TEST REPORT

**REPORT NUMBER: 3196773TOR-009**
ISSUE DATE: October 15, 2010

**EVALUATION CENTER**
Intertek
6225 Kenway Drive
Mississauga, Ontario L5T 2L3

## RENDERED TO

## NATIONAL GYPSUM COMPANY
## 2001 Rexford Road
## Charlotte, North Carolina 06524-3423

## and

## LATICRETE INTERNATIONAL INC.
## One Laticrete Park North, 91 Amity Road
## Bethany, Connecticut 06524-3423

PRODUCT EVALUATED: Wall Assembly Test Frames
EVALUATION PROPERTY: Structural Performance

**Report for National Gypsum Company of assembly and test witnessing of test frames for structural performance conducted in accordance with a modified ASTM E330-02, *"Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference"***

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**Report for National Gypsum Company of assembly and test witnessing of test frames for structural performance conducted in accordance with a modified ASTM E330-02, *"Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference"***

# 2 Introduction

Intertek has witnessed the installation and structural (wind load) testing of various wall assemblies. A total of eighteen wall assemblies were assembled and tested (3 different types of cladding materials, 2 different structural systems, 3 samples of each). The wall components were sampled at various manufacturing locations and then shipped to NGC Testing Services in Buffalo, NY for assembly and testing.

Structural testing of the assemblies was conducted in accordance with the methods of a modified ASTM E330-02, *"Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference"* and evaluated against International Building Code sections 1405.9 (2006) and 1405.10 (2009).The sampling, assembly and test witnessing dates are outlined below.

# 3 Material Sampling and Assembly and Test Witnessing

| Task | Product / Test | Inspector | Date | Location |
|---|---|---|---|---|
| Material Sampling | PermaBase Cement Board | Jeffrey Patterson | February 17, 2010 | Unifix, Bromont, QC |
| Material Sampling | Laticrete Masonry Pointing Mortar | David Obedzinski | March 25, 2010 | Laticrete, Intl Inc., Bethany, CT |
| Material Sampling | Laticrete Masonry Veneer Mortar | David Obedzinski | March 25, 2010 | Laticrete, Intl Inc., Bethany, CT |
| Material Sampling | Laticrete Hydro Ban | David Obedzinski | March 25, 2010 | Laticrete, Intl Inc., Bethany, CT |
| Assembly Witnessing | Witness assembly of masonry on test walls | Claudio Sacilotto | April 19, 20, May 14, 2010 | NGC, Buffalo, NY |
| Test Witnessing | Structural test on wall assemblies | Claudio Sacilotto | May 10, 11, 12, 14, 28, 2010 | NGC, Buffalo, NY |

# 4 Sampled Materials

### 4.1. CEMENT BOARD

- PermaBase® Cement Board 1/2″×4′×8′
- Manufacturer – National Gypsum Company
- Lot/Serial No. BRO 02-17-10 09:06

### 4.2. WATERPROOFING MEMBRANE

- Laticrete Hydro Ban™
- Manufacturer – Laticrete International Inc.
- Lot/Serial No. 372931

### 4.3. MASONRY ADHESIVE

- Laticrete Masonry Veneer Mortar
- Manufacturer – Laticrete International Inc.
- Lot/Serial No. 371788-001 MFG 03/10
    - 373157-005

### 4.4. MASONRY GROUT

#### 4.4.1. Laticrete Masonry Pointing Mortar - Gray

- Manufacturer – Laticrete International Inc.
- Lot/Serial No. 372655-001 MFG 03/10

#### 4.4.2. Laticrete Masonry Pointing Mortar – Almond

- Manufacturer – Laticrete International Inc.
- Lot/Serial No. 367073 4 MFG 11/09

# 5 Other Notable Materials

## 5.1. FIBERGLASS-COATED GYPSUM SHEATHING

- 5/8″ thick

## 5.2. CDX PLYWOOD

- 1/2″ thick

## 5.3. GYPSUM BOARD

- 5/8″ Type X Gypsum Board

## 5.4. CEMENT BOARD FIBERGLASS TAPE

- 4″×150′

## 5.5. GALVANIZED STEEL STUDS

- Generic Manufacturer – 6″ wide 18 Ga

## 5.6. MASONRY VENEER UNITS

**5.6.1** Manufactured Stone

**5.6.2** Natural Stone

**5.6.3** Thin Brick

# 6 Test Sample Assembly

## 6.1. ASSEMBLY OF BED BASE on WOOD FRAMES

The bed base on wood frames was constructed in the following manner:

- 1/2″ thick CDX plywood nailed to 2×4 wood stud frame (16″ spacing) with 6d common nails. 6 mil polyethylene sheet was applied between the plywood and studs. The polyethylene sheet overhung the perimeter approximately 12″. Nails were spaced 6″ around perimeter and 12″ on intermediate studs
- 1″ thick rimboard was affixed to each end of the test assembly with six #10 screws
- 1/2″ thick PermaBase® cement board was screwed onto CDX plywood with 2-1/4″ corrosion-resistant screws. Screws were spaced 6″ around the perimeter and along intermediate studs. At 8′ mark, a second sheet of PermaBase® cement board was butt joined next to full sheet. The joint was treated with veneer mortar (about 1/16″ thick) and 4″ wide cement board fibreglass tape.
- Two coats of Hydro Ban™ were rolled on covering the PermaBase® cement board and fibreglass tape (0.030″ total wet thickness)
- 5/8″ gypsum board was placed on back of the assembly and screwed to the studs with 1-1/4″ screws and spaced 12″ throughout.

