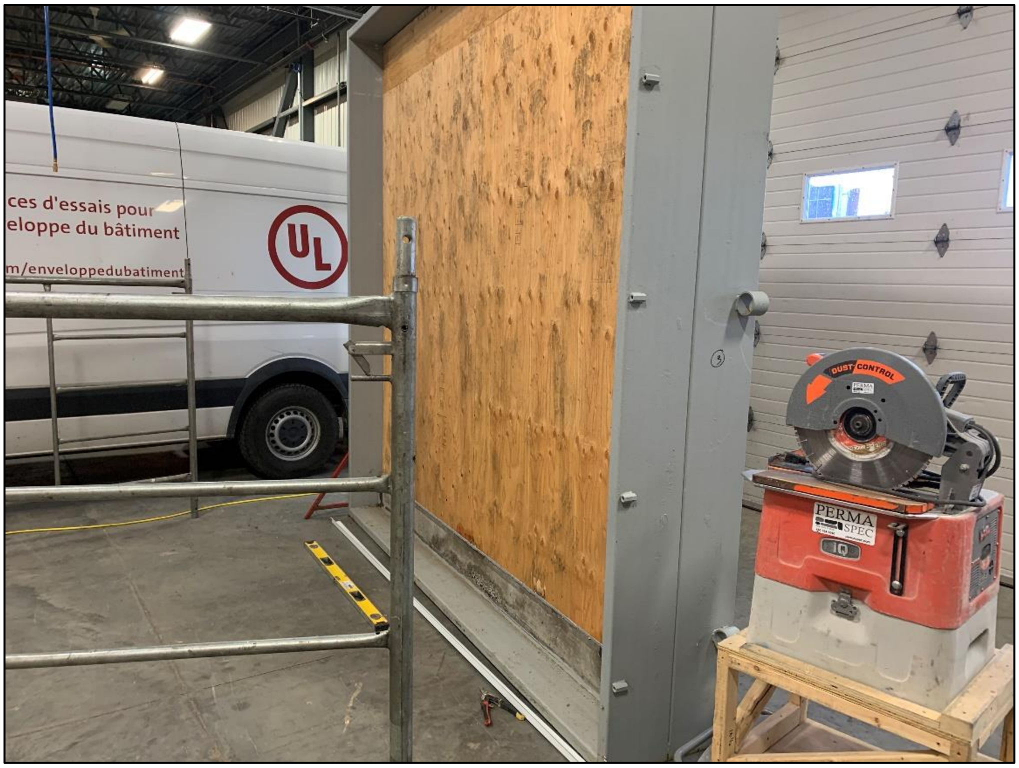
B-04


ces d'essais pour
eloppe du bâtiment
m/enveloppedubatiment
DUST CONTROL
PERMA
SPEC

B-05

B-06

B-07

B-08

B-09

B-10

B-11

B-12


BP
AIR-LOCK
BP
AIR-LOCK
3M

B-13


MADE IN CANADA BY / FABRIQUÉ AU CANA
BP
AIR-

B-14


3M

B-15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Diameter/diamètre
1"
500
quantity/quantité
QC-8317
WHITE
BLANC
1/4
ATTACHES Reliable FASTENERS Longueuil J4G 1R8 Made in/Fabriqué VIETNAM
Quality controlled
Qualité contrôlée
20210
RSZ91W
7 72436 41702 7

