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The Engineered Wood Association

APA Report T2006P-33

Standardization Testing of Structural Insulated Panels (SIPs) for The Structural Insulated Panel Association, Gig Harbor, Washington

by Edward L. Keith, P.E.
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May 5, 2006

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Standardization Testing of Structural Insulated Panels (SIPs) for The Structural Insulated Panel Association, Gig Harbor, Washington

SUMMARY

APA–The Engineered Wood Association worked with the Structural Insulated Panel Association (SIPA) and the wood structural panel industry in the development of minimum design properties for the wood structural panel skins. Using these industry-developed minimum properties for panels, APA conducted a series of tests on SIPs manufactured to reflect these minimums, including shear, axial, transverse and lintel testing. These tests were conducted in accordance with recognized test methods (ASTM E72, D198, E1803, and ICC-ES AC04). From the results of these tests, design capacities were established and used as prescriptive requirements for the SIPA prescriptive method.

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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

In 2003, the Structural Insulated Panel Association (SIPA) made a proposal to the U. S. Department of Housing and Urban Development (HUD), through their Partnership for Advancing Technology in Housing (PATH), to develop a prescriptive method for the residential design using structural insulated panels (SIPs). HUD approved the proposal and subsequently signed a contract with the National Association of Home Builders – Research Center (NAHB-RC) to manage the project. The NAHB-RC has worked in conjunction with Building Works, Inc., to develop this method. The result of this effort was the development of a prescriptive method for adoption by the International Residential Code (IRC).

APA–The Engineered Wood Association worked with SIPA and the wood structural panel industry in the development of minimum design properties for the wood structural panel skins. Using these industry-developed minimum properties for panels, APA conducted a series of tests on SIPs manufactured to reflect these minimums, including shear, axial, transverse, and lintel testing. These tests were conducted in accordance with recognized test methods (ASTM E72, D198, E1803, and ICC-ES AC04). From the results of these tests, design capacities were established and used in the development of the SIPA prescriptive method and IRC code change proposal.

2. MATERIAL DESCRIPTION

2.1.1 SIPS Panel Construction

SIP test specimens were manufactured as follows (details can be found in Appendix A):

2.1.1.1 Core

The core materials of SIPs were composed of molded expanded polystyrene (EPS) meeting the requirements of ASTM C578, Type I, with a minimum density of 0.90 lbf/ft^3.

2.1.1.2 Facing

Facing materials for structural insulated panels were oriented strand board (OSB) panels, each having a minimum nominal thickness of 7/16 inch and conforming to DOC PS 2, as manufactured by Ainsworth, Cook, Minnesota. The properties of the OSB panels were characterized, as given in APA Report T2006P-28.

2.1.1.3 Adhesives

Adhesives used to structurally laminate the EPS insulation core to the structural wood facings were Type II, Class 2, conforming to ASTM D2559.

2.1.1.4 SIP assemblies

All SIP assemblies were fabricated at Premier Building Systems, Fife, WA, on November 14, 2005 and witnessed by APA staff.

2.1.1.5 Fasteners

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

2.1.1.6 Lumber

Lumber used for the assembly of test specimen was spruce-pine-fir #2 or better.

3. TEST METHODS AND TEST ASSEMBLY DESCRIPTIONS

3.1 Racking Shear Test

Tests were conducted to develop racking shear design properties for prescriptive SIP panels.

3.1.1 Test Assemblies

Test assemblies were fabricated from SIP panels as described below:

Table 1. Racking Shear Test Assemblies

SIP Specimen Size (Thickness x width x height)	Number of Assemblies
4-1/2" x 8' x8'	3
6-1/2" x 8' x8'	3
4-1/2" x 8' x10'	3
6-1/2" x 8' x10'	3

3.1.2 Test Assembly Preparation

Test assemblies were fabricated from the SIP panel sizes listed in Table 1 and prepared in accordance with Figure B1. The adjoining specimen edges of the panel were routed out 1-1/2" to accommodate a spline fabricated out of a 3"-wide SIP panel with an outside dimension equal to the foam-core thickness. These splines were placed such that the outside OSB faces on the spline were in contact with the inside OSB faces of the two SIP panels being joined. The SIP panel faces were attached on both sides to the spline with 8d common nails (0.131" x 2-1/2") placed at 6" on center.