## 6.2. ASSEMBLY OF BED BASE on METAL FRAMES

The bed base on steel frames was constructed in the following manner:

- 5/8″ thick fibreglass-coated gypsum sheathing was screwed into 6″ 18Ga galvanized steel stud frame (16″ spacing) with 1-1/4″ screws. 6 mil polyethylene sheet was applied between the fibreglass-coated gypsum sheathing and studs. The polyethylene sheet overhung the perimeter approximately 12″. Screws were spaced 12″ around the perimeter and on intermediate studs.
- 1″ thick rimboard was affixed to each end of the test assembly with six #10 screws
- 1/2″ thick PermaBase® cement board was screwed onto plywood with 2-1/4″ corrosion-resistant screws. Screws were spaced 6″ throughout. At 8′ mark, a second sheet of PermaBase® cement board was butt joined next to full sheet. The joint was treated with veneer mortar (about 1/16″ thick) and 4″ wide cement board fibreglass tape.
- Two coats of Hydro Ban™ were rolled on covering the PermaBase® cement board and fibreglass tape (0.030″ total wet thickness).
- 5/8″ gypsum board was placed on back of the assembly and screwed to the studs with 1-1/4″ screws and spaced 12″ throughout.

## 6.3. ASSEMBLY OF MASONRY VENEER UNITS AND GROUTING

Three different types of masonry veneer units were applied to the test frames (natural stone, manufactured stone and thin brick.):

### 6.3.1. MIXING OF MORTAR

The mortar was mixed as per the instructions on the bag. 6.25 quarts (5.9 ℓ) of water was added per 40 lbs bag. The mixture was thoroughly mixed and then allowed to slake for approximately 5 minutes and then mixed again.

The grout was also mixed as per the instructions on the bag. 4 quarts (3.8 ℓ) of water was added to each 50 lbs bag).

### 6.3.2. ASSEMBLY OF MASONRY VENEER UNITS AND GROUTING

The masonry veneer units were brushed on the back to remove excessive dust and loose stones. Laticrete Masonry Veneer Mortar was applied to the bed with a square notch trowel (1/2″ × 1/2″ × 1/2″). The masonry veneer units were laid on the test bed. A spacing of 3/16″ separated each masonry unit. Once the veneer mortar cured, the test samples were grouted. The grouting process was conducted with a grout bag and small amounts of water were added as required to wet the grout and ease the grouting process.

# 7 Testing and Evaluation Methods

## 7.1 DEVIATION FROM ASTM E330-02

Structural performance testing was conducted in one direction only (negative wind load direction). Deviation from the standard procedure was based on the reasonable assumption that negative wind load testing would be the weakest direction, and therefore positive wind load testing was not evaluated. Because of this, the preload pressure (one-half of the test pressure) was not applied prior to the application of the test pressure.

## 7.2 STRUCTURAL PERFORMANCE (UNIFORM LOAD TESTS)

A modified Uniform Load Deflection test was conducted in accordance with ASTM E-330-02 *"Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference,"* Procedure A. The test sample was installed into NGC's Structural Performance Test Frame apparatus. The NGC Structural Performance Test Frame apparatus is set up such that the ends of the sample are fixed against the apparatus. Only one deflection point (at the center of the test sample) is set up at the center. (An assumption is made to ensure that there are no net deflections at the ends of the specimen).

The sample was sealed to the test apparatus. A negative wind load test pressure was applied to the sample until a deflection outlined below was achieved. The test pressure was measured after maintaining the load for 10 seconds. The test sample was observed (through the portholes) and inspected for cracking of the mortar or deterioration of the test sample.

| Test span:120 inches | Deflection | |
|---|---|---|
| 1. | Span/960 | 0.125″ |
| 2. | Span/840 | 0.143″ |
| 3. | Span/720 | 0.167″ |
| 4. | Span/600 | 0.200″ |
| 5. | Span/480 | 0.250″ |
| 6. | Span/360 | 0.333″ |

After two minutes with the pressure released, the residual deflection of the test sample assembly was recorded. Once complete, the samples were subjected to a pressure that corresponded to the next deflection level.

The deflection measurement of the test sample was measured on the interior side of the gypsum board. Simultaneous measurements of the sample were also recorded at the back of the fibreglass-coated gypsum sheathing/plywood on the exterior side of the steel/wood studs.