B-16

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B-18


PIERRES
ROYALES
ATTACHES
VENA
180 MCX
2022-09-29

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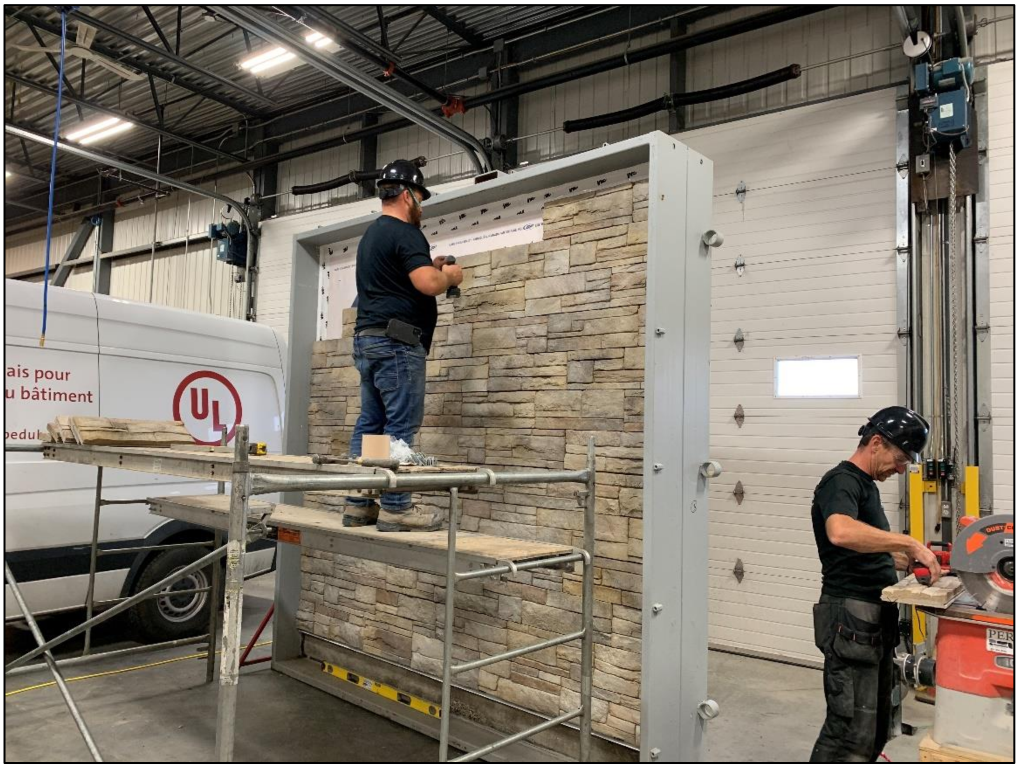
VENA
180 MCX
2022-09-29

B-20

B-21



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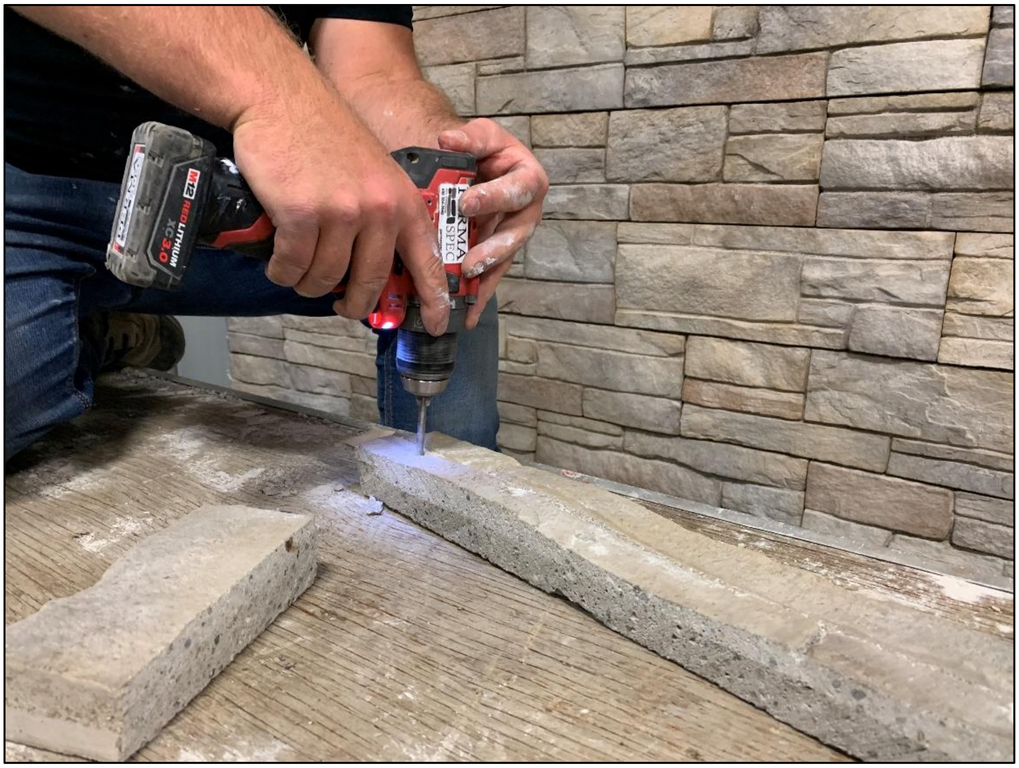