The outside vertical panel edges of the panel were routed out 1-1/2" to accommodate a #2 or better spruce-pine-fir 2x member sized to match the foam thickness. These members ran the full height of the specimen and were attached to both OSB skins with 8d common (0.131" x 2-1/2") nails placed at 6" o.c.

The top and bottom edges of the specimen were routed out to 1-1/2" to accommodate a spruce-pine-fir 2x member sized to match the foam thickness. The bottom plate was attached to the test apparatus prior to attachment to the SIP test specimen to provide access to the anchor bolts. A Simpson HD-8 was lag-screwed to the top plate to facilitate anchoring of the load head. Top and bottom plates were attached to the SPF framing with 8d common nails (0.131" x 2-1/2") placed at 6" on center from each side.

3.1.3 Test Method

The shearwall specimens were tested in accordance with ASTM E72-05, Section 14, and Figure C1.

3.2 Axial Load (Compressive) Tests

Tests were conducted to develop axial load (compressive) design properties for prescriptive SIP panels.

3.2.1 Test Specimen

Test specimen were fabricated from SIP panels as described below:

Table 2. Axial Load (Compression) Specimen

SIP Specimen Size (Thickness x width x height)	Number of Specimens
4-1/2" x 4' x8'	3
6-1/2" x 4' x8'	3
4-1/2" x 4' x10'	3
6-1/2" x 4' x10'	3

3.2.2 Test Specimen Preparation

Test specimens were fabricated from the SIP panel sizes listed in Table 2 and prepared in accordance with Figure B2. All outside ends and edges were routed out 1-1/2". Along the four-foot panel ends, a #2 or better spruce-pine-fir 2x member sized to match the foam thickness was placed within this routed area and was attached to both OSB skins with 8d common (0.131" x 2-1/2") nails placed at 6" o.c.

3.2.3 Test Method

The axial load (compression) specimens were tested in accordance with ASTM E72-05, Section 9, and Figures C2 – C5. Route-outs for electrical junction boxes were placed on the compression side (on the side of the eccentric load) of the SIP during testing.

3.3 Transverse Load Tests

Tests were conducted to develop transverse load (load perpendicular to the plane) design properties for prescriptive SIP panels.

3.3.1 Test Specimen

Test specimens were fabricated from SIP panels as described below:

Table 3. Transverse Load Specimen

SIP Specimen Size (Thickness x width x height)	Number of Specimen
4-1/2" x 4' x8'	3
6-1/2" x 4' x8'	3
4-1/2" x 4' x10'	3
6-1/2" x 4' x10'	3

3.3.2 Test Specimen Preparation

Test specimens were fabricated from the SIP panel sizes listed in Table 3 and prepared in accordance with Figure B3. All outside ends and edges were routed out 1-1/2". Along the four-foot panel ends a #2 spruce-pine-fir 2x member sized to match the foam thickness was placed within this routed area and was attached to both OSB skins with 8d common (0.131" x 2-1/2") nails placed at 6" o.c.

3.3.3 Test Method

The transverse load specimens were tested in accordance with ASTM E72-05, Section 11, and Figures C6 – C8. Route-outs for electrical junction boxes were placed on the tension side of the SIP.

3.4 SIP Lintel Test

Tests were conducted to develop prescriptive capacities for nominal 12-inch deep SIP lintels in various lengths.

3.4.1 Test Specimen

Samples were prepared as described below:

Table 4. SIP Lintel Test Specimens

Test Number	Thickness (in.)	Nominal Depth (in.)[a]	Length (in.)	Number of Specimen
1	4-1/2	12	24	3
2		12	48	3
3		12	72	3
4		12	96	3
5	6-1/2	12	24	3
6		12	48	3
7		12	72	3
8		12	96	3

(a) Actual depth of specimen - 11-7/8" ± 1/8".

