APA Report T2011P-73

Durability Testing
for Structural Insulated Panels (SIPs)

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SUMMARY

The purpose of this testing was to determine the impact of moisture cycling on the axial and transverse load capacity of SIPs manufactured with APA N-610 facers. The testing in this report supplements the durability study reported in APA Report T2011P-43 where cyclic shear testing was conducted on both dry and moisture-cycled SIP specimens.

The results of this study showed a marginal impact on the SIP axial load and transverse load capacities due to 72-hour water-soak and ASTM E72 moisture exposure, respectively, when tested after the specimens were redried.

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The precision and bias of the test methods given in this report are being established.

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1. INTRODUCTION

The purpose of this testing was to determine the impact of moisture cycling on the axial and transverse load capacity of SIPs manufactured with APA N-610 facers. The testing in this report supplements the durability study reported in APA Report T2011P-43 where cyclic shear testing was conducted on both dry and moisture-cycled SIP specimens.

2. MATERIAL DESCRIPTION

2.1 SIPS Panel Construction

SIP test specimens were fabricated as follows:

The OSB facers were 7/16 Performance Category OSB manufactured by Tolko Industries, Ltd., Meadow Lake, Saskatchewan, Canada and trademarked with the APA N-610 designation. The SIPs were fabricated by Premier Building Systems, Kent, Washington, on behalf of the Structural Insulated Panel Association, Gig Harbor, Washington. The SIPs were sampled by representatives of Premier Building Systems. The SIPs bore an NTA trademark and the panels were presumed to be consistent with routine production. Each 4x8 foot SIP contained a single 1-1/2-inch diameter vertical and two horizontal electrical chases in the expanded polystyrene (EPS) core. Two double electrical-box holes (4-3/4 inches x 4-3/4 inches) were routed at the APA laboratory in one face of each SIP specimen. See Figures A1 and A2.

The core material of SIPs was composed of EPS foam meeting the requirements of ASTM C578, with minimum density of 1.00 lbf/ft^3. The minimum thickness of the core for SIP walls was 3.5 inches (89 mm).

Adhesives used to structurally laminate the EPS insulation core material to the structural wood facings conforming to ASTM D2559 specifically intended for use as an adhesive for the lamination of structural insulated panels.

2.2 Fasteners

Fasteners used to connect the SIP facing panels to framing were 8d common nails (0.131 inch x 2-1/2 inches) conforming to ASTM F1575.

2.3 Lumber

Lumber used for assembly of test specimen was spruce-pine-fir No.2 or better.

3. PANEL CONDITIONING

Panels were tested in two conditioned states. The first being in the as-received conditions and the second tested after moisture cycling and redrying.

3.1 Axial Load (Compressive) Tests.

Three specimens were subjected to the moisture cycle protocol for flood soak. The SIPs were soaked under tap water for 72 hours based on the National Evaluation Service (NES) protocol for determining flood-resistance properties. The specimens were soaked with fresh water. The SIPs were redried at lab conditions until they regained their as-received weight (approximately 30 days at lab conditions) prior to testing.

3.2 Transverse Load Tests

Three specimens were subjected to the ASTM E72 moisture cycling for wet-dry specimens per Section 15.3 (2.5 wet-redry cycles), except that the panels were redried at lab conditions until they regained their as-received weight (approximately 30 days at lab conditions) prior to testing.

4. TEST METHODS AND TEST ASSEMBLY DESCRIPTIONS

4.1 Axial Load (Compressive) Tests

Tests were conducted to determine the effect of moisture cycling on the axial load capacity of SIPs.

4.1.1 Test Specimen

Test specimens are described in Table 1.

Table 1. Axial Load (Compression) Specimen

SIP Specimen Size Thickness (in.) x Width (ft) x Height (ft)	Test Conditions	Number of Tests
3-1/2 x 4 x 8	As-received	3
3-1/2 x 4 x 8	Following the NES water soak protocol and redry	3

4.1.2 Test Specimen Preparation

Test specimens were fabricated from the SIP sizes listed in Table 1 and prepared in accordance with Figure A1. All outside ends and edges were routed at Premier Building Systems to 1-1/2 inches. Along the four-foot panel ends, No.2 or better spruce-pine-fir 2x4 members were placed within this routed area and attached to both OSB skins with 8d common (0.131 inch x 2-1/2 inches) nails placed at 6 inches on center. Two double electrical-junction-box holes (4-3/4 inches x 4-3/4 inches) were routed at the APA laboratory to one face of each SIP specimen. See Figure A1.