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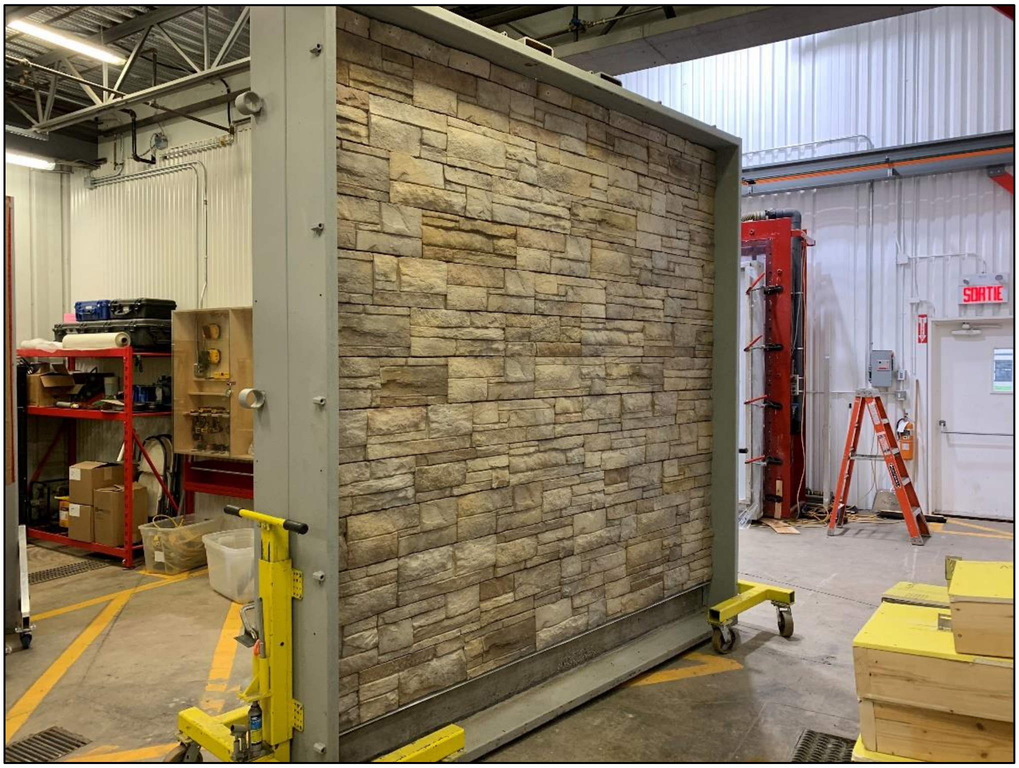

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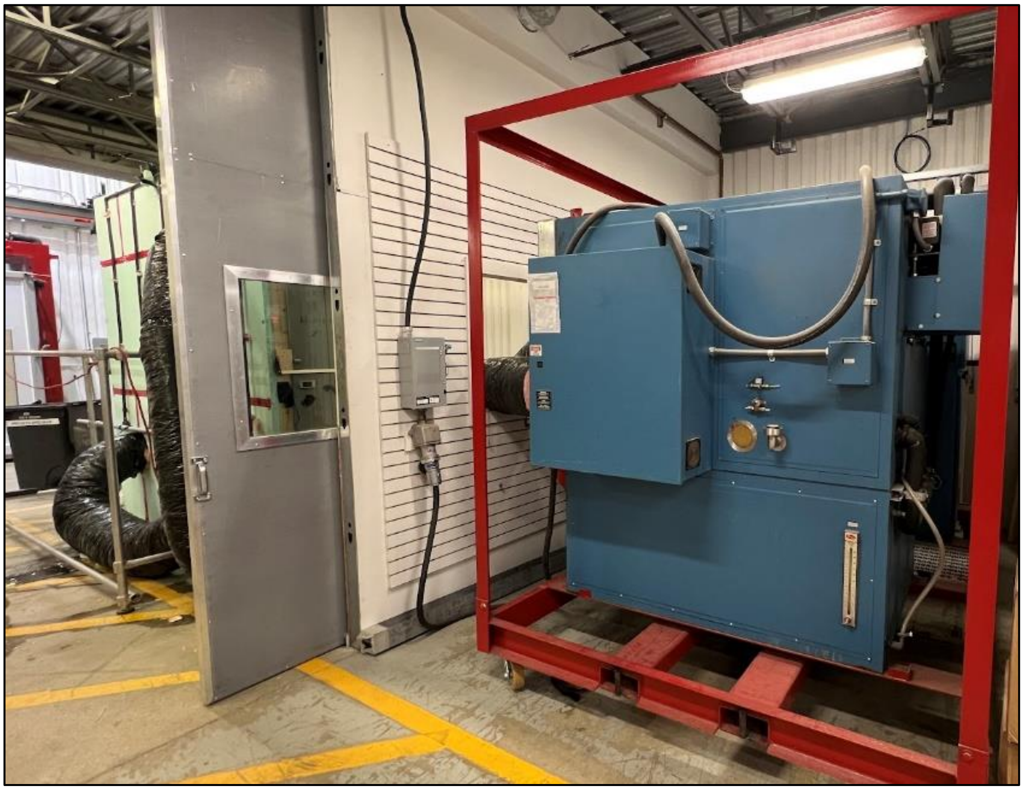
Annex C

