MOCK-UP TEST REPORT

Rendered to:

SMITH-MIDLAND CORPORATION

PROJECT: Slenderwall Precast Concrete Panel

ARCHITECTURAL TESTING INC.

Laboratories in Pennsylvania, Minnesota & California

ARCHITECTURAL TESTING INC.
130 Derry Court • York, PA 17402-9405
web www.testati.com • Facsimile 717-764-4129 • Telephone 717-764-7700

MOCK-UP TEST REPORT

Rendered to:

SMITH-MIDLAND CORPORATION
Route 28
Midland, Virginia 22728

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

Project: 60 PSF Slenderwall Precast Concrete Panel

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. ¼" 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/ft^2/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/ft^2/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	Smith-Midland
Rick Groves	Smith-Midland
Allen Reeves	Architectural Testing, Inc.
Tom Sands	Architectural Testing, Inc.
Joseph Wise	Architectural Testing, Inc.

TEST RESULTS

Title of test	Measured	Allowed
Preload at +50% Design Pressure (15.0 psf)	-----	
Static Pressure Air Infiltration @ 6.24 psf	<0.01 cfm/ft^2	0.06 cfm/ft^2 max.
Static Pressure Water Resistance @10.0 psf	No leakage	No leakage
Dynamic Pressure Water Resistance @ 10.0 psf	No leakage	No leakage
Uniform Load Deflection @ Design Loads (±60.0psf)	See Table #1 and Sketch #1	See Table #1
Repeat Static Pressure Air Infiltration @ 6.24 psf	<0.01 cfm/ft^2	0.06 cfm/ft^2 max.
Repeat Static Pressure Water Resistance @ 10.0 psf	No leakage	No leakage

TEST RESULTS
(Continued)

Title of test	Measured	Allowed
Repeat Dynamic Pressure Water Resistance @ 10.0 psf	No leakage	No leakage
Thermal Cycling (0F to 160F)	See Note #1, Table #2 and Sketch #2	

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.*

Repeat Static Pressure Air Infiltration @ 6.24 psf	<0.01 cfm/ft^2	0.06 cfm/ft^2 max.
Repeat Static Pressure Water Resistance @ 10.0 psf	No leakage	No leakage
Repeat Dynamic Pressure Water Resistance @ 10.0 psf	No leakage	No leakage
Uniform Structural Overloads @ 150% Design Loads (±90.0psf)	See Table #3 and Sketch #1	See Table #3
Seismic Test (Lateral Cycling to ±1.62")	See Note #2	

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.:

Joseph W. Wise
Sr. Project Manager

JWW:ksk

Allen R. Reeves, P.E.
Director of Engineering
12 JUNE 1998

REGISTERED PROFESSIONAL ENGINEER
ALLEN N. REEVES
C 056869
EXP. 30 JUNE 2001
CIVIL
STATE OF CALIFORNIA

DOCUMENT CONTROL ADDENDUM #01-31388.00

Current Issue Date: 06/12/98

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.

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Curtain Wall Mock-up Test Procedure

for

SLENDERWALL PRECAST CONCRETE PANEL SYSTEM

Mock-up testing for the *Slenderwall 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 l/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)

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

Note: See Sketch #1 for indicator locations.