4.1.3 Test Method

The axial load (compression) specimens were tested in accordance with ASTM E72, Section 9 and Figure B1. Route-outs for electrical junction boxes were placed on the compression side of the SIP.

4.2 Transverse Load Tests

Tests were conducted to determine the effect of moisture cycling on the transverse load (load perpendicular to the plane) design capacity of SIPs.

4.2.1 Test Specimen

Test specimens are described in Table 2.

Table 2. Transverse Load Specimen

SIP Specimen Size Thickness (in.) x Width (ft) x Height (ft)	Test Conditions	Number of Tests
3-1/2 x 4 x 8	As-received	3
3-1/2 x 4 x 8	After ASTM E72 moisture cycling and redry	3

4.2.2 Test Specimen Preparation

Test specimens were fabricated from the SIP sizes listed in Table 2 and prepared in accordance with Figure A2. All outside ends and edges were routed at Premier Building Systems to 1-1/2 inches. Along the four-foot panel ends, No.2 or better spruce-pine-fir 2x4 members were placed within this routed area and attached to both OSB skins with 8d common (0.131 inch x 2-1/2 inches) nails placed at 6 inches on center. Two double electrical-junction-box holes (4-3/4 inches x 4-3/4 inches) were routed at the APA laboratory to one face of each SIP specimen. See Figure A2.

4.2.3 Test Method

The transverse load specimens were tested in accordance with ASTM E72, Section 11 and Figure B2. Route-outs for electrical junction boxes were placed on the Tension side of the SIP.

5. RESULTS AND DISCUSION

5.1 Axial Load (Compressive) Tests

The results of the axial load tests are shown in Table 3.

Table 3. Axial Load Test Results

Test Criteria	Specimen 1	Specimen 2	Specimen 3	Mean
As-Received				
Ultimate (plf)	9,630	9,171	9,104	9,301
Ult/3.0 (plf)	3,210	3,057	3,035	3,100
Net deflection at Ult/3.0 (in.)	0.124	0.088	0.146	0.119
Load at 1/8 in. net deflection (plf)	3,226	3,972	2,820	3,340
Water-Soaked				
Ultimate (plf)	11,585	9,181	8,922	9,896
Ult/3.0 (plf)	3,862	3,060	2,974	3,299
Net deflection at Ult/3.0 (in.)	0.085	0.174	0.183	0.147
Load at 1/8 in. net deflection (plf)	4,694	2,716	2,408	3,273

5.2 Transverse Load Test

The results of the transverse load tests are shown In Table 4.

Table 4. Transverse Load Test Results

Specimen	Length (in.)	Ultimate load (lbf)	Slope (lbf/in./4 ft)	Load (lbf) at the deflection of			
				H/360	H/240	H/180	H/120
As-Received							
1	96	4,280	--[d]	--[d]	--[d]	--[d]	--[d]
2	96	4,021	2,632	828	1,226	1,613	2,348
3	96	3,852	2,691	844	1,231	1,598	2,292
Mean		**4,051**	**2,641**	**836**	**1,229**	**1,601**	**2,320**
Calculated allowable load (psf)		42[a]	--	26[b]	38[b]	50[b]	73[b]
Allowable load[c] (psf)		--	--	**26**	**38**	**42**	**42**
Moisture-Cycled							
1	96	3,909	2,896	836	1,250	1,652	2,375
2	96	4,121	2,921	855	1,272	1,668	2,407
3	96	3,915	2,509	734	1,070	I,416	2,084
Mean		**3,982**	**2,775**	**808**	**1,097**	**1,579**	**2,289**
Calculated allowable load (psf)		41[a]	--	28[b]	34[b]	49[b]	72[b]
Allowable load[c] (psf)		--	--	**28**	**34**	**41**	**41**

(a) Calculated allowable load (psf) is based on the mean ultimate load (lbf) divided by the total SIP panel area (ft^2) and by a factor of 3.0.
(b) Allowable load (psf) is based on the mean load (lbf) at a specific deflection limit and by the total SIP panel area (ft^2).
(c) Allowable load (psf) is tabulated based on the calculated ultimate load or the calculated load at a specific deflection limit, whichever is less.
(d) The first As-Received specimen was tested with the load heads at the ¼ points on the specimen, versus 1/3 points as specified. As a result, the As-Received test #1 was not used in averages for stiffness. However, due to the failure mode for this specimen is the same as the other specimens – shear failure at the foam core and OSB facer interface (see Figure C7), it is included in the average of the ultimate load.

6. CONCLUSION

6.1 Axial Load (Compressive) Tests

In Table 3, it can be seen that the ultimate load was approximately 16 percent higher for the water-soak and redry specimens than for the as-received specimens. This is the result of one high reading for the water-soak and redry specimen (Specimen #1). Otherwise, the results are very comparable between the as-received and water-soaked specimens.