3.4.2 Test Specimen Preparation:

Specimens were cut in accordance with Table 4 and Figure B4. The long edges of the panel were routed out 1-1/2" to accommodate a spruce-pine-fir 2x member sized to match the foam thickness. These members ran the full length of the specimen and were attached to OSB skins with 8d common nails places at 6" o.c. on each side.

The cutting pattern in Figure B4 was used for all SIP sizes. Three full panels of 4-1/2" thickness and three full panels of 6-1/2" thickness were cut as shown and prepared as described below. The foam was kept flush with the ends (11-7/8" side) of all of the specimens except for those of 96" long. As they were cut from panels that had a factory rout along all 4 edges, the 96" long specimens were tested with the factory 1-1/2" rout along the narrow edge.

3.4.3 Test Method:

Testing was conducted in accordance with ASTM D198 and Figures C9 – C11. Load and deflection data were continuously recorded until failure.

4. RESULTS AND DISCUSION

4.1 Racking Shear Test Results

The results of racking shear tests are shown below. The typical failure mode was the failure of the nailed connections at spline, as shown in Figure D1.

Table 5. Racking shear test results (plf) for 4-1/2-in. x 8-ft SIPs

Test Criteria	Wall 1	Wall 2	Wall 3	Mean
Ultimate (plf)	960	1028	954	981
Ult/3.0 (plf)	320	343	318	327
Deflection at 1/8" (plf)	465	416	444	442

Table 6. Racking shear test results (plf) for 4-1/2-in. x 10-ft SIPs

Test Criteria	Wall 1	Wall 2	Wall 3	Mean
Ultimate (plf)	945	1052	924	973
Ult/3.0 (plf)	315	351	308	324
Deflection at 1/8" (plf)	400	349	256	335

Table 7. Racking shear test results (plf) for 6-1/2-in. x 8-ft SIPs

Test Criteria	Wall 1	Wall 2	Wall 3	Mean
Ultimate (plf)	935	934	960	943
Ult/3.0 (plf)	312	311	320	314
Deflection at 1/8" (plf)	407	344	401	384

Table 8. Racking shear test results (plf) for 6-1/2-in. x 10-ft SIPs

Test Criteria	Wall 1	Wall 2	Wall 3	Mean
Ultimate (plf)	960	978	967	969
Ult/3.0 (plf)	320	326	322	323
Deflection at 1/8" (plf)	308	360	337	335

4.2 Axial Load Test

The results of axial load tests are shown below. The typical failure modes were the buckling failure on compression face at electrical chase and the shear failure through foam due to eccentric loading, as shown in Figures D2 and D3, respectively.

Table 9. Axial load test results (plf) for 4-1/2-in. x 8-ft SIPs

Test Criteria	Specimen 1	Specimen 2	Specimen 3	Mean
Ultimate (plf)	11,092	10,785	10,695	10,857
Ult/3.0 (plf)	3,697	3,595	3,565	3,619
Deflection at Ult/3.0 (in.)	0.047	0.080	0.051	0.059

Table 10. Axial load test results (plf) for 4-1/2-in. x 10-ft SIPs

Test Criteria	Specimen 1	Specimen 2	Specimen 3	Mean
Ultimate (plf)	10,591	10,159	7,442	9,398
Ult/3.0 (plf)	3,530	3,386	2,481	3,133
Deflection at Ult/3.0 (in.)	0.121	0.081	0.045	0.082

Table 11. Axial load test results (plf) for 6-1/2-in. x 8-ft SIPs

Test Criteria	Specimen 1	Specimen 2	Specimen 3	Mean
Ultimate (plf)	10,359	10,334	8,341	9,650
Ult/3.0 (plf)	3,453	3,445	2,780	3,217
Deflection at Ult/3.0 (in.)	0.024	0.067	0.029	0.046

Table 12. Axial load test results (plf) for 6-1/2-in. x 10-ft SIPs

Test Criteria	Specimen 1	Specimen 2	Specimen 3	Mean
Ultimate (plf)	11,020	11,374	10,476	10,957
Ult/3.0 (plf)	3,673	3,791	3,492	3,652
Deflection at Ult/3.0 (in.)	0.086	0.077	0.081	0.081

4.3 Transverse Load Test

The results of transverse load tests are shown below. The typical failure mode was the tension failure of OSB skin at electrical chase, as shown in Figure D4.