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

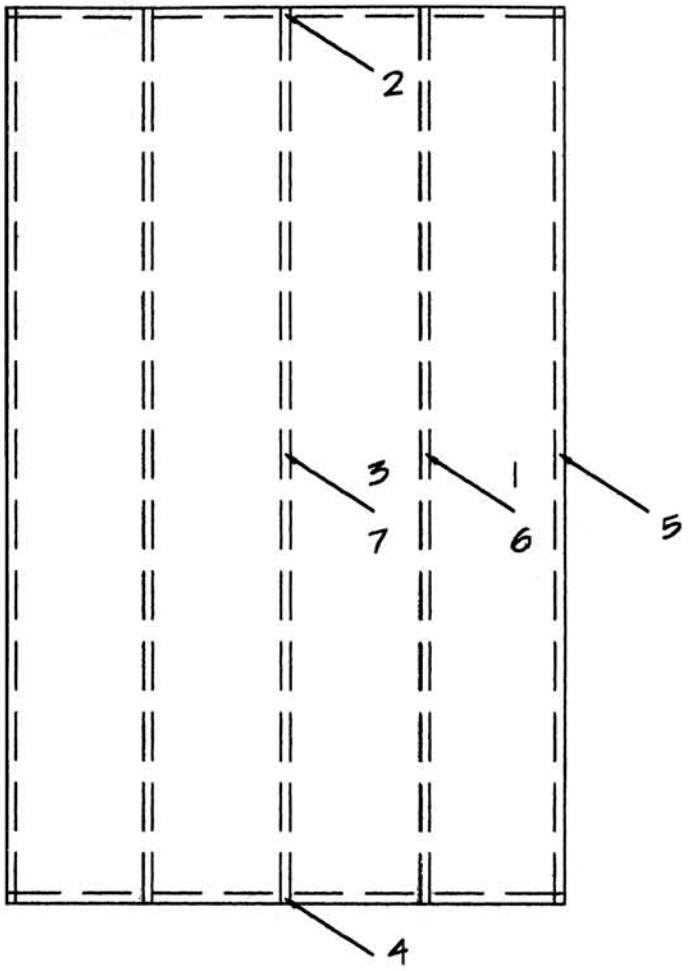
Location	Cold Cycle	Hot Cycle
Interior Ambient	68	75
Exterior Ambient	0	205
Averager on Ext. Surface	21.9	155
T1	34.5	145.2
T2	38.3	137.1
T3	30.4	137.6
T4	29.4	138.4
T5	33.8	120.1
D1	+0.037"	-0.041"

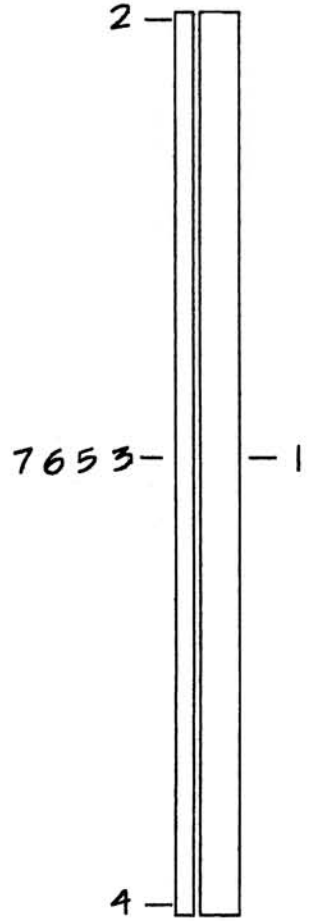
Note: See Sketch #2 for locations.

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

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

Note: 1. See Sketch #1 for indicator locations.