Photographs of Tests

C-01 Air Leakage Test

C-02 Taking leak measurements from the test bench during airtightness tests

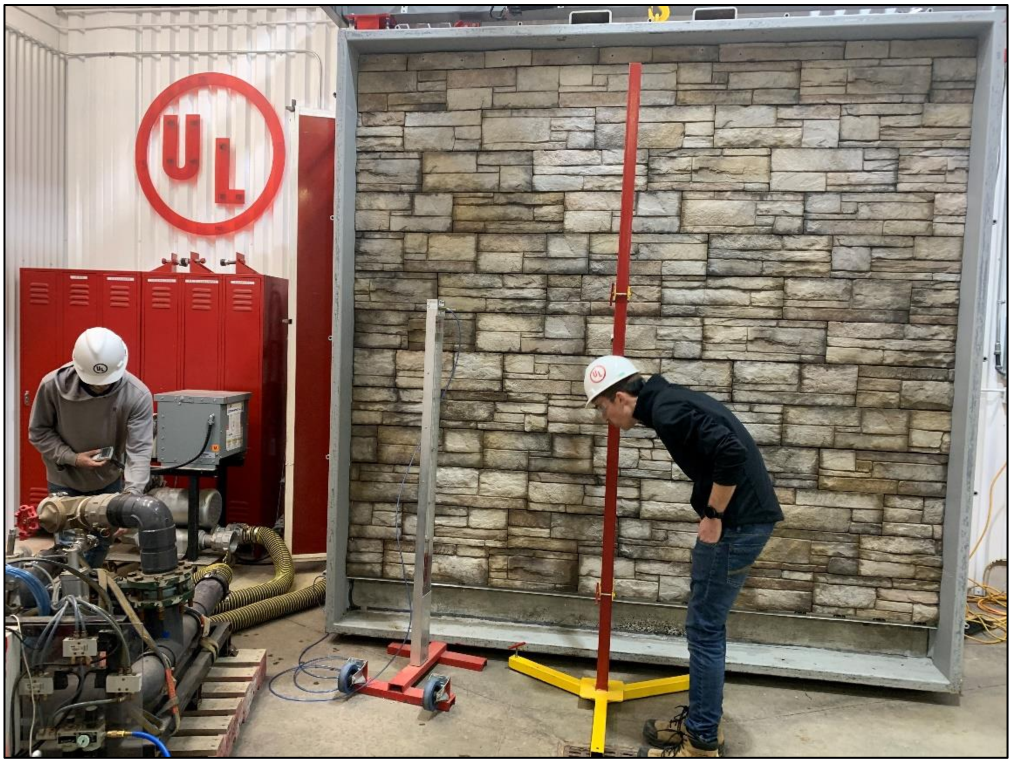
C-03 Test bench for extreme thermal conditioning and freeze/thaw



C-04 Programmable environmental chamber equipment

C-05 Water Resistance Penetration Test Under Static Pressure

C-06 Water Resistance Penetration Test Under Static Pressure



C-07 Wind Load Cyclic Pressure Test

C-08 Preparation of the dynamic test bench

C-09 Mobilization for rain resistance test under dynamic pressure

C-10 Water Resistance Penetration Test Under Static Pressure

Annex D

Structural Performance Results
Report AS-01646 – August 31th, 2022

STRUCTURAL PERFORMANCE
EVALUATION OF MECHANICALLY FASTENED STONE VENEER SYSTEM - *VENA*
IN ACCORDANCE WITH *ASTM E330* STANDARD