6.2 Transverse Load Tests

From the test results shown in Table 4, the average ultimate strength values for the moisture-cycled specimens were slightly reduced by 1.7 percent, and the load at the deflection limit of H/360 by 3.3 percent, where H is the wall height, when comparing with the as-received specimens.

7. REFERENCES

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NES. 2000. *Evaluation Protocol for Determination of Flood-Resistance Properties of Building Elements*. National Evaluation Service, Falls Church, VA.

8. APPENDICES

List of Appendices

Appendix A: Drawings of Test Specimens (2 pages)

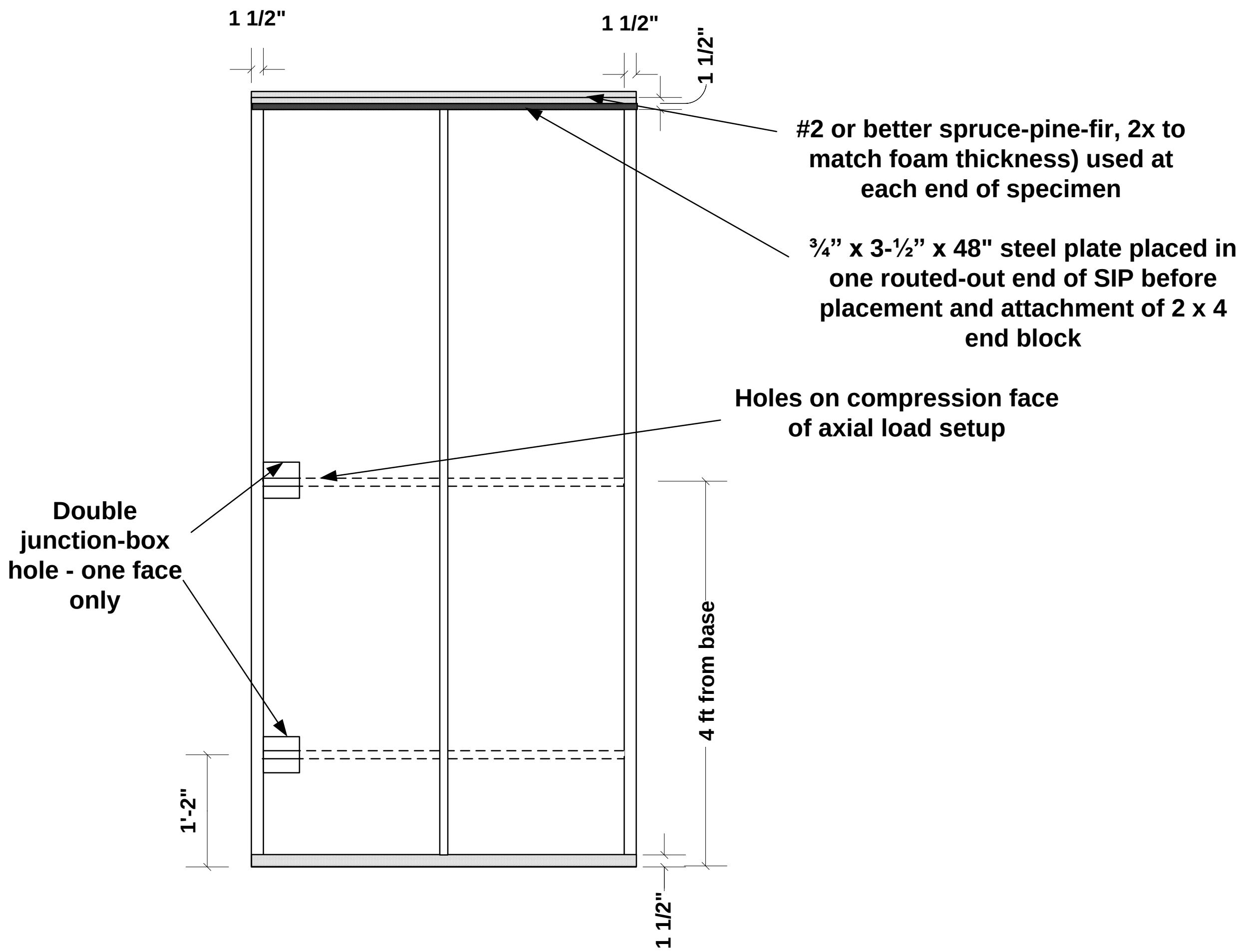

FIGURE A1. AXIAL (COMPRESSIVE) LOAD TEST SPECIMENS

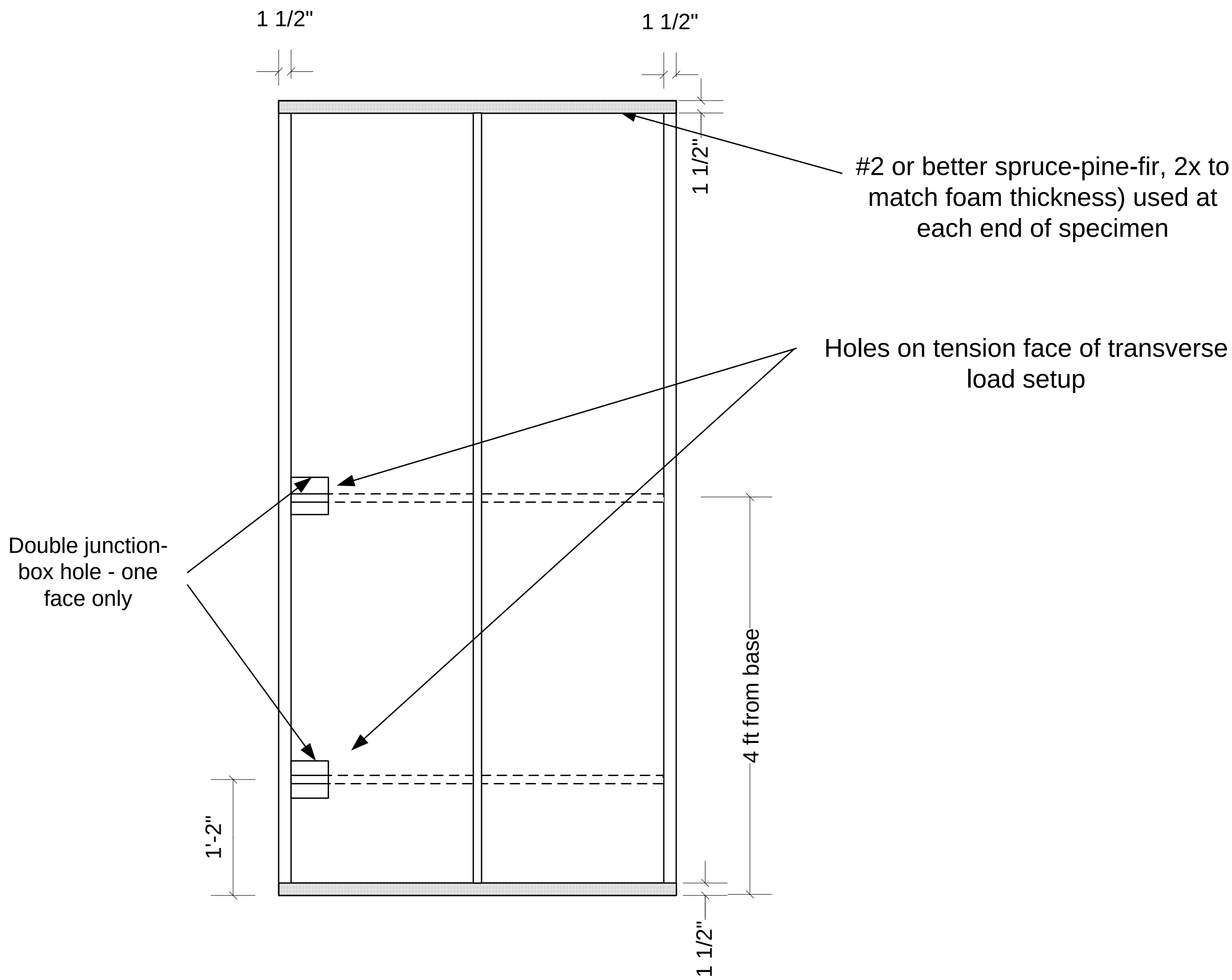

FIGURE A2. TRANSVERSE LOAD TEST SPECIMENS

Appendix B: Drawings of Test Assemblies (2 pages)