Table 13. Transverse load test results (lbf) for 4-1/2-in. x 8-ft SIPs

Wall	Height (in.)	Ultimate load (lbf)	Slope (lbf/in./4 ft)	Load at deflection (lbf)			
				L/360	L/240	L/180	L/120
1	96	3,691	3,473	953	1,415	1,876	2,603
2	96	3,755	3,373	972	1,421	1,869	2,605
3	96	3,421	3,367	913	1,361	1,809	2,602
Mean		3,622	3,404	946	1,399	1,852	2,603
Calculated allowable load (psf)		38[a]	--	30[b]	44[b]	58[b]	81[b]
Allowable load[c] (psf)		--	--	30	38	38	38

(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.

Table 14. Transverse load test results (lbf) for 4-1/2-in. x 10-ft SIPs

Wall	Height (in.)	Ultimate load (lbf)	Slope (lbf/in./4 ft)	Load at deflection (lbf)			
				L/360	L/240	L/180	L/120
1	120	3,308	2,053	735	1,078	1,421	2,105
2	120	3,329	2,234	768	1,141	1,514	2,258
3	120	3,197	1,957	705	1,032	1,358	2,010
Mean		3,278	2,081	736	1,084	1,431	2,124
Calculated allowable load (psf)		27[a]	--	18[b]	27[b]	36[b]	53[b]
Allowable load[c] (psf)		--	--	18	27	27	27

(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.

Table 15. Transverse load test results (lbf) for 6-1/2-in. x 8-ft SIPs

Wall	Height (in.)	Ultimate load (lbf)	Slope (lbf/in./4 ft)	Load at deflection (lbf)			
				L/360	L/240	L/180	L/120
1	96	3,330	5,649	1,528	2,279	2,910	3,311
2	96	3,919	5,594	1,564	2,308	3,052	3,692
3	96	3,569	5,387	1,427	2,144	2,700	3,439
Mean		3,606	5,543	1,506	2,244	2,887	3,481
Calculated allowable load (psf)		38[(a)]	--	47[(b)]	70[(b)]	90[(b)]	109[(b)]
Allowable load[(c)] (psf)		--	--	38	38	38	38

(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.

Table 16. Transverse load test results (lbf) for 6-1/2-in. x 10-ft SIPs

Wall	Height (in.)	Ultimate load (lbf)	Slope (lbf/in./4 ft)	Load at deflection (lbf)			
				L/360	L/240	L/180	L/120
1	120	3,381	4,060	1,362	2,040	2,637	3,286
2	120	3,436	3,866	1,301	1,947	2,545	3,241
3	120	3,508	3,758	1,259	1,887	2,446	3,220
Mean		3,442	3,895	1,308	1,958	2,543	3,249
Calculated allowable load (psf)		29[(a)]	--	33[(b)]	49[(b)]	64[(b)]	81[(b)]
Allowable load[(c)] (psf)		--	--	29	29	29	29

(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.

4.4 Lintel Test

The results of the SIP lintel tests are shown below. The typical failure mode was the tension failure under loading points, as shown in Figure D5.