# 8 Testing and Evaluation Results

## MANUFACTURED STONE ON METAL STUDS

| Test | Manufactured Stone |
|---|---|
| 1 | Steel Studs |

| Frame ID | Span |
|---|---|
| 4 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 12-May-10 | 61.7 | 49% |

| | Load Applied | | |
|---|---|---|---|
| | y | | |
| | " WC | psf | Pa |
| | 5.0 | 26.0 | 1245 |
| | 5.4 | 28.1 | 1345 |
| | 6.4 | 33.3 | 1594 |
| | 7.8 | 40.6 | 1943 |
| | 10.1 | 52.5 | 2516 |
| | 14.0 | 72.8 | 3487 |
| Failure | | | |
| Max | 26.8 | 139.4 | 6676 |

| | Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|---|
| | x | | | | |
| | L/ | inches | mm | inches | mm |
| | 960 | 0.125 | 3.18 | 0.033 | 0.83 |
| | 840 | 0.143 | 3.63 | 0.038 | 0.98 |
| | 720 | 0.167 | 4.24 | 0.048 | 1.22 |
| | 600 | 0.200 | 5.08 | 0.057 | 1.45 |
| | 480 | 0.250 | 6.35 | 0.073 | 1.85 |
| | 360 | 0.333 | 8.46 | 0.085 | 2.17 |
| | | | | | |
| | | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.145 | 3.68 | 0.042 | 1.07 |
| 0.162 | 4.11 | 0.047 | 1.19 |
| 0.185 | 4.70 | 0.054 | 1.37 |
| 0.218 | 5.54 | 0.062 | 1.57 |
| 0.274 | 6.96 | 0.070 | 1.78 |
| 0.360 | 9.14 | 0.085 | 2.16 |
| **Comments:** no failures observed | | | |

| Test | Manufactured Stone |
|---|---|
| 2 | Steel Studs |

| Frame ID | Span |
|---|---|
| 3 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 12-May-10 | 61.7 | 49% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 3.5 | 18.2 | 872 |
| | 4.2 | 21.8 | 1046 |
| | 5.5 | 28.6 | 1370 |
| | 6.2 | 32.3 | 1544 |
| | 8.0 | 41.6 | 1993 |
| | 11.8 | 61.4 | 2939 |
| Failure | | | |
| Max | 24.5 | 127.5 | 6103 |

| | Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|---|
| | L/ | inches | mm | inches | mm |
| | 960 | 0.125 | 3.18 | 0.046 | 1.17 |
| | 840 | 0.143 | 3.63 | 0.054 | 1.38 |
| | 720 | 0.167 | 4.24 | 0.066 | 1.68 |
| | 600 | 0.200 | 5.08 | 0.079 | 2.00 |
| | 480 | 0.250 | 6.35 | 0.097 | 2.46 |
| | 360 | 0.333 | 8.46 | 0.118 | 3.00 |
| | | | | | |
| | | 0.650 | 16.51 | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.138 | 3.51 | 0.056 | 1.42 |
| 0.159 | 4.04 | 0.066 | 1.68 |
| 0.187 | 4.75 | 0.077 | 1.96 |
| 0.216 | 5.49 | 0.085 | 2.16 |
| 0.286 | 7.26 | 0.098 | 2.49 |
| 0.346 | 8.79 | 0.118 | 3.00 |
| **Comments:** lost suction due to plastic tear; no failures observed | | | |

| Test | Manufactured Stone |
|---|---|
| 3 | Steel Studs |

| Frame ID | Span |
|---|---|
| 2 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 12-May-10 | 61.7 | 49% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 4.3 | 22.4 | 1071 |
| | 4.8 | 25.0 | 1196 |
| | 6.0 | 31.2 | 1495 |
| | 7.9 | 41.1 | 1968 |
| | 10.7 | 55.7 | 2665 |
| | 15.0 | 78.0 | 3736 |
| Failure | | | |
| Max | 29.2 | 151.9 | 7273 |

| | Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|---|
| | L/ | inches | mm | inches | mm |
| | 960 | 0.125 | 3.18 | 0.006 | 0.16 |
| | 840 | 0.143 | 3.63 | 0.010 | 0.25 |
| | 720 | 0.167 | 4.24 | 0.014 | 0.36 |
| | 600 | 0.200 | 5.08 | 0.019 | 0.49 |
| | 480 | 0.250 | 6.35 | 0.029 | 0.74 |
| | 360 | 0.333 | 8.46 | 0.046 | 1.18 |
| | | | | | |
| | | 0.701 | 17.81 | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.130 | 3.30 | 0.007 | 0.18 |
| 0.146 | 3.71 | 0.009 | 0.23 |
| 0.171 | 4.34 | 0.014 | 0.36 |
| 0.207 | 5.26 | 0.018 | 0.46 |
| 0.265 | 6.73 | 0.029 | 0.74 |
| 0.360 | 9.14 | 0.048 | 1.22 |
| **Comments:** no catastrophic failure | | | |