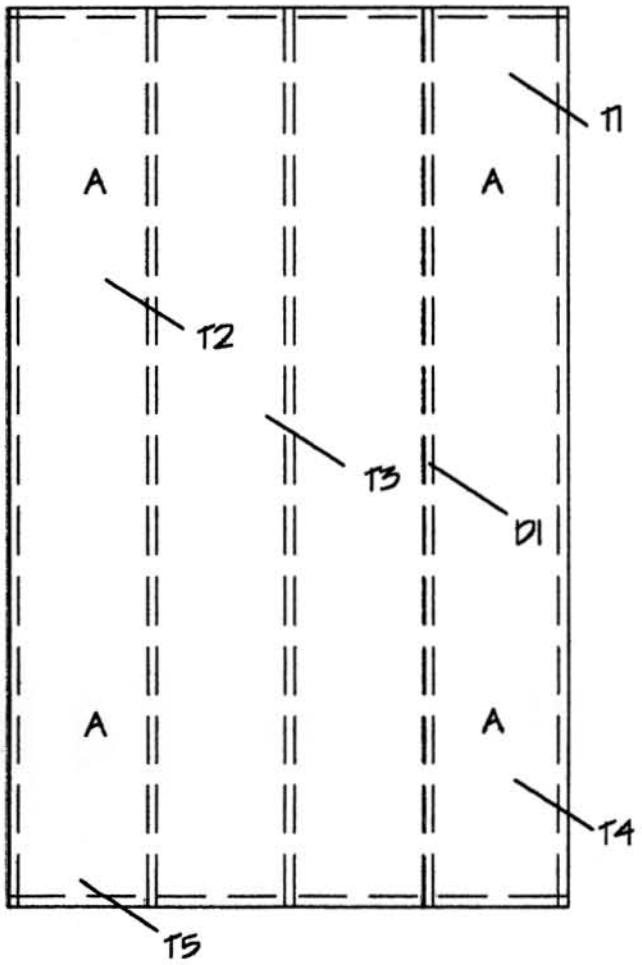


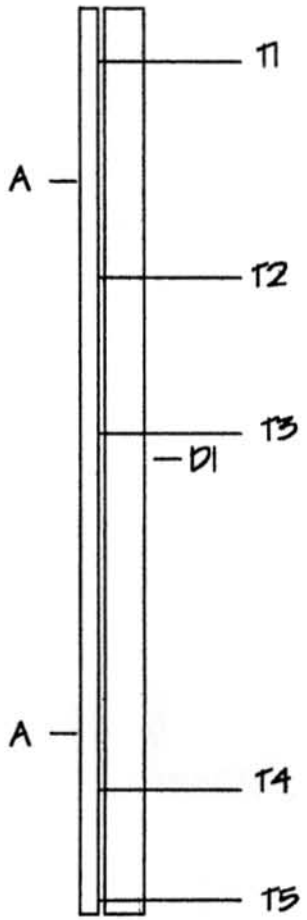


SKETCH #1

PROJECT NO.	PROJECT NAME: PRECAST CONCRETE PANEL MOCK-UP		DRAWING:	DWG. BY: JWW	SHEET
01-31388	CLIENT: SMITH-MIDLAND		DIAL INDICATOR LOCATIONS	DATE: 09/28/98	OF

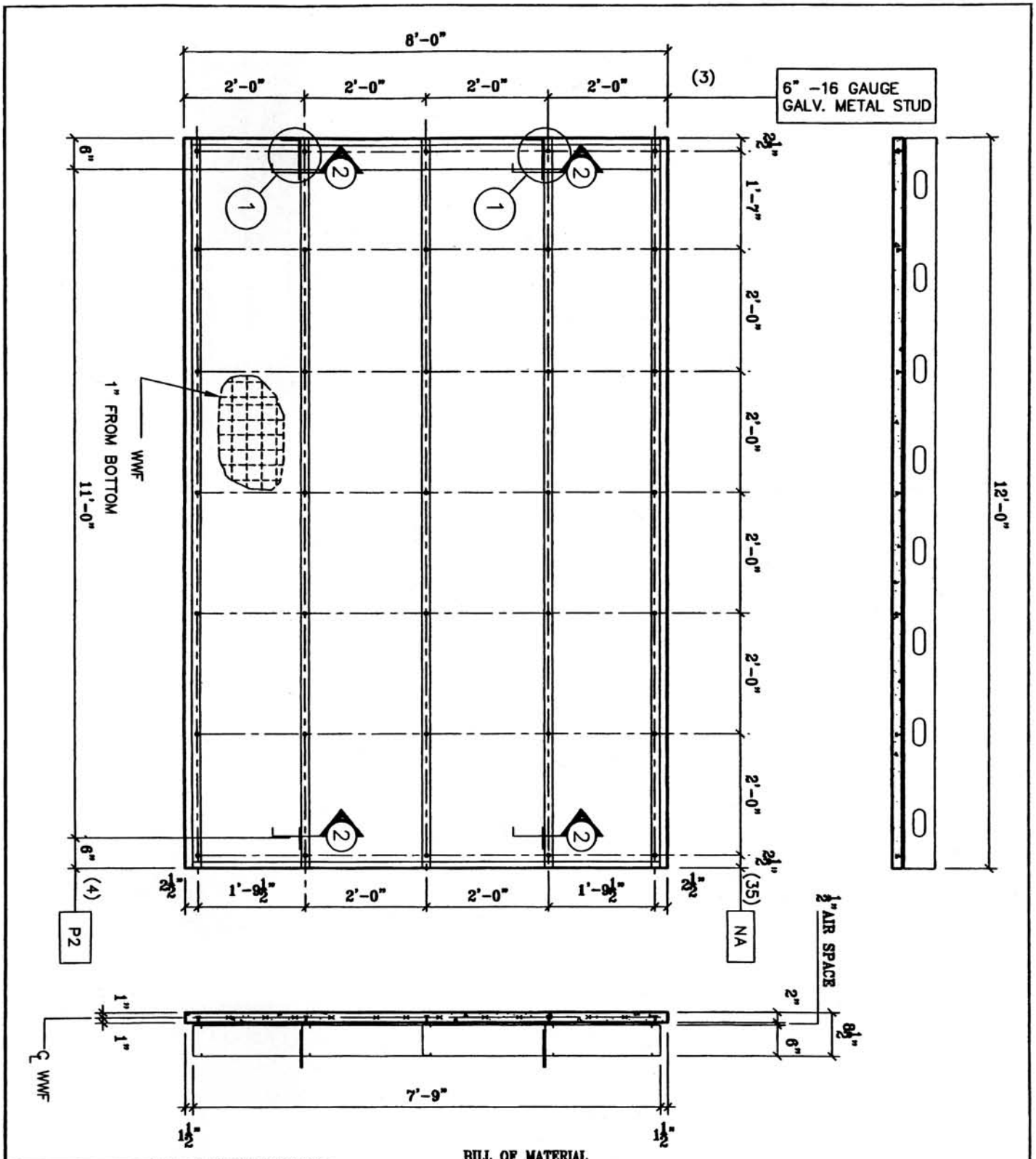
KEY:
A - Averager on ext. surface
T1-T5 - Int. concrete surface temp. locs.
D1 - Deflection recorded during test