Prepared for: ***LES PIERRES ROYALES INC.***
1041 Boulevard Lionel-Boulet,
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Attn: M. Dominic Vézina

Report no.: AS-01646

Date: August 31st, 2022

Number of pages: 8 pages et annexes A à B

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ANNEXES

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1. INTRODUCTION

This report presents the structural performance evaluation of a mechanically fastened stone veneer system - *Vena* and their fasteners. The tests were performed in accordance with the ASTM E330/E330M-14(2021) test procedure. The tests were performed on August 29th, 2022.

2. WITNESSES

The following witnesses were present for part of or all the testing sequence:

M. Samuel Lortie	-	*UL Laboratory Canada Inc.*
M. Dominic Vézina	-	*Les Pierres Royales Inc.*
Mme Karen Barrette	-	*Les Pierres Royales Inc.*
M. Richard Arsenault	-	*Les Pierres Royales Inc.*
M. Ludovic Legendre	-	*Les Pierres Royales Inc.*
M. Benoit Slavinski	-	*Slab Innovation Inc.*

3. TEST METHOD

The tests presented herein were performed in accordance with the following testing procedure:

ASTM E330/E330M-14(2021) "Standard Test Method Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference".

The main objective of this test was to evaluate the structural performance of the screw-on panels and their fasteners. To do so, a perforated test bench was prepared in order to maximize the pressure difference between the back of the stones and the ambient atmosphere (see Appendix A and Appendix B). This test bench allowed to apply pressure directly on the back face of the panels and not on the plywood to which the stone panels were fastened.

Displacement gauges were installed at the locations shown in Figure 1 to record the deformation of the system during the test.

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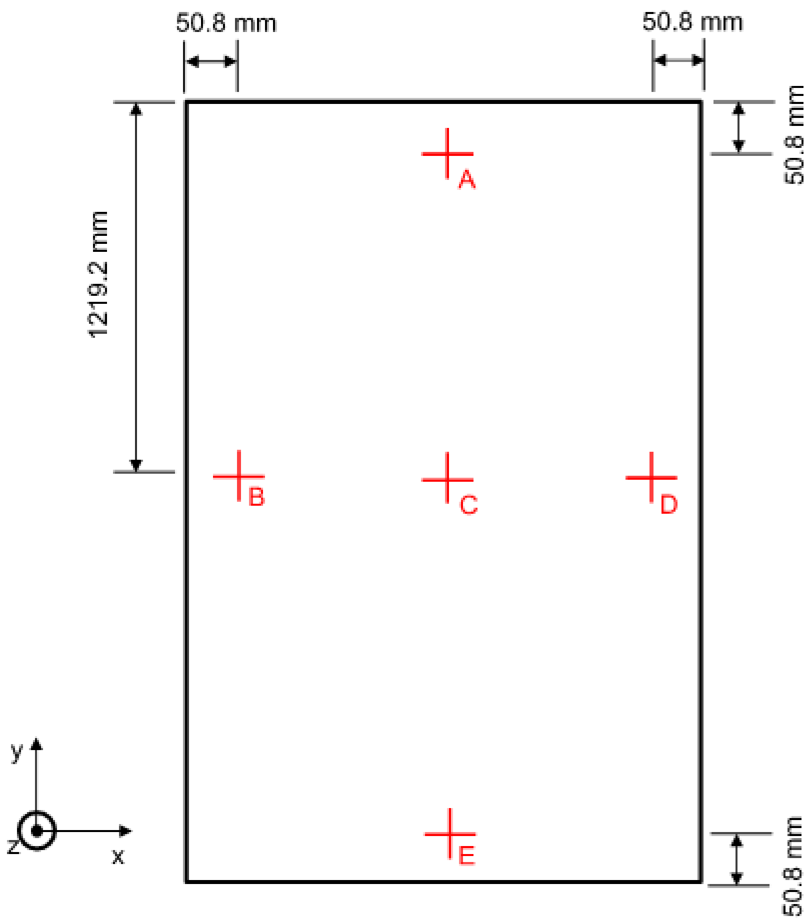

Figure 1: Positions of the deflection-measuring gauges.