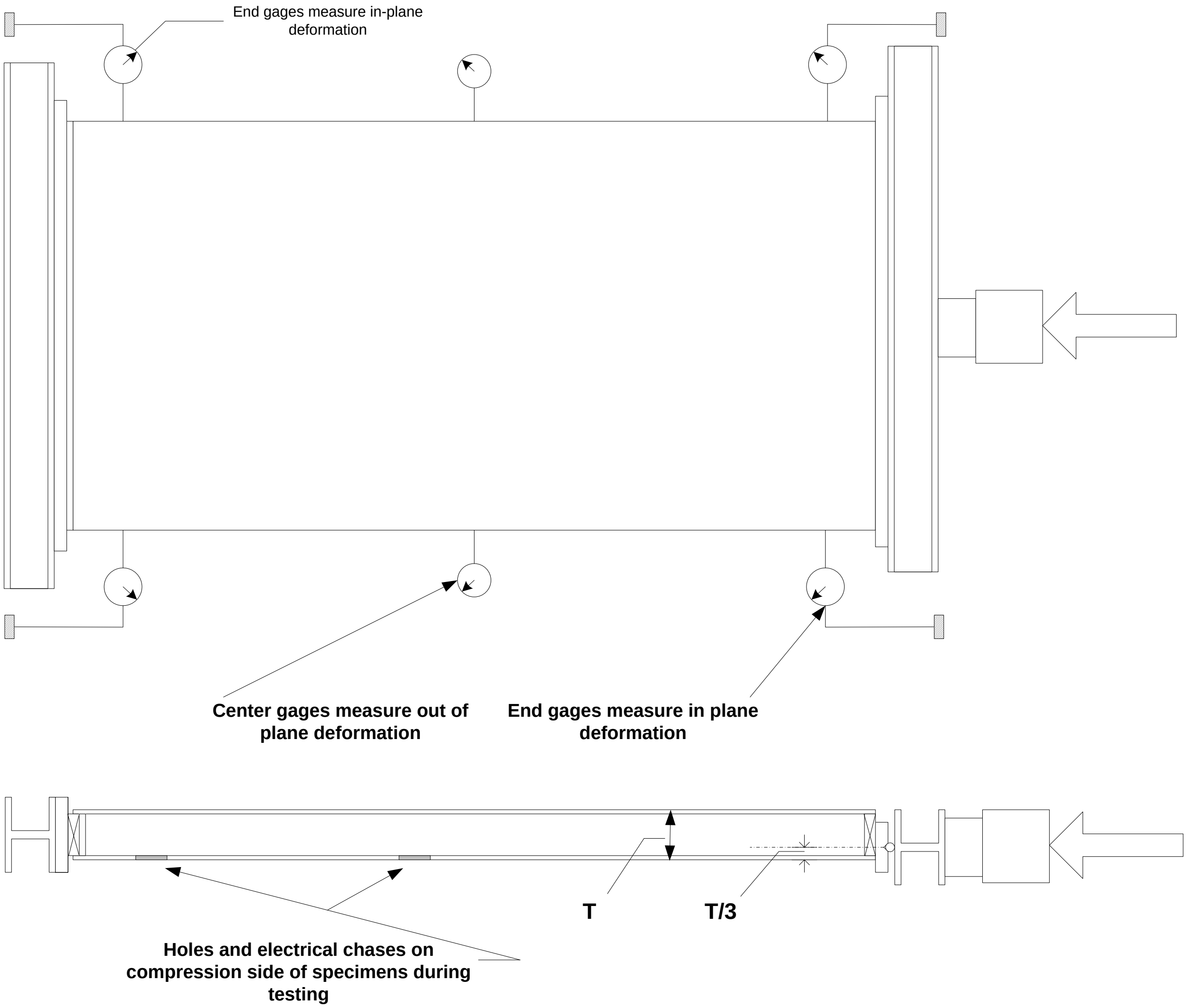

FIGURE B1. AXIAL (COMPRESSION) LOAD TEST ASSEMBLY

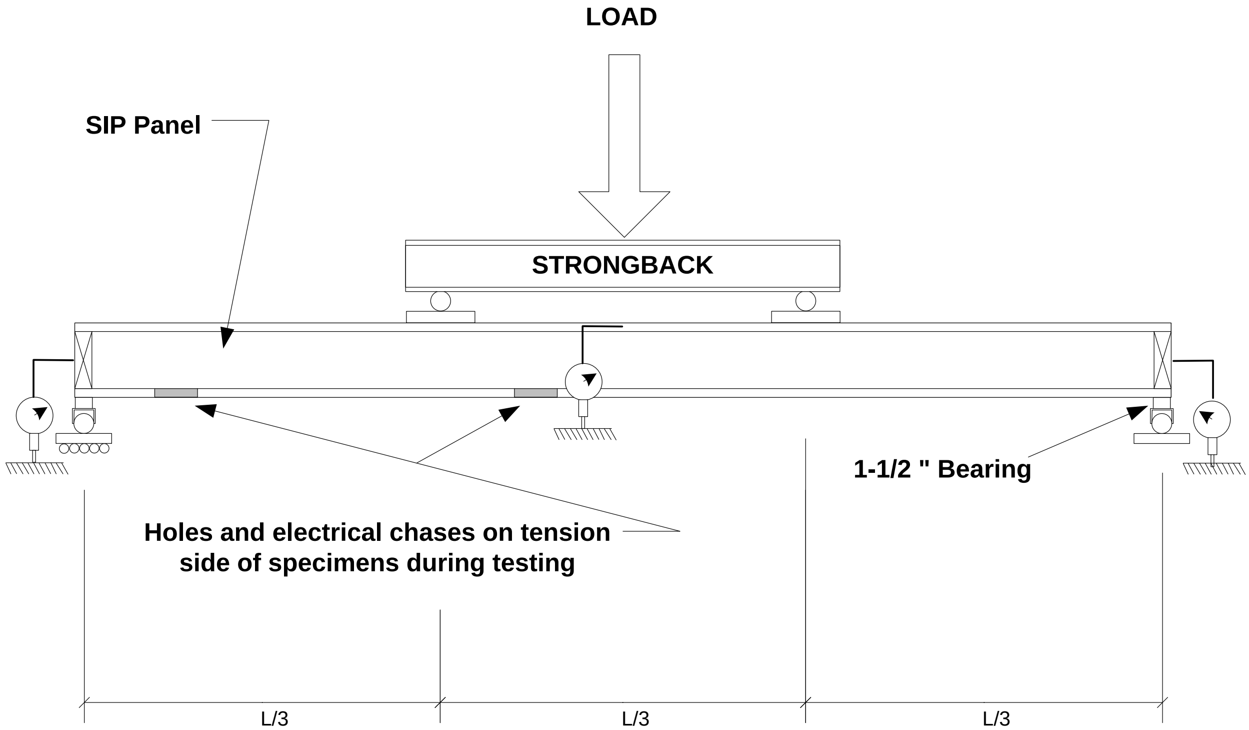

FIGURE B2. TRANSVERSE LOAD TEST ASSEMBLY

Appendix C: Pictures of Tests in Progress and Failure Modes (7 pages)