SKETCH #2

PROJECT NO.	PROJECT NAME: PRECAST CONCRETE PANEL MOCK-UP		DRAWING:	DWG. BY: JWW	SHEET
01-31388	CLIENT: SMITH-MIDLAND		Temp. measurement/ deflection locations	DATE: 05/20/98	OF

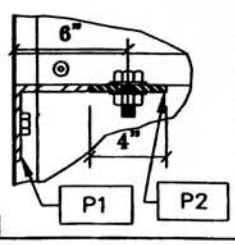


BILL OF MATERIAL

MK. #	QNT'Y.	DESCRIPTION
WWF	ONE	6 x 6 W2.9 x W2.9 MESH 11'-9" x 7'-9" (91.06)
NA	35	1/4" x 1 1/2" NELSON ANCHOR STAINLESS EPOXY COATED
P1	2	LIFTING PLATE
P2	4	PLATE 3/16"x4"x0'-7 1/2" GRAVITY CONN. PLATE

SMITH-MIDLAND
EXCELLENCE IN PRECAST CONCRETE
P.O. Box 300 Midland, VA 22728
(540) 439-3266 1(800) 364-3961 FAX (540) 439-1232

PROJECT:	TEST PANEL		
PRODUCT:	–		
LOCATION:	–		
DATE REL.	5-26-98	DATE CHECKED:	
DRAWN BY:		CHECKED BY:	
QUANTITY:	ONE	MARK NO.	TEST PANEL
JOB NO.	–		