Table 17. Test results (plf) for 8-ft SIP lintel

Specimen	Depth (in.)	Width (in.)	Span (in.)	Max Load (lbf)	Max Load/3 (lbf)	Load at deformation L/			Slope (lbf/in.)	MOE (psi)	MOR (psi)	Max Load/3 /span (plf)
						180	240	360				
1	11.854	4.471	94.5	4,280	1,427	3,857	3,151	2,392	9,391	226,632	644	
2	11.854	4.471	94.5	4,122	1,374	3,216	2,403	1,601	7,903	190,729	620	
3	11.843	4.476	94.5	4,198	1,399	3,608	2,994	2,265	9,987	241,419	632	
Mean				4,200	1,400	3,560	2,849	2,086	9,094	219,593	632	175
1	11.920	6.518	94.5	4,609	1,536	3,485	2,550	1,706	7,494	122,001	470	
2	11.918	6.474	94.5	4,141	1,380	3,392	2,777	2,046	7,438	121,977	426	
3	11.850	6.528	94.5	4,280	1,427	3,255	2,611	1,887	10,649	176,183	441	
Mean				4,343	1,448	3,377	2,646	1,880	8,527	140,054	446	181
Mean (4-1/2" and 6-1/2" combined)												178

Table 18. Test results (plf) for 6-ft SIP lintel

Specimen	Depth (in.)	Width (in.)	Span (in.)	Max Load (lbf)	Max Load/3 (lbf)	Load at deformation L/			Slope (lbf/in.)	MOE (psi)	MOR (psi)	Max Load/3 /span (plf)
1	11.867	4.454	70.5	5,356	1,785	5,336	4,545	3,044	16,590	166,320	602	
2	11.883	4.491	70.5	5,545	1,848	5,003	3,660	2,798	18,875	186,907	616	
3	11.848	4.479	70.5	5,235	1,745	4,810	4,478	3,232	18,400	184,320	587	
Mean				5,379	1,793	5,050	4,228	3,025	17,955	179,183	602	299
1	11.878	6.478	70.5	5,724	1,908	5,073	4,007	2,664	15,740	108,195	442	
2	11.832	6.447	70.5	5,355	1,785	5,178	4,337	3,114	15,246	106,536	418	
3	11.814	6.449	70.5	5,467	1,822	4,875	4,052	2,876	15,232	106,892	428	
Mean				5,515	1,838	5,042	4,132	2,885	15,406	107,207	429	306
Mean (4-1/2" and 6-1/2" combined)												303

Table 19. Test results (plf) for 4-ft SIP lintel

Specimen	Depth (in.)	Width (in.)	Span (in.)	Max Load (lbf)	Max Load/3 (lbf)	Load at deformation L/			Slope (lbf/in.)	MOE (psi)	MOR (psi)	Max Load/3 /span (plf)
1	11.869	4.511	46.5	5,972	1,991	4,381	5,251	3,812	43,202	122,645	437	
2	11.872	4.495	46.5	5,092	1,697	4,696	4,265	4,154	48,787	138,888	374	
3	11.880	4.453	46.5	6,574	2,191	5,305	5,854	3,880	44,202	126,766	486	
Mean				5,879	1,960	4,794	5,123	3,949	45,397	129,433	432	490
1	11.970	6.522	46.5	6,447	2,149	4,439	2,892	1,516	32,981	63,134	321	
2	11.858	6.492	46.5	7,090	2,363	6,726	5,866	4,288	43,662	86,368	361	
3	11.880	6.484	46.5	7,717	2,572	5,660	5,914	4,421	46,747	92,071	392	
Mean				7,084	2,361	5,608	4,891	3,408	41,130	80,525	358	590
Mean (4-1/2" and 6-1/2" combined)												540

Table 20. Test results (plf) for 2-ft SIP lintel

Specimen	Depth (in.)	Width (in.)	Span (in.)	Max Load (lbf)	Max Load/3 (lbf)	Load at deformation L/			Slope (lbf/in.)	MOE (psi)	MOR (psi)	Max Load/3 /span (plf)
1	11.803	4.473	22.5	7,046	2,349	--	--	5,641	220,637	72,770	254	
2	11.803	4.473	22.5	5,258	1,753	--	--	4,643	215,807	71,177	190	
3	11.777	4.480	22.5	6,938	2,313	6,206	5,238	3,217	183,589	60,858	251	
Mean				6,414	2,138	6,206	5,238	4,500	206,677	68,268	232	1,069
1	11.899	6.485	22.5	6,385	2,128	6,016	3,533	1,325	239,958	53,278	156	
2	11.861	6.478	22.5	6,657	2,219	5,766	6,514	3,774	303,693	68,152	164	
3	11.851	6.457	22.5	5,919	1,973	4,974	5,448	5,675	382,088	86,242	147	
Mean				6,320	2,107	5,585	5,165	3,591	308,580	69,224	156	1,053
Mean (4-1/2" and 6-1/2" combined)												1,061

5. CONCLUSION

From the test results shown in Section 4, the allowable design values were established, as shown in Tables 21 through 24.

