MOCK-UP TEST REPORT

Rendered to:

SMITH-MIDLAND CORPORATION

PROJECT: Slenderwall Precast Concrete Panel
MOCK-UP TEST REPORT

Rendered to:

SMITH-MIDLAND CORPORATION
Route 28
Midland, Virginia 22728

Project: 60 PSF Slenderwall Precast Concrete Panel

Report No: 01-31388.02
Test Date: 04/09/98
Thru: 04/22/98
Report Date: 06/12/98

Project Summary: Architectural Testing, Inc. (ATI) was contracted by Smith-Midland Corporation to conduct performance testing on a mock-up of the referenced project. All testing was performed in accordance with the attached test procedure. This report includes detailed written and photographic documentation of all testing and results thereof and a copy of the “As-Tested” mock-up drawing.

Drawing Reference: Smith-Midland’s drawing titled Test Panel dated 05/26/98

General Mock-Up Description:

Overall Size: 8’ 1” wide x 12’ 1” high

Type: The system tested was a reinforced concrete panel. The concrete was 2” thick and contained a 6 x 6-W2.9 x W2.9 mesh reinforcing measuring 11’ 9” x 7’ 9”. The concrete panel was attached to a 6” 16 gauge galvanized stud wall. The studs were located 2’ 0” on center. ½” x 1 ½” stainless steel Nelson stud anchors with a specially formulated epoxy thermal break coating were used 2’ 0” on center to attach the concrete panel to the galvanized studs. The entire panel system was anchored to the steel test chamber using 4” x 7-1/2” 3/16” thick steel plates, which was fully welded to the chamber and bolted to the studs. The system anchors were located on the 2nd and 4th studs, 6” from each end. Reference the attached drawing for additional construction details.

Test Methods:

Air Infiltration-ASTM E283-91, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen. Testing was conducted at 6.24 psf positive static air pressure difference.

Static Pressure Water Resistance-ASTM E331-93, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference. Testing was conducted at 10.0 psf positive static air pressure difference for a 15 minute duration. Water was applied to the mock-up at a maximum rate of 5 gal/ft²/hr.

Dynamic Pressure Water Resistance - AAMA 501.1-94, Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure. Testing was conducted with a dynamic pressure equivalent of 10.0 psf for a 15 minute duration. Water was applied to the mock-up at a minimum rate of 5 gal/ft²/hr.
Test Methods: (Continued)

Structural Performance—ASTM E330-96, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference. Testing was conducted at positive and negative loads as indicated in the test results.

Thermal Cycling—AAMA 501.5-98, Test Method for Thermal Cycling of Exterior Walls. Reference should be made to test No. 9 in the attached Test Procedure and to the test results.

Seismic Test (Lateral Cycling) — AAMA 501.4-98, Standard Test Method for Evaluating Performance of Curtain Walls Due to Displacements Associated with Seismic Movements and Building Sway. Reference should be made to test No. 14 in the attached Test Procedure and to the test results.

Test Witnesses: The following representatives witnessed all or part of the testing.

Rodney Smith
Rick Groves
Allen Reeves
Tom Sands
Joseph Wise

Smith-Midland
Smith-Midland
Architectural Testing, Inc.
Architectural Testing, Inc.

TEST RESULTS

<table>
<thead>
<tr>
<th>Title of test</th>
<th>Measured</th>
<th>Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preload at +50% Design Pressure (15.0 psf)</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>Static Pressure Air Infiltration @ 6.24 psf</td>
<td>&lt;0.01 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
</tr>
<tr>
<td>Static Pressure Water Resistance @10.0 psf</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>Dynamic Pressure Water Resistance @ 10.0 psf</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>Uniform Load Deflection @ Design Loads (±60.0 psf)</td>
<td>See Table #1 and Sketch #1</td>
<td>See Table #1</td>
</tr>
<tr>
<td>Repeat Static Pressure Air Infiltration @ 6.24 psf</td>
<td>&lt;0.01 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
</tr>
<tr>
<td>Repeat Static Pressure Water Resistance @ 10.0 psf</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
</tbody>
</table>
**TEST RESULTS**
(Continued)

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Measured</th>
<th>Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat Dynamic Pressure Water Resistance</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>@ 10.0 psf</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>Thermal Cycling (0F to 160F)</td>
<td>See Note #1, Table #2 and Sketch #2</td>
<td></td>
</tr>
<tr>
<td>Repeat Static Pressure Air Infiltration</td>
<td>&lt;0.01 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
</tr>
<tr>
<td>@ 6.24 psf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat Static Pressure Water Resistance</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>@ 10.0 psf</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>Repeat Dynamic Pressure Water Resistance</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>@ 10.0 psf</td>
<td>No leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>Uniform Structural Overloads</td>
<td>See Table #3 and Sketch #1</td>
<td></td>
</tr>
<tr>
<td>@ 150% Design Loads (±90.0psf)</td>
<td>See Table #3</td>
<td></td>
</tr>
<tr>
<td>Seismic Test (Lateral Cycling to ±1.62&quot;)</td>
<td>See Note #2</td>
<td></td>
</tr>
</tbody>
</table>

**Note #1:** The thermal cycling was conducted according to the attached test procedure. At the conclusion of the cycling, there were no visible detrimental effects to the wall. Reference Table #2 and Sketch #2 for Temperatures and Deflection recorded during the cycling.