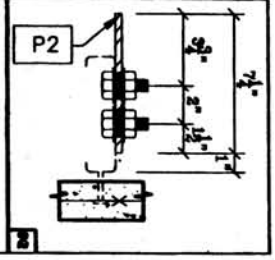


Photo No. 1
Steel Test Chamber

Photo No. 2
Bottom Panel Anchor

Photo No. 3
Chamber Calibration for Air Filtration

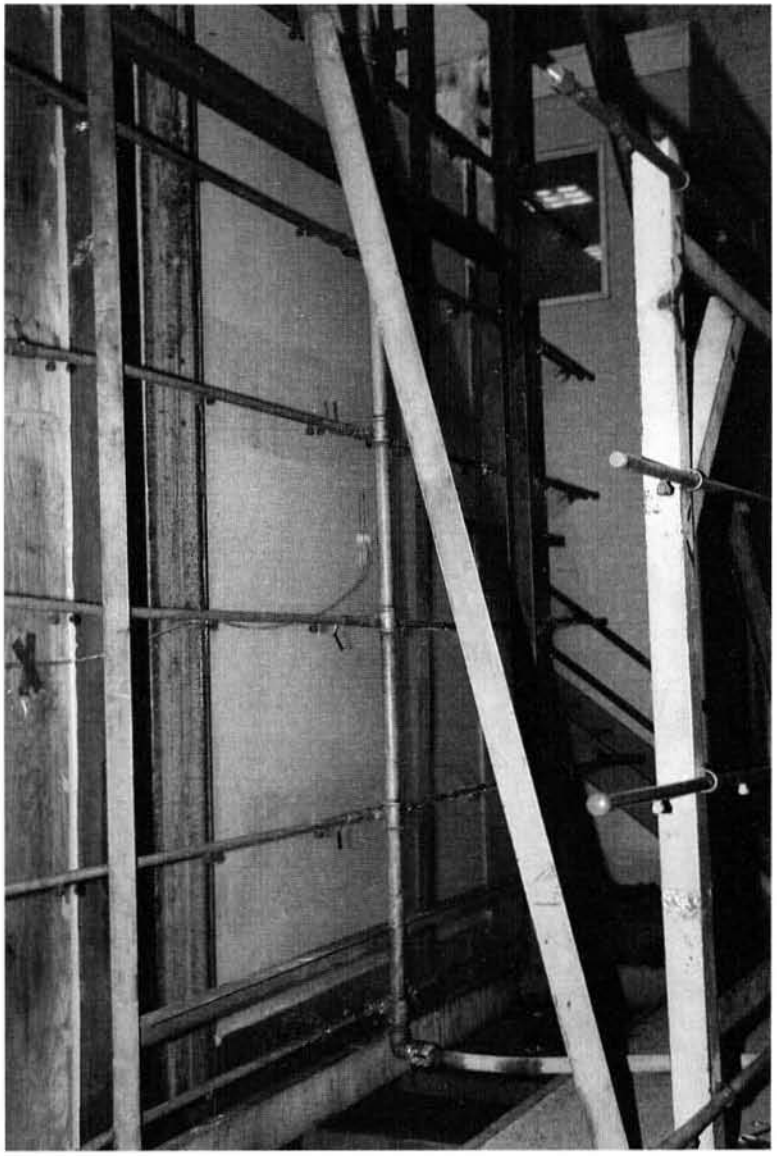


Photo No. 4