## MANUFACTURED STONE ON WOOD STUDS

| Test | Manufactured Stone |
|---|---|
| 1 | Wood Studs |

| Frame ID | Span |
|---|---|
| 1 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 10-May-10 | 62.1 | 49% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 3.2 | 16.6 | 797 |
| | 3.4 | 17.7 | 847 |
| | 3.8 | 19.8 | 947 |
| | 4.3 | 22.4 | 1071 |
| | 5.4 | 28.1 | 1345 |
| | 6.6 | 34.3 | 1644 |
| Failure | 18.6 | 96.8 | 4633 |
| Max | 29.7 | 154.5 | 7398 |

| | Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|---|
| | L/ | inches | mm | inches | mm |
| | 960 | 0.125 | 3.18 | 0.010 | 0.25 |
| | 840 | 0.143 | 3.63 | 0.014 | 0.36 |
| | 720 | 0.167 | 4.24 | 0.018 | 0.45 |
| | 600 | 0.200 | 5.08 | 0.022 | 0.56 |
| | 480 | 0.250 | 6.35 | 0.032 | 0.81 |
| | 360 | 0.333 | 8.46 | 0.044 | 1.13 |
| | | | | | |
| | | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| N/A | N/A | 0.012 | 0.30 |
| 0.150 | 3.81 | 0.017 | 0.43 |
| 0.175 | 4.45 | 0.020 | 0.51 |
| 0.220 | 5.59 | 0.025 | 0.64 |
| 0.260 | 6.60 | 0.036 | 0.91 |
| 0.350 | 8.89 | 0.050 | 1.27 |
| **Comments:** cracking of mortar joint at 18.6 "WC; no catastrophic failure. No defl recorded at L/960 | | | |

| Test | Manufactured Stone |
|---|---|
| 2 | Wood Studs |

| Frame ID | Span |
|---|---|
| 3 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 10-May-10 | 62.1 | 49% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.8 | 14.6 | 697 |
| | 3.0 | 15.6 | 747 |
| | 3.5 | 18.2 | 872 |
| | 4.2 | 21.8 | 1046 |
| | 5.0 | 26.0 | 1245 |
| | 5.8 | 30.2 | 1445 |
| Failure | 19.6 | 102.0 | 4882 |
| Max | 29.8 | 155.0 | 7423 |

| | Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|---|
| | L/ | inches | mm | inches | mm |
| | 960 | 0.125 | 3.18 | 0.009 | 0.24 |
| | 840 | 0.143 | 3.63 | 0.013 | 0.33 |
| | 720 | 0.167 | 4.24 | 0.018 | 0.45 |
| | 600 | 0.200 | 5.08 | 0.024 | 0.61 |
| | 480 | 0.250 | 6.35 | 0.052 | 1.33 |
| | 360 | 0.333 | 8.46 | 0.084 | 2.14 |
| | | 0.160 | 4.06 | | |
| | | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.145 | 3.68 | 0.013 | 0.33 |
| 0.160 | 4.06 | 0.017 | 0.43 |
| 0.184 | 4.67 | 0.022 | 0.56 |
| 0.214 | 5.44 | 0.030 | 0.76 |
| 0.230 | 5.84 | 0.051 | 1.30 |
| 0.330 | 8.38 | 0.075 | 1.91 |
| **Comments:** cracking of mortar joint at 19.6 "WC; no catastrophic failure | | | |

| Test | Manufactured Stone |
|---|---|
| 3 | Wood Studs |

| Frame ID | Span |
|---|---|
| 3 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 10-May-10 | 62.1 | 49% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 3.2 | 16.6 | 797 |
| | 3.5 | 18.2 | 872 |
| | 3.8 | 19.8 | 947 |
| | 4.5 | 23.4 | 1121 |
| | 5.5 | 28.6 | 1370 |
| | 6.8 | 35.4 | 1694 |
| Failure | 12.9 | 67.1 | 3213 |
| Max | 30.2 | 157.1 | 7522 |

| | Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|---|
| | L/ | inches | mm | inches | mm |
| | 960 | 0.125 | 3.18 | 0.013 | 0.32 |
| | 840 | 0.143 | 3.63 | 0.015 | 0.39 |
| | 720 | 0.167 | 4.24 | 0.018 | 0.47 |
| | 600 | 0.200 | 5.08 | 0.024 | 0.60 |
| | 480 | 0.250 | 6.35 | 0.033 | 0.83 |
| | 360 | 0.333 | 8.46 | 0.046 | 1.16 |
| | | 1.400 | 35.56 | | |
| | | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.145 | 3.68 | 0.021 | 0.53 |
| 0.157 | 3.99 | 0.025 | 0.64 |
| 0.180 | 4.57 | 0.028 | 0.71 |
| 0.215 | 5.46 | 0.034 | 0.86 |
| 0.272 | 6.91 | 0.045 | 1.14 |
| 0.360 | 9.14 | 0.058 | 1.47 |
| **Comments:** cracking of mortar joint at 12.9 "WC; no catastrophic failure | | | |

## THIN BRICK ON STEEL STUDS

| Test | Thin Brick |
|---|---|
| 1 | Steel Studs |

| Frame ID | Span |
|---|---|
| 6 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 28-May-10 | 73.9 | 58% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 4.5 | 23.4 | 1121 |
| | 4.8 | 25.0 | 1196 |
| | 5.5 | 28.6 | 1370 |
| | 6.3 | 32.8 | 1569 |
| | 7.5 | 39.0 | 1868 |
| | 11.6 | 60.3 | 2889 |
| Failure | | | |
| Max | 18.4 | 95.7 | 4583 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.006 | 0.14 |
| 840 | 0.143 | 3.63 | 0.038 | 0.97 |
| 720 | 0.167 | 4.24 | 0.050 | 1.26 |
| 600 | 0.200 | 5.08 | 0.071 | 1.79 |
| 480 | 0.250 | 6.35 | 0.083 | 2.11 |
| 360 | 0.333 | 8.46 | 0.099 | 2.52 |
| | | | | |
| | 0.520 | 13.21 | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.152 | 3.86 | 0.016 | 0.41 |
| 0.179 | 4.55 | 0.058 | 1.47 |
| 0.208 | 5.28 | 0.074 | 1.88 |
| 0.251 | 6.38 | 0.098 | 2.49 |
| 0.310 | 7.87 | 0.116 | 2.95 |
| 0.412 | 10.46 | 0.135 | 3.43 |