Structural Performance Evaluation of a mechanically fastened stone veneer system - Vena
Issuance: August 31st, 2022

AS-01646
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4. DESCRIPTION OF THE SPECIMENS AND TEST EQUIPMENT

A description of the tested specimens and the equipment used is given below. Note that a detailed drawing of the test bench is available in Appendix A.

Product name:	VENA stones
Manufacturer:	Les Pierres Royales inc.
Tested specimens:	AS-01646-A
Specimens' dimensions :	1219.2 mm (4 ft) par 2438.4 mm (8 ft)
Assembly date :	August 29th, 2022
Test date :	August 29th, 2022
Equipment:	Blower (EQ-BL-02), pressure transducer and deflection gauge acquisition board (EQ-DM-05).

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5. TEST RESULTS

The tests were carried out by first applying a pressure of 0 Pa to 4450 Pa and then from 0 Pa to 6500 Pa. The displacement and pressure graphs are shown in Figures 2 and 3. A summary of the structural performance test results is available in Table 1.

For the tests from 0 Pa to 4450 Pa, the only failure mode that was observed is the following:

1. Permanent deformation, mainly due to the deformation of the steel brackets behind the stone panels (shown in Figure 1).

For the tests from 0 Pa to 6500 Pa the following failures were observed:

1. Significant permanent deformation, mainly due to the deformation of the steel brackets behind the stone panels (shown graphically in Figure 2 and with pictures in Appendix A),
2. Partial breaks within the joints between the stone panels (see pictures in Appendix A) at pressures above 6000 Pa,
3. Partial disengagement of the joint between the stone panels and the starter strip at pressures above 6000 Pa.

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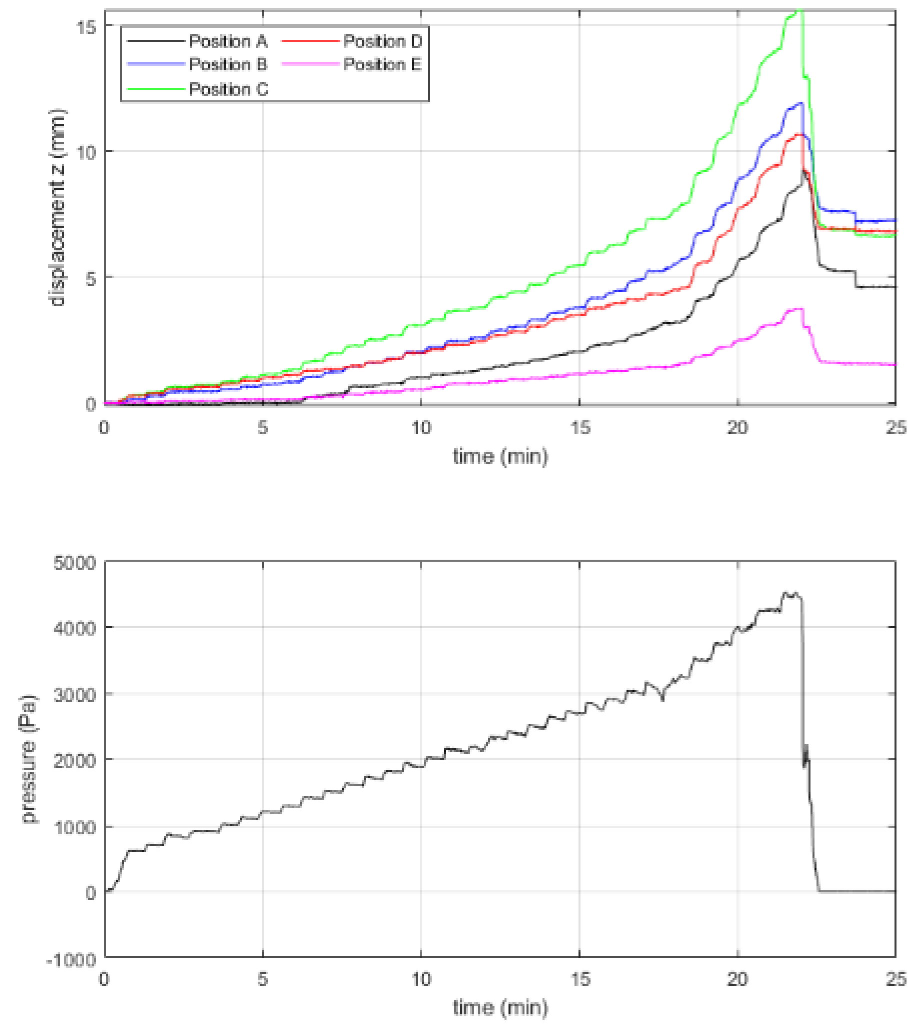

Figure 2 : Displacement and pressure for the first test from 0 Pa to 4450 Pa.