5.1 Allowable Racking Shear Design Values

Table 21. Allowable racking shear design values (plf) for SIP wall panels[(a)]

Wall height (in.)	Wall thickness	
	4-1/2 in.	6-1/2 in.
	Allowable racking shear (plf)	
96 120	315	

[(a)] Applicable to short-term load duration (10 minutes).

5.2 Allowable Axial Load (Compressive) Design Values

Table 22. Allowable axial load design values (plf) for the SIP wall panels[(a)]

Wall height (in.)	Wall thickness	
	4-1/2 in.	6-1/2 in.
	Allowable axial load (plf)	
96 120	3,200 3,100	3,200 3,100

[(a)] Applicable to long-term load duration (10 years). The tabulated values may be adjusted for other load durations in accordance with the code.

5.3 Allowable Transverse Load Design Values

Table 23. Allowable transverse load design values (psf) for SIP wall panels[(a)]

SIP Panel	Height (in.)	Allowable transverse load for deflection limits (psf)			
		L/360	L/240	L/180	L/120
8' high x 4-1/2"	96	30	38	38	38
10' high x 4-1/2"	120	18	27	27	27
8' high x 6-1/2"	96	38	38	38	38
10' high x 6-1/2"	120	29	29	29	29

[(a)] Applicable to long-term load duration (10 years). The tabulated values may be adjusted for other load durations in accordance with the code provided that the adjusted value does not exceed the allowable load at the specific deflection limit (see Tables 13 through 16).

5.4 Allowable SIP Lintel Design Values

Table 24. Allowable design values (plf) for SIP lintels[(a)]

Lintel Span (ft)	Allowable Load (plf)
2	1,060
4	540
6	300
8	175

[(a)] Applicable to long-term load duration (10 years). The tabulated values may be adjusted for other load durations in accordance with the code.

6. REFERENCES

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7. APPENDICES

List of Appendices

Appendix A: Fabrication Witness Report .... 1 page

Appendix B: Drawings of Test Specimens .... 4 pages

Appendix C: Test Assemblies .... 11 Pages

Appendix D: Failure Modes of Test Assemblies .... 5 pages

Appendix A: Fabrication Witness Report (1 page)

Fabrication Witness Report
Edward L. Keith, P.E.
November 14, 2005

Purpose: Witness manufacturing of 84 SIPS specimen to be tested at the APA laboratory for SIPA.

Location: Fabrication was done at:
Premier Building Systems
4607 70th Ave East
Fife, WA 98424-3711

Panels: Panels were APA-Rated Sheathing 24/16, 7/16" OSB, manufactured by Ainsworth, Cook, Minnesota (Mill 366)
4 x 8 manufactured - Sept 7, 2005, Shift A
4 x 10 manufactured - _Sept 28, 2005, Shift D.

Foam: Expanded poly styrene (EPS), density 0.88 – 0.90 pcf, manufactured out of virgin material

Adhesive: Ashland Chemical, product 3030D (ISOGRIP SP), moisture cured, lot# SD28AO04, expiration date 15 Dec 05.

Target spread rate: Mfg. Target = 9 – 11 grams/sf/side. Premier Target = 14 grams/sf/side.

Actual spread rate: 3.5-inch-thick cores – 13-13.5 grams/sf/side
5.5-inch-thick cores – 11-11.5 grams/sf/side

Presses: Three pneumatic presses used, maintaining a 5 –7 psf pressure on panels.

Fabrication: Based on the adhesive used and ambient temperature, the panels had a 61-minute build time with an 81-minute press time. Build time is the total fabrication time for the whole stack of panels. Whatever of the build time that was not used in fabrication, was added to the press time. As a result the total fabrication plus press time shall not be less than 142 minutes. Panels were fabricated in accordance with the attached matrix.