**Note #2:** There was visible distortion occurring to the metal framing and anchoring system, however there was no failure. Refer to the photo section for additional information.

The "As Built" mock-up drawings and a copy of this report will be retained by ATI for a period of four years. This report is the exclusive property of the client so named herein and is applicable to the sample tested. Results obtained are tested values and do not constitute an opinion or endorsement by this laboratory.

For ARCHITECTURAL TESTING, INC.:

[Signature]
Joseph W. Wise  
Sr. Project Manager

[Signature]
Allen R. Reeves, P.E.  
Director of Engineering  
12 JUNE 1998
Report No.: 01-31388.01

Requested by: Rick Groves, Smith-Midland Corporation
Purpose: Summary Report for Slenderwall Precast Concrete Panel Project
Issued Date: 04/23/98
Comments:

Report No.: 01-31388.02

Requested by: Rick Groves, Smith-Midland Corporation
Purpose: Mock-Up Test Report for Slenderwall Precast Concrete Panel Project
Issued Date: 06/12/98
Comments: California P.E. seal requested on report.
Curtain Wall Mock-up Test Procedure

for

SLENDERWALL PRECAST CONCRETE PANEL SYSTEM

Mock-up testing for the Slanderwall Precast Concrete Panel System project shall be performed in accordance with referenced test methods. Mock-up is subject to observation by Owner, Architect, and their consultants during construction and testing.

The final test procedure shall be as follows:

1. **Preload (ASTM E330):** Preload the mock-up at 50% of the inward design pressure (+115.0 psf) for a period of 10 seconds.

2. **Static Pressure Air Infiltration (ASTM E283):** Air infiltration tests will be conducted at 6.24 psf. Allowable air leakage shall not exceed 0.06 cfm/ft² of fixed area. A chamber tare calibration will be performed immediately prior to the air infiltration test.

3. **Static Pressure Water Resistance (ASTM E331):** Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft² at a pressure differential of 10 psf. No uncontrolled water penetration is allowed. Water penetration is defined as the appearance of uncontrolled water on the indoor face of any part of the work. Controlled water or condensation is that which is demonstrably drained harmlessly to the exterior without endangering or construction.

4. **Dynamic Pressure Water Resistance (AAMA 501.1-83):** Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft² and dynamic air stream equivalent to static pressure of 10 psf. No uncontrolled water penetration is allowed. Engine calibration shall be performed prior to testing.

5. **Uniform Load Deflection Test (ASTM E330):** Deflection of the system shall be tested at design pressure when held for 10 seconds.

5.A The deflection within the system in a direction normal or perpendicular to the plane of the wall when subjected to a uniform load deflection test in accordance with ASTM E-330-90 shall not exceed 1/360 of its clear span or 3/4", whichever is less.

Each load shall be held for 10 seconds as follows:

+15.0 psf - 50% Positive Design Load
+30.0 psf - 100% Positive Design Load
-15.0 psf - 50% Negative Design Load
-30.0 psf - 100% Negative Design Load
6. **Repeat Static Pressure Air Infiltration (ASTM E283):** Air infiltration tests will be conducted at 6.24 psf. Allowable air leakage shall not exceed 0.06 cfm/ft² of fixed area.

7. **Repeat Static Pressure Water Resistance (ASTM E331):** Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft² at a pressure differential of 10 psf. No uncontrolled water penetration is allowed.

8. **Repeat Dynamic Pressure Water Resistance (AAMA 501.1-83):** Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft² and dynamic air stream equivalent to static pressure of 10 psf. No uncontrolled water penetration is allowed.

9. **Thermal Cycles:** The entire mock-up shall be subjected to three thermal cycles; each cycle shall consist of:
   
   a. Nominal exterior air temperature of 0°F and nominal interior air temperature of 70°F for two hours after establishing equilibrium.
   
   b. Nominal exterior surface temperature of 160°F with a nominal interior air temperature of 70°F for two hours after establishing equilibrium.

   At the conclusion of thermal cycling the wall shall be inspected for detrimental effects.

10. **Repeat Static Pressure Air Infiltration (ASTM E283):** Air infiltration tests will be conducted at 6.24 psf. Allowable air leakage shall not exceed 0.06 cfm/ft² of fixed area.

11. **Repeat Static Pressure Water Resistance (ASTM E331):** Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft² at a pressure differential of 10 psf. No uncontrolled water penetration is allowed.

12. **Repeat Dynamic Pressure Water Resistance (AAMA 501.1-83):** Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft² and dynamic air stream equivalent to static pressure of 10 psf. No uncontrolled water penetration is allowed.