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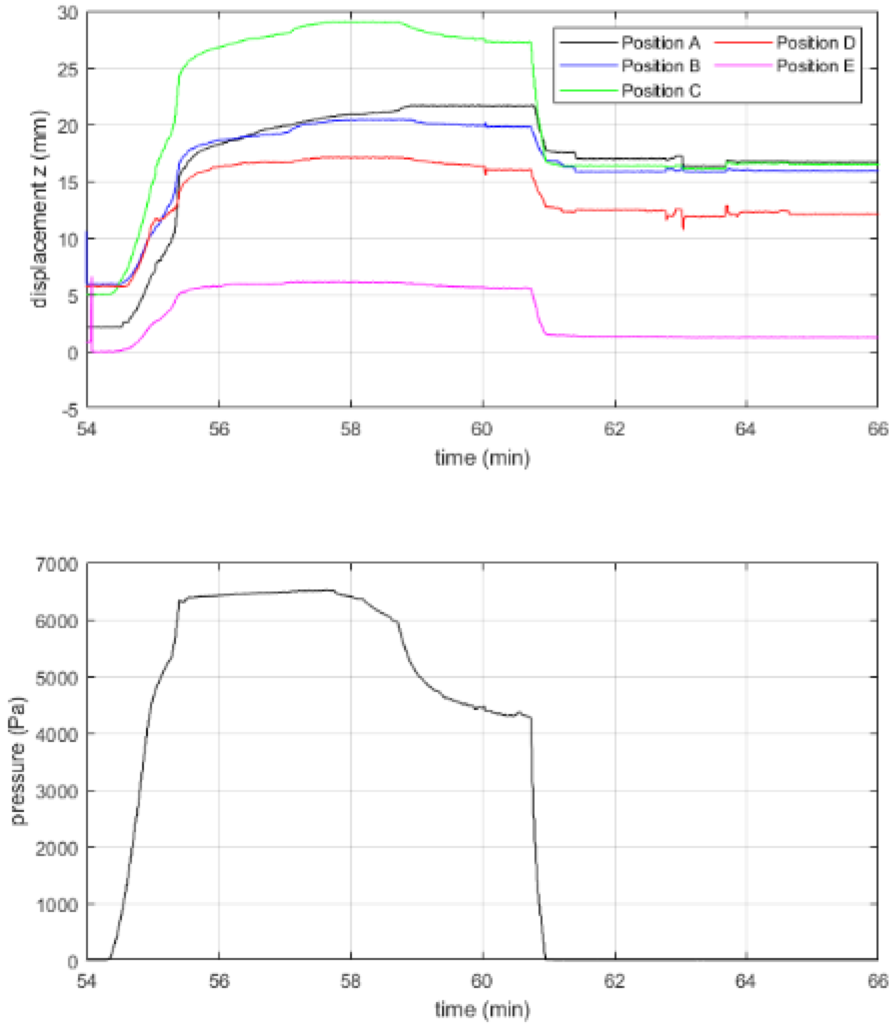

Figure 3: Displacement and pressure for the second test from 0 Pa to 6500 Pa.

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Table 1 : Deformations at Various Pressure Levels

Pressure (Pa)	Δz_A (mm)	Δz_B (mm)	Δz_C (mm)	Δz_D (mm)	Δz_E (mm)
1000	-0.05	0.53	0.8	0.73	0.08
2000	1.17	2.23	3.29	2.11	0.6
3000	3.07	5.24	7.29	4.31	1.4
4000	5.92	9.25	12.22	8.01	2.59
5000	8.1	11.55	17.27	11.7	2.93
6000	12.64	15.54	22.54	13	4.87
6500	20.35	20.0492	28.76	16.97	6.11
Permanent deformation	16.67	15.9	16.47	12.07	1.24

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6. REVISION LOG

Rev. #	Date	Page(s)	Revision(s)

Note on the Limitation of Liability:

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