Static Water Pressure Test

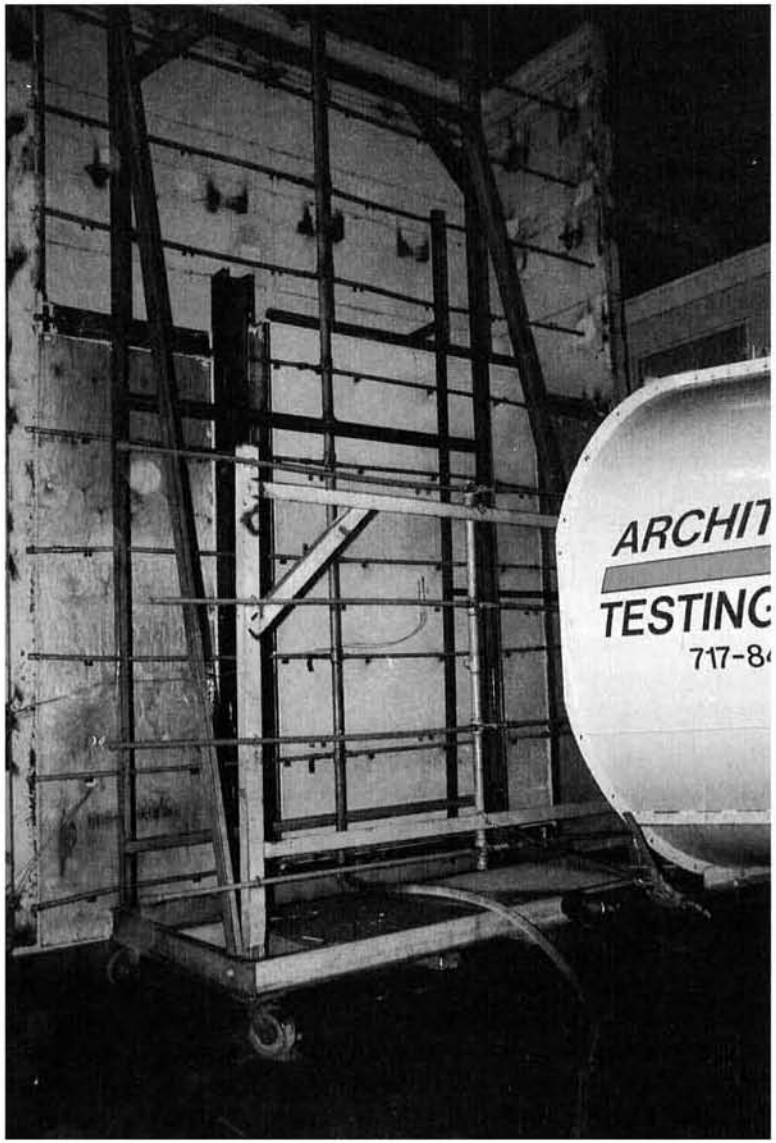


Photo No. 5
Dynamis Water Pressure Test

Photo No. 6
Dial Indicators Used During Uniform Structural Loading

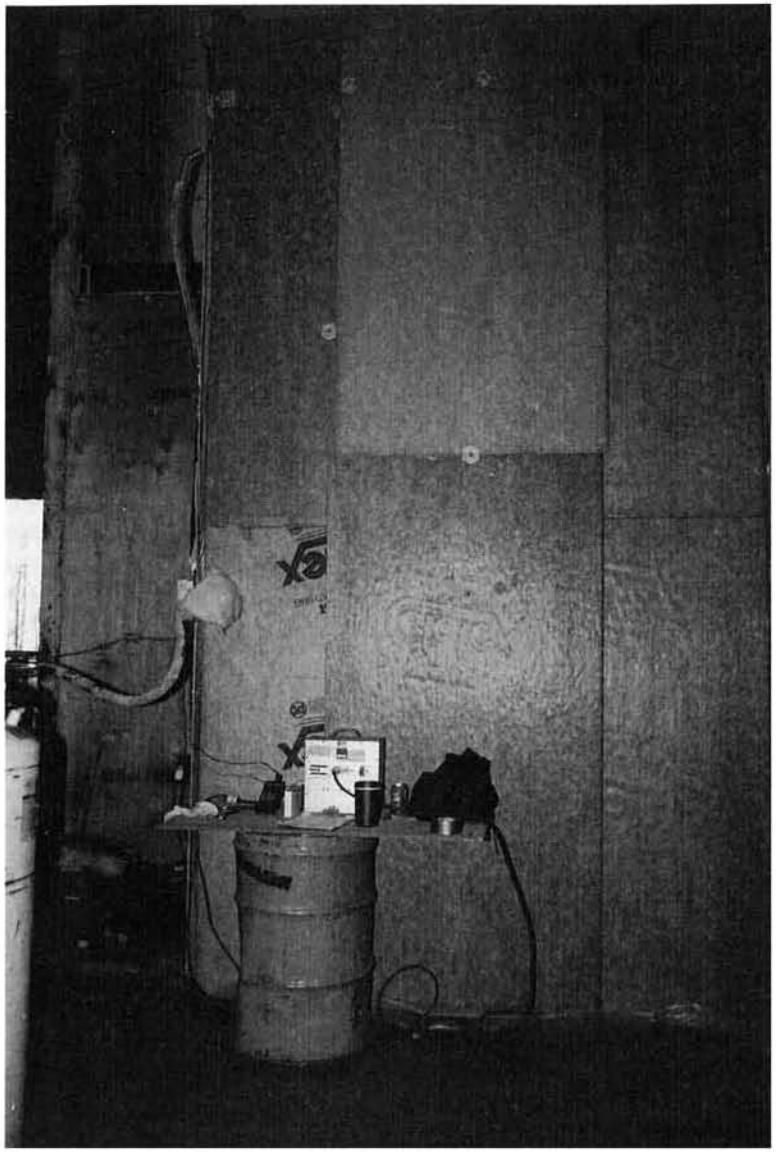