**Comments:** no failures observed

| Test | Thin Brick |
|---|---|
| 2 | Steel Studs |

| Frame ID | Span |
|---|---|
| 1 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 28-May-10 | 73.9 | 58% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 6.6 | 34.3 | 1644 |
| | 7.5 | 39.0 | 1868 |
| | 8.6 | 44.7 | 2142 |
| | 10.0 | 52.0 | 2491 |
| | 12.0 | 62.4 | 2989 |
| | 15.9 | 82.7 | 3961 |
| Failure | | | |
| Max | 25.6 | 133.2 | 6377 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.006 | 0.14 |
| 840 | 0.143 | 3.63 | 0.009 | 0.22 |
| 720 | 0.167 | 4.24 | 0.012 | 0.31 |
| 600 | 0.200 | 5.08 | 0.017 | 0.42 |
| 480 | 0.250 | 6.35 | 0.022 | 0.57 |
| 360 | 0.333 | 8.46 | 0.034 | 0.86 |
| | | | | |
| | 0.620 | 15.75 | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.148 | 3.76 | 0.018 | 0.46 |
| 0.167 | 4.24 | 0.022 | 0.56 |
| 0.193 | 4.90 | 0.027 | 0.69 |
| 0.230 | 5.84 | 0.032 | 0.81 |
| 0.286 | 7.26 | 0.040 | 1.02 |
| 0.385 | 9.78 | 0.056 | 1.42 |

**Comments:** no failures observed

| Test | Thin Brick |
|---|---|
| 3 | Steel Studs |

| Frame ID | Span |
|---|---|
| 5 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 28-May-10 | 73.9 | 58% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 7.9 | 41.1 | 1968 |
| | 7.8 | 40.6 | 1943 |
| | 8.0 | 41.6 | 1993 |
| | 9.4 | 48.9 | 2341 |
| | 12.2 | 63.5 | 3039 |
| | 15.4 | 80.1 | 3836 |
| Failure | 29.5 | 153.5 | 7348 |
| Max | | | |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.001 | 0.02 |
| 840 | 0.143 | 3.63 | 0.003 | 0.08 |
| 720 | 0.167 | 4.24 | 0.002 | 0.04 |
| 600 | 0.200 | 5.08 | 0.004 | 0.10 |
| 480 | 0.250 | 6.35 | 0.015 | 0.37 |
| 360 | 0.333 | 8.46 | 0.030 | 0.75 |
| | 0.780 | 19.81 | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.169 | 4.29 | 0.022 | 0.56 |
| 0.185 | 4.70 | 0.027 | 0.69 |
| 0.206 | 5.23 | 0.027 | 0.69 |
| 0.242 | 6.15 | 0.032 | 0.81 |
| 0.300 | 7.62 | 0.043 | 1.09 |
| 0.390 | 9.91 | 0.061 | 1.55 |

**Comments:** Top screw at base sheared off

## THIN BRICK ON WOOD STUDS

| Test | Thin Brick |
|---|---|
| 1 | Wood Studs |

| Frame ID | Span |
|---|---|
| 5 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 10-May-10 | 64.3 | 46% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.2 | 11.4 | 548 |
| | 2.5 | 13.0 | 623 |
| | 2.9 | 15.1 | 722 |
| | 3.2 | 16.6 | 797 |
| | 4.1 | 21.3 | 1021 |
| | 5.0 | 26.0 | 1245 |
| Failure | 22.6 | 117.6 | 5629 |
| Max | 25.8 | 134.2 | 6426 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.011 | 0.28 |
| 840 | 0.143 | 3.63 | 0.017 | 0.42 |
| 720 | 0.167 | 4.24 | 0.023 | 0.58 |
| 600 | 0.200 | 5.08 | 0.030 | 0.77 |
| 480 | 0.250 | 6.35 | 0.057 | 1.45 |
| 360 | 0.333 | 8.46 | 0.076 | 1.93 |
| | 2.000 | 50.80 | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.110 | 2.79 | 0.016 | 0.41 |
| 0.132 | 3.35 | 0.024 | 0.61 |
| 0.150 | 3.81 | 0.032 | 0.81 |
| 0.195 | 4.95 | 0.040 | 1.02 |
| 0.240 | 6.10 | 0.068 | 1.73 |
| 0.331 | 8.41 | 0.086 | 2.18 |