FIGURE C1. SIP IN AXIAL LOAD (COMPRESSION) TEST APPARATUS

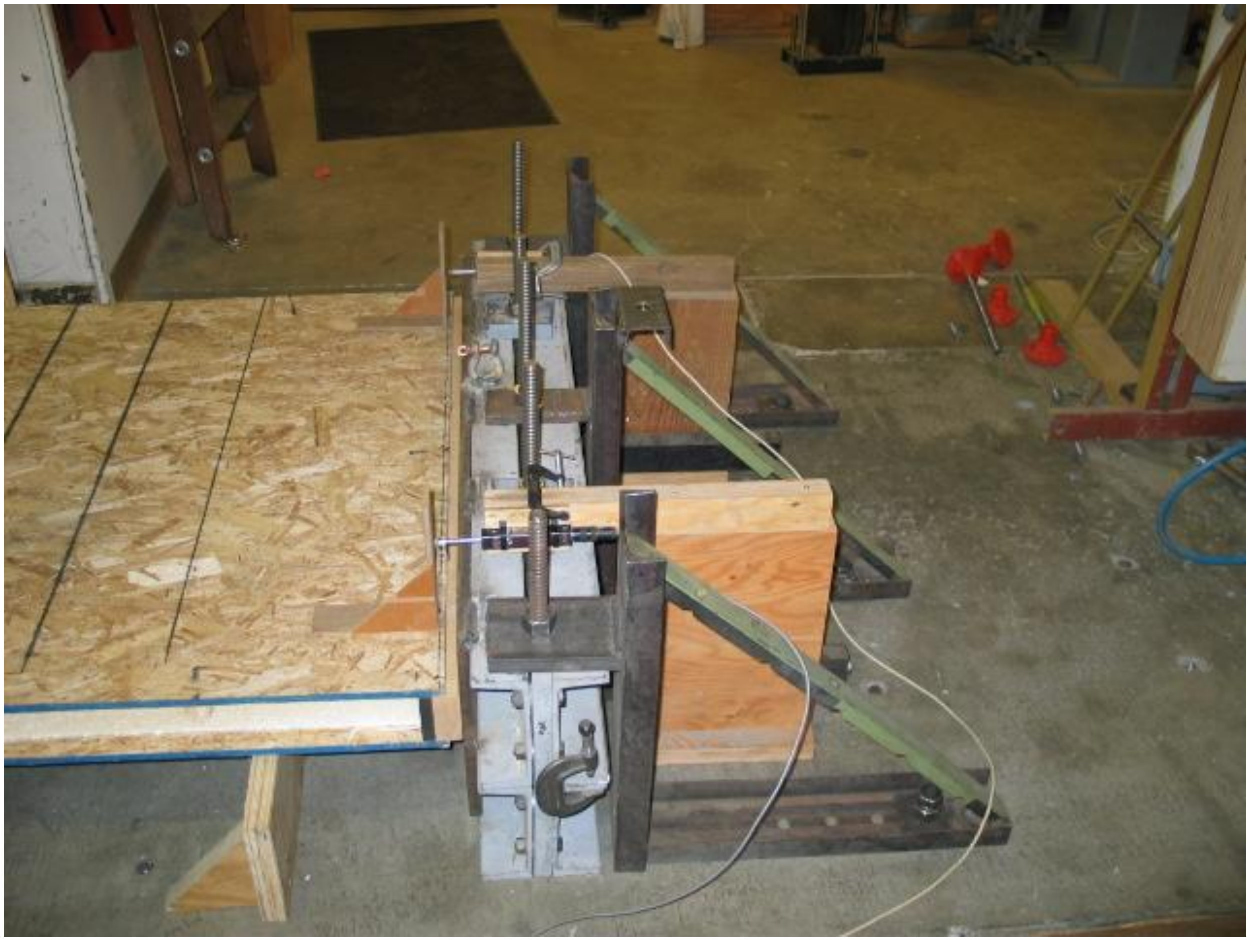

FIGURE C2. SIP IN AXIAL LOAD (COMPRESSION) TEST APPARATUS – RESTRAINT END

FIGURE C3. SIP IN AXIAL LOAD (COMPRESSION) TEST APPARATUS – LOAD HEAD END

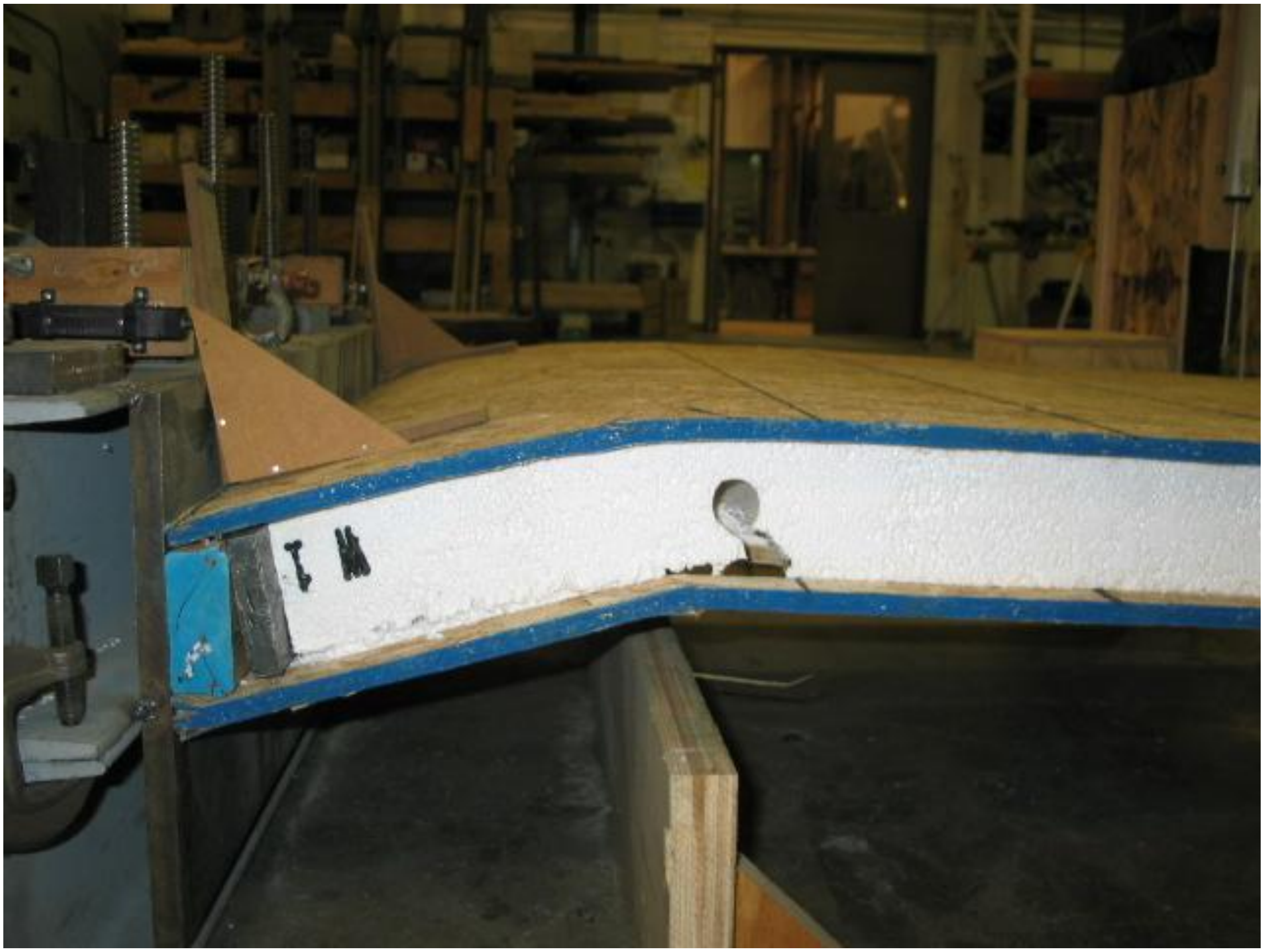

FIGURE C4. TYPICAL AXIAL LOAD (COMPRESSION) FAILURE (REPRESENTATIVE PICTURE)