Photo No. 7
Thermal Cycling

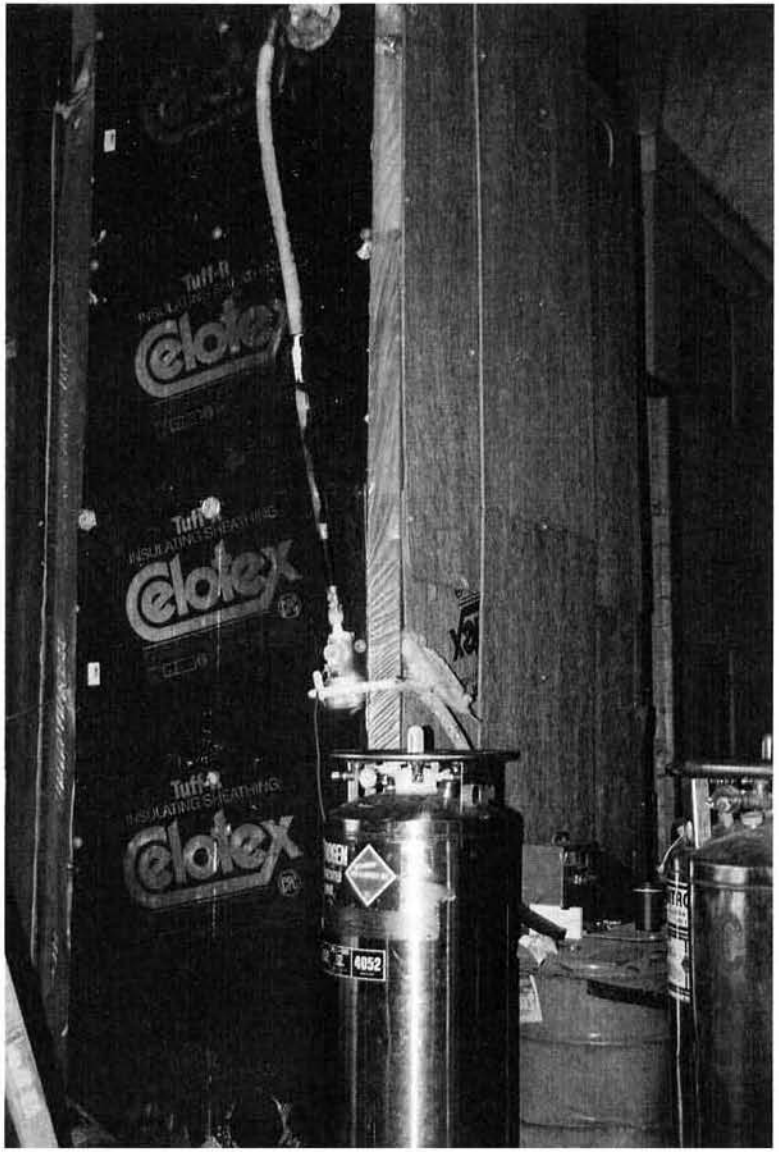


Photo No. 8
Thermal Cycling

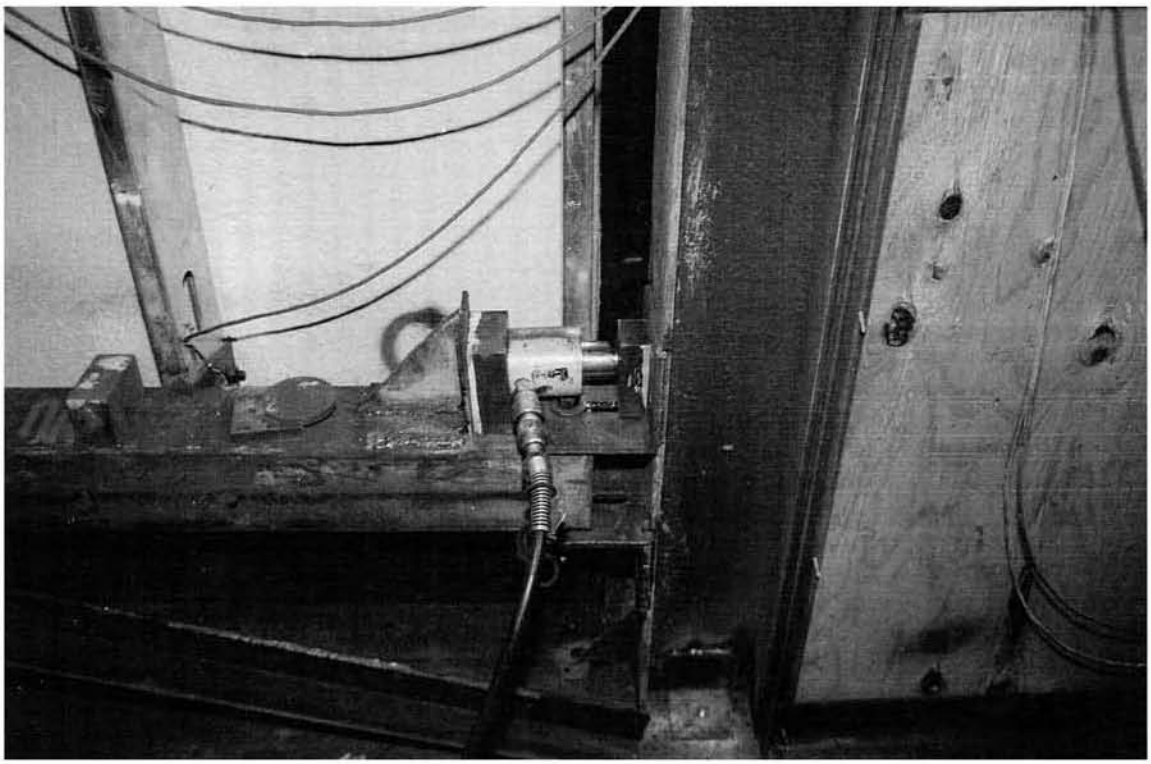


Photo No. 9
Seismic Evaluation