**Comments:** Top screw at base sheared off

| Test | Thin Brick |
|---|---|
| 2 | Wood Studs |

| Frame ID | Span |
|---|---|
| 4 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 11-May-10 | 61.4 | 48% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.4 | 12.5 | 598 |
| | 2.9 | 15.1 | 722 |
| | 3.3 | 17.2 | 822 |
| | 3.8 | 19.8 | 947 |
| | 4.8 | 25.0 | 1196 |
| | 6.0 | 31.2 | 1495 |
| Failure | 15.9 | 82.7 | 3961 |
| Max | 26.7 | 138.9 | 6651 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.006 | 0.15 |
| 840 | 0.143 | 3.63 | 0.008 | 0.21 |
| 720 | 0.167 | 4.24 | 0.011 | 0.27 |
| 600 | 0.200 | 5.08 | 0.015 | 0.37 |
| 480 | 0.250 | 6.35 | 0.021 | 0.52 |
| 360 | 0.333 | 8.46 | 0.032 | 0.82 |
| | | | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.125 | 3.18 | 0.009 | 0.23 |
| 0.145 | 3.68 | 0.011 | 0.28 |
| 0.167 | 4.24 | 0.014 | 0.36 |
| 0.200 | 5.08 | 0.017 | 0.43 |
| 0.250 | 6.35 | 0.024 | 0.61 |
| 0.330 | 8.38 | 0.035 | 0.89 |

**Comments:** cracking of mortar joint at 15.9 "WC; no catastrophic failure

| Test | Thin Brick |
|---|---|
| 3 | Wood Studs |

| Frame ID | Span |
|---|---|
| 7 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 11-May-10 | 61.4 | 48% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.4 | 12.5 | 598 |
| | 2.6 | 13.5 | 648 |
| | 2.9 | 15.1 | 722 |
| | 3.5 | 18.2 | 872 |
| | 4.1 | 21.3 | 1021 |
| | 5.4 | 28.1 | 1345 |
| Failure | | | |
| Max | 28.8 | 149.8 | 7174 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.006 | 0.14 |
| 840 | 0.143 | 3.63 | 0.009 | 0.22 |
| 720 | 0.167 | 4.24 | 0.010 | 0.25 |
| 600 | 0.200 | 5.08 | 0.014 | 0.36 |
| 480 | 0.250 | 6.35 | 0.022 | 0.55 |
| 360 | 0.333 | 8.46 | 0.038 | 0.97 |
| | | | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.125 | 3.18 | 0.012 | 0.30 |
| 0.143 | 3.63 | 0.016 | 0.41 |
| 0.170 | 4.32 | 0.018 | 0.46 |
| 0.203 | 5.16 | 0.023 | 0.59 |
| 0.252 | 6.40 | 0.031 | 0.79 |
| 0.340 | 8.64 | 0.046 | 1.17 |

**Comments:** no failures observed

## NATURAL STONE ON METAL STUDS

| Test | Natural Stone (Granite) |
|---|---|
| 1 | Metal Studs |

| Frame ID | Span |
|---|---|
| 9 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 14-May-10 | 61.9 | 60% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 7.1 | 36.9 | 1769 |
| | 7.7 | 40.1 | 1918 |
| | 9.1 | 47.3 | 2267 |
| | 10.2 | 53.1 | 2541 |
| | 12.4 | 64.5 | 3089 |
| | 15.9 | 82.7 | 3961 |
| Failure | | | |
| Max | 31.5 | 163.9 | 7846 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.015 | 0.38 |
| 840 | 0.143 | 3.63 | 0.018 | 0.46 |
| 720 | 0.167 | 4.24 | 0.021 | 0.54 |
| 600 | 0.200 | 5.08 | 0.025 | 0.65 |
| 480 | 0.250 | 6.35 | 0.031 | 0.79 |
| 360 | 0.333 | 8.46 | 0.041 | 1.04 |
| | | | | |
| | 0.835 | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.142 | 3.61 | 0.022 | 0.56 |
| 0.165 | 4.19 | 0.026 | 0.66 |
| 0.195 | 4.95 | 0.030 | 0.76 |
| 0.238 | 6.05 | 0.036 | 0.91 |
| 0.304 | 7.72 | 0.044 | 1.12 |
| 0.402 | 10.21 | 0.054 | 1.37 |

**Comments:** no failures observed

| Test | Natural Stone (Granite) |
|---|---|
| 2 | Metal Studs |

| Frame ID | Span |
|---|---|
| 7 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 14-May-10 | 61.9 | 60% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 5.2 | 27.1 | 1295 |
| | 5.4 | 28.1 | 1345 |
| | 6.2 | 32.3 | 1544 |
| | 7.0 | 36.4 | 1744 |
| | 10.1 | 52.5 | 2516 |
| | 13.6 | 70.8 | 3388 |
| Failure | | | |
| Max | 29.2 | 151.9 | 7273 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.025 | 0.64 |
| 840 | 0.143 | 3.63 | 0.031 | 0.78 |
| 720 | 0.167 | 4.24 | 0.035 | 0.88 |
| 600 | 0.200 | 5.08 | 0.040 | 1.00 |
| 480 | 0.250 | 6.35 | 0.049 | 1.23 |
| 360 | 0.333 | 8.46 | 0.063 | 1.60 |
| | | | | |
| | 0.820 | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.145 | 3.68 | 0.032 | 0.81 |
| 0.171 | 4.34 | 0.039 | 0.99 |
| 0.197 | 5.00 | 0.043 | 1.09 |
| 0.237 | 6.02 | 0.049 | 1.24 |
| 0.295 | 7.49 | 0.060 | 1.52 |
| 0.400 | 10.16 | 0.078 | 1.98 |