Points of Contact: Gary Wood – Assistant Production Manager, Dan – Shift Foreman, and Ralph – Adhesive Supervisor.

Appendix B: Drawings of Test Specimens (4 pages)

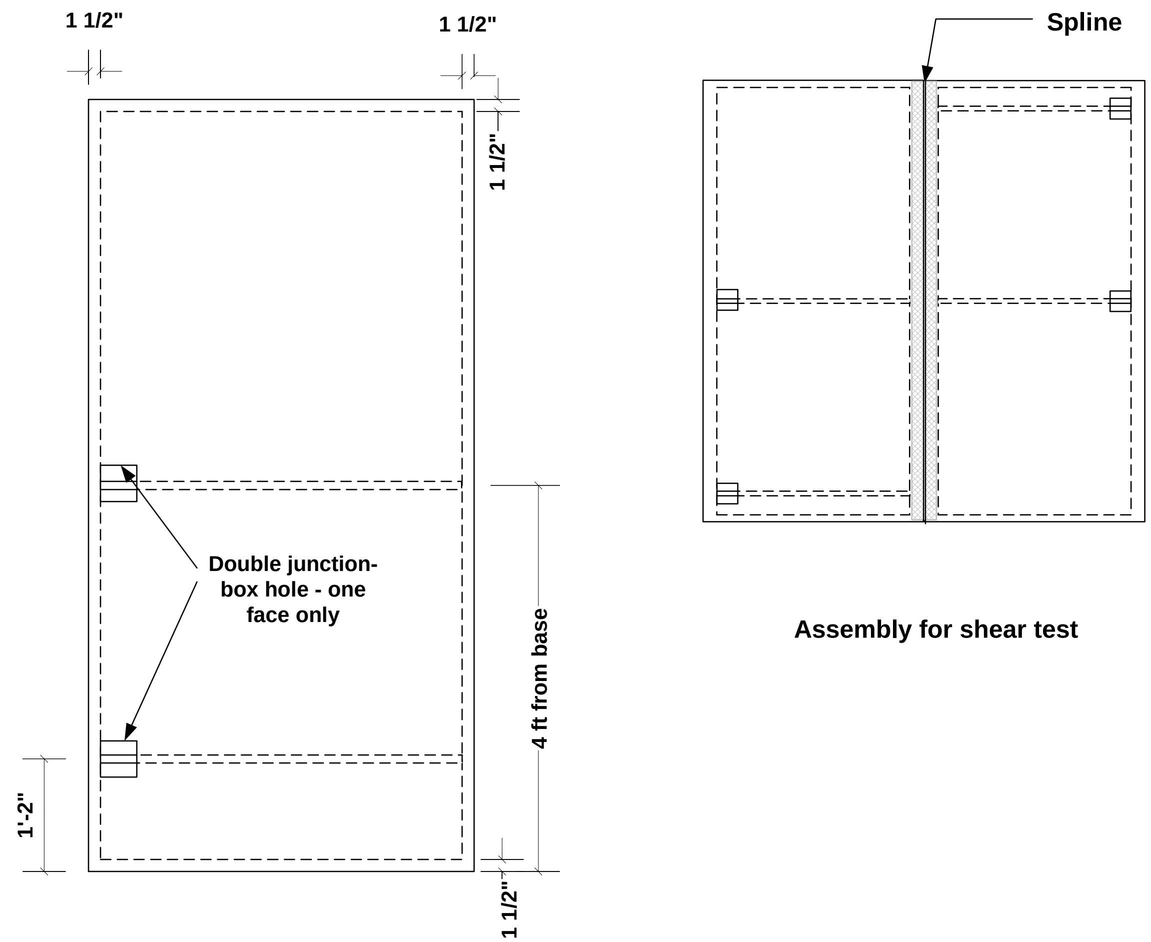


FIGURE B1. RACKING SHEAR TEST SPECIMEN AND ASSEMBLY