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

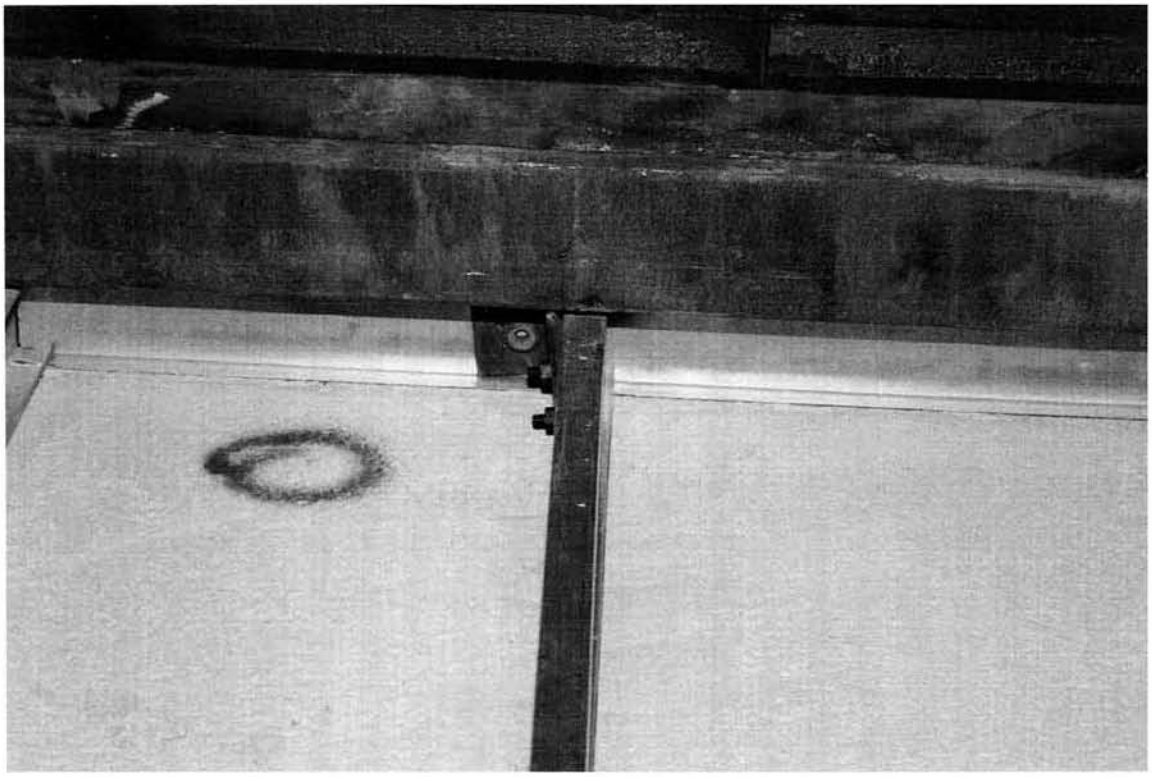


Photo No. 11
Top Anchor Bending Causing Stud Rotation During Seismic Test

Photo No. 12
Bottom Plate Deforming During Seismic Test