13. **Uniform Structural Overload (ASTM E330):** Each load will be held for 10 seconds as follows:

   +45.0 psf  -  (75% of Positive Design Pressure)  -  to remove slack
   +90.0 psf  -  (150% of Positive Design Pressure)  -  positive overload
   -45.0 psf  -  (75% of Negative Design Pressure)  -  to remove slack
   -90.0 psf  -  (150% of Negative Design Pressure)  -  negative overload

   At the conclusion of this test there shall be no glass breakage, permanent damage to fasteners or anchors, hardware parts or actuating mechanisms. Main frame members shall have no permanent deformation in excess of 0.1% of their clear span.
14. **Seismic Test (Lateral Cycling):** Three cycles as follows:

One cycle shall consist of moving the lower floor simulation laterally 1.62" to the left, back to "zero", 1.62" to the right, and back to "zero".

At the conclusion of the cycling the mock-up will be inspected for any detrimental effects.

JWW; dml
cc: 01-31388
# TABLE 1
Uniform Load Deflection
(Deflection in inches)

<table>
<thead>
<tr>
<th>Indicator Location</th>
<th>Positive 60.0 psf</th>
<th>Net Deflection</th>
<th>Negative 60.0 psf</th>
<th>Net Deflection</th>
<th>Allowed (L/360)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.280</td>
<td>0.280</td>
<td>0.250</td>
<td>0.250</td>
<td>0.366</td>
</tr>
<tr>
<td>2</td>
<td>0.015</td>
<td>---</td>
<td>0.015</td>
<td>0.045</td>
<td>---</td>
</tr>
<tr>
<td>3</td>
<td>0.310</td>
<td>0.277</td>
<td>0.290</td>
<td>0.255</td>
<td>0.400</td>
</tr>
<tr>
<td>4</td>
<td>0.050</td>
<td>---</td>
<td>0.055</td>
<td>0.490</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>0.235</td>
<td>---</td>
<td>0.225</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>0.275</td>
<td>0.003</td>
<td>0.260</td>
<td>0.003</td>
<td>0.133</td>
</tr>
<tr>
<td>7</td>
<td>0.310</td>
<td>---</td>
<td>0.290</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Note: See Sketch #1 for indicator locations.

# TABLE 2
Average Temps.(F)/Deflection
Recorded During Thermal Cycling

<table>
<thead>
<tr>
<th>Location</th>
<th>Cold Cycle</th>
<th>Hot Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Ambient</td>
<td>68</td>
<td>75</td>
</tr>
<tr>
<td>Exterior Ambient</td>
<td>0</td>
<td>205</td>
</tr>
<tr>
<td>Averager on Ext. Surface</td>
<td>21.9</td>
<td>155</td>
</tr>
<tr>
<td>T1</td>
<td>34.5</td>
<td>145.2</td>
</tr>
<tr>
<td>T2</td>
<td>38.3</td>
<td>137.1</td>
</tr>
<tr>
<td>T3</td>
<td>30.4</td>
<td>137.6</td>
</tr>
<tr>
<td>T4</td>
<td>29.4</td>
<td>138.4</td>
</tr>
<tr>
<td>T5</td>
<td>33.8</td>
<td>120.1</td>
</tr>
<tr>
<td>D1</td>
<td>+0.037”</td>
<td>-0.041”</td>
</tr>
</tbody>
</table>

Note: See Sketch #2 for locations.

# TABLE 3
Uniform Structural Overloads
(Permanent Set in inches)

<table>
<thead>
<tr>
<th>Indicator Location</th>
<th>Positive 90.0 psf</th>
<th>Net Perm. Set</th>
<th>Negative 90.0 psf</th>
<th>Net Perm. Set</th>
<th>Allowed (.1% of span)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.045</td>
<td>0.045</td>
<td>0.040</td>
<td>0.040</td>
<td>0.132</td>
</tr>
<tr>
<td>2</td>
<td>0.005</td>
<td>---</td>
<td>0.010</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3</td>
<td>0.055</td>
<td>0.040</td>
<td>0.055</td>
<td>0.040</td>
<td>0.144</td>
</tr>
<tr>
<td>4</td>
<td>0.025</td>
<td>---</td>
<td>0.020</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>0.045</td>
<td>---</td>
<td>0.030</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>0.050</td>
<td>0.000</td>
<td>0.045</td>
<td>0.003</td>
<td>0.048</td>
</tr>
<tr>
<td>7</td>
<td>0.055</td>
<td>---</td>
<td>0.055</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Note: 1. See Sketch #1 for indicator locations.
Photo No. 1
Steel Test Chamber

Photo No. 2
Bottom Panel Anchor
Photo No. 5
Dynamic Water Pressure Test

Photo No. 6
Dial Indicators Used During Uniform Structural Loading
Photo No. 9
Seismic Evaluation

Photo No. 10
Bottom Anchor Bending Causing Stud Rotation During Seismic Test
Photo No. 11
Top Anchor Bending Causing Stud Rotation During Seismic Test

Photo No. 12
Bottom Plate Deforming During Seismic Test