**Comments:** no failures observed

| Test | Natural Stone (Granite) |
|---|---|
| 3 | Metal Studs |

| Frame ID | Span |
|---|---|
| 8 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 14-May-10 | 61.9 | 60% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 6.8 | 35.4 | 1694 |
| | 7.8 | 40.6 | 1943 |
| | 9.2 | 47.9 | 2292 |
| | 11.0 | 57.2 | 2740 |
| | 12.7 | 66.1 | 3163 |
| | 15.9 | 82.7 | 3961 |
| Failure | 29.2 | 151.9 | 7273 |
| Max | | | |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.000 | 0.00 |
| 840 | 0.143 | 3.63 | 0.000 | 0.00 |
| 720 | 0.167 | 4.24 | 0.000 | 0.01 |
| 600 | 0.200 | 5.08 | 0.001 | 0.03 |
| 480 | 0.250 | 6.35 | 0.007 | 0.19 |
| 360 | 0.333 | 8.46 | 0.023 | 0.58 |
| | 0.640 | 16.26 | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.148 | 3.76 | 0.006 | 0.15 |
| 0.169 | 4.29 | 0.008 | 0.20 |
| 0.196 | 4.98 | 0.009 | 0.23 |
| 0.235 | 5.97 | 0.015 | 0.38 |
| 0.300 | 7.62 | 0.019 | 0.48 |
| 0.405 | 10.29 | 0.037 | 0.94 |

**Comments:** Top screws at base sheared off

## NATURAL STONE ON WOOD STUDS

| Test | Natural Stone (Granite) |
|---|---|
| 1 | Wood Studs |

| Frame ID | Span |
|---|---|
| 6 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 11-May-10 | 60.4 | 48% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.7 | 14.0 | 673 |
| | 2.9 | 15.1 | 722 |
| | 3.3 | 17.2 | 822 |
| | 3.2 | 16.6 | 797 |
| | 3.2 | 16.6 | 797 |
| | 4.5 | 23.4 | 1121 |
| Failure | 16.0 | 83.2 | 3985 |
| Max | 25.8 | 134.2 | 6426 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.006 | 0.14 |
| 840 | 0.143 | 3.63 | 0.011 | 0.27 |
| 720 | 0.167 | 4.24 | 0.050 | 1.26 |
| 600 | 0.200 | 5.08 | 0.057 | 1.44 |
| 480 | 0.250 | 6.35 | 0.083 | 2.11 |
| 360 | 0.333 | 8.46 | 0.124 | 3.16 |
| | 1.350 | 34.29 | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.130 | 3.30 | 0.001 | 0.03 |
| 0.147 | 3.73 | 0.005 | 0.13 |
| 0.180 | 4.57 | 0.031 | 0.79 |
| 0.193 | 4.90 | 0.037 | 0.94 |
| 0.238 | 6.05 | 0.054 | 1.37 |
| 0.310 | 7.87 | 0.084 | 2.13 |

**Comments:** cracking of mortar joint at 16.0 "WC; no catastrophic failure

| Test | Natural Stone (Granite) |
|---|---|
| 2 | Wood Studs |

| Frame ID | Span |
|---|---|
| 9 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 11-May-10 | 60.4 | 48% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.2 | 11.4 | 548 |
| | 2.5 | 13.0 | 623 |
| | 2.6 | 13.5 | 648 |
| | 3.2 | 16.6 | 797 |
| | 3.8 | 19.8 | 947 |
| | 4.9 | 25.5 | 1221 |
| Failure | 19.0 | 98.8 | 4733 |
| Max | 28.1 | 146.2 | 6999 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.003 | 0.08 |
| 840 | 0.143 | 3.63 | 0.005 | 0.13 |
| 720 | 0.167 | 4.24 | 0.008 | 0.19 |
| 600 | 0.200 | 5.08 | 0.014 | 0.36 |
| 480 | 0.250 | 6.35 | 0.026 | 0.66 |
| 360 | 0.333 | 8.46 | 0.049 | 1.24 |
| | 1.650 | 41.91 | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.032 | 0.81 | 0.007 | 0.18 |
| 0.051 | 1.30 | 0.009 | 0.23 |
| 0.076 | 1.93 | 0.013 | 0.33 |
| 0.112 | 2.84 | 0.020 | 0.51 |
| 0.170 | 4.32 | 0.034 | 0.86 |
| 0.265 | 6.73 | 0.061 | 1.55 |