**FIGURE C5. SIP IN TRANSVERSE LOAD
TEST APPARATUS – THIRD-POINT LOADING APPARATUS**

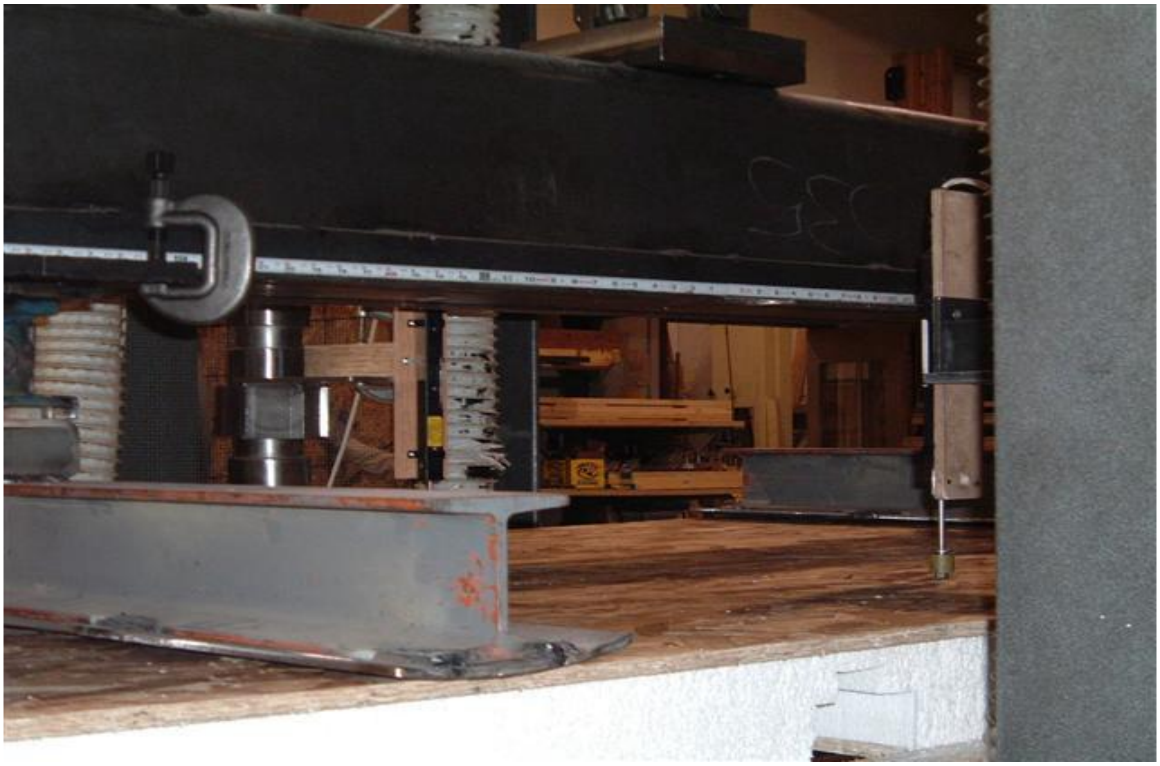

**FIGURE C6. TRANSVERSE LOAD TEST ASSEMBLY –
THIRD-POINT LOADING APPARATUS - WITH INSTRUMENTATION**

FIGURE C7. TYPICAL SIP TRANSVERSE LOAD FAILURE
(Failure plane at the foam core and OSB facer interface shown just above dotted line)