**Comments:** cracking of mortar joint at 19.0 "WC; no catastrophic failure

| Test | Natural Stone (Granite) |
|---|---|
| 3 | Wood Studs |

| Frame ID | Span |
|---|---|
| 8 | 120" |

| Test Date | Temp (°F) | Humidity |
|---|---|---|
| 11-May-10 | 60.4 | 48% |

| | Load Applied | | |
|---|---|---|---|
| | " WC | psf | Pa |
| | 2.7 | 14.0 | 673 |
| | 3.0 | 15.6 | 747 |
| | 3.4 | 17.7 | 847 |
| | 3.9 | 20.3 | 971 |
| | 4.6 | 23.9 | 1146 |
| | 5.8 | 30.2 | 1445 |
| Failure | | 0.0 | 0 |
| Max | 26.4 | 137.3 | 6576 |

| Assembly Deflection | | | Assembly Residual Defl. | |
|---|---|---|---|---|
| L/ | inches | mm | inches | mm |
| 960 | 0.125 | 3.18 | 0.007 | 0.18 |
| 840 | 0.143 | 3.63 | 0.011 | 0.27 |
| 720 | 0.167 | 4.24 | 0.015 | 0.38 |
| 600 | 0.200 | 5.08 | 0.021 | 0.54 |
| 480 | 0.250 | 6.35 | 0.031 | 0.78 |
| 360 | 0.333 | 8.46 | 0.044 | 1.12 |
| | | | | |
| | | | | |

| Back of Panel Deflection | | Back of Panel Residual Defl. | |
|---|---|---|---|
| inches | mm | inches | mm |
| 0.125 | 3.18 | 0.008 | 0.20 |
| 0.145 | 3.68 | 0.012 | 0.30 |
| 0.172 | 4.37 | 0.018 | 0.46 |
| 0.209 | 5.31 | 0.025 | 0.64 |
| 0.262 | 6.65 | 0.035 | 0.89 |
| 0.352 | 8.94 | 0.050 | 1.27 |

**Comments:** no failures observed

# 9 Summarized Results

**Negative Wind Load Pressure Test**

| Masonry Veneer | Sheathing material | Stud wall construction | Ultimate Load (psf) | | |
|---|---|---|---|---|---|
| | | | Test 1 | Test 2 | Test 3 |
| Manufactured Stone | CDX Plywood | 2×4 Wood studs | 96.8 | 102.0 | 67.1 |
| Natural Stone | CDX Plywood | 2×4 Wood studs | 83.2 | 98.8 | *137.3** |
| Thin Brick | CDX Plywood | 2×4 Wood studs | 117.6 | 82.7 | *149.8** |
| Manufactured Stone | Fiberglass-coated gypsum sheathing | 16 Ga steel studs | *139.4** | *127.5** | *151.9** |
| Natural Stone | Fiberglass-coated gypsum sheathing | 16 Ga steel studs | *163.9** | *151.9** | 151.9 |
| Thin Brick | Fiberglass-coated gypsum sheathing | 16 Ga steel studs | *95.7** | *133.2** | 153.5 |

**includes a maximum obtainable load in which failure was not reached*

# 10 Conclusion

A total of 18 test walls were witnessed for installation and subsequent structural testing. All observations and test results are reported herein.

At the deflection of L/600, there were no mortar cracks, no mortar failures or any wall system failures observed. The wall assemblies were also tested to a more rigorous deflection of L/360 at which there were no mortar cracks, no mortar failures or any wall system failures observed.

All tested wall assemblies witnessed by Intertek and reported herein were tested to meet the standard range of wall deflections, including a deflection of L/600 which is required to adhered masonry veneer installations per International Building Code sections 1405.9 (2006) and 1405.10 (2009).

**INTERTEK**

Components verified, construction witnessed, test supervised and reported by:

Claudio Sacilotto
**Physical Testing Services**

Reviewed by:

Ryan Huynh
**Physical Testing Services**

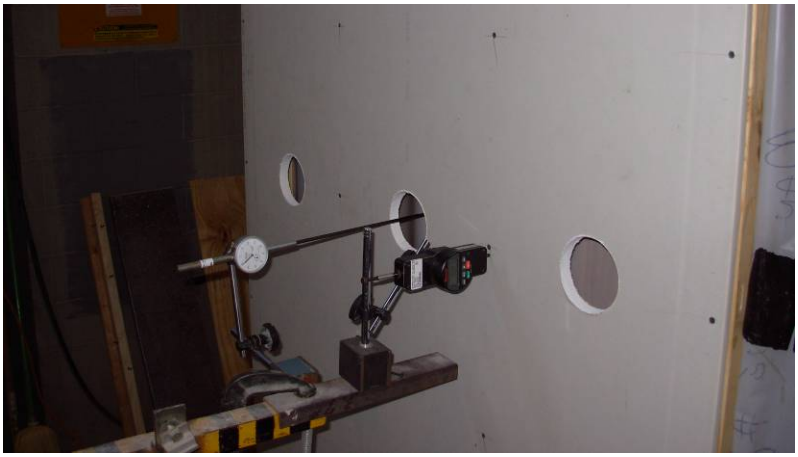
# Appendix A – Photos

(Photos – 2 Pages)

Masonry application on to test frame

Grouting of masonry units

Structural performance test frame with wall assembly installed



Gage locations on test wall assembly. One gage on back of wall assembly and one gage on back of plywood/fiberglass gypsum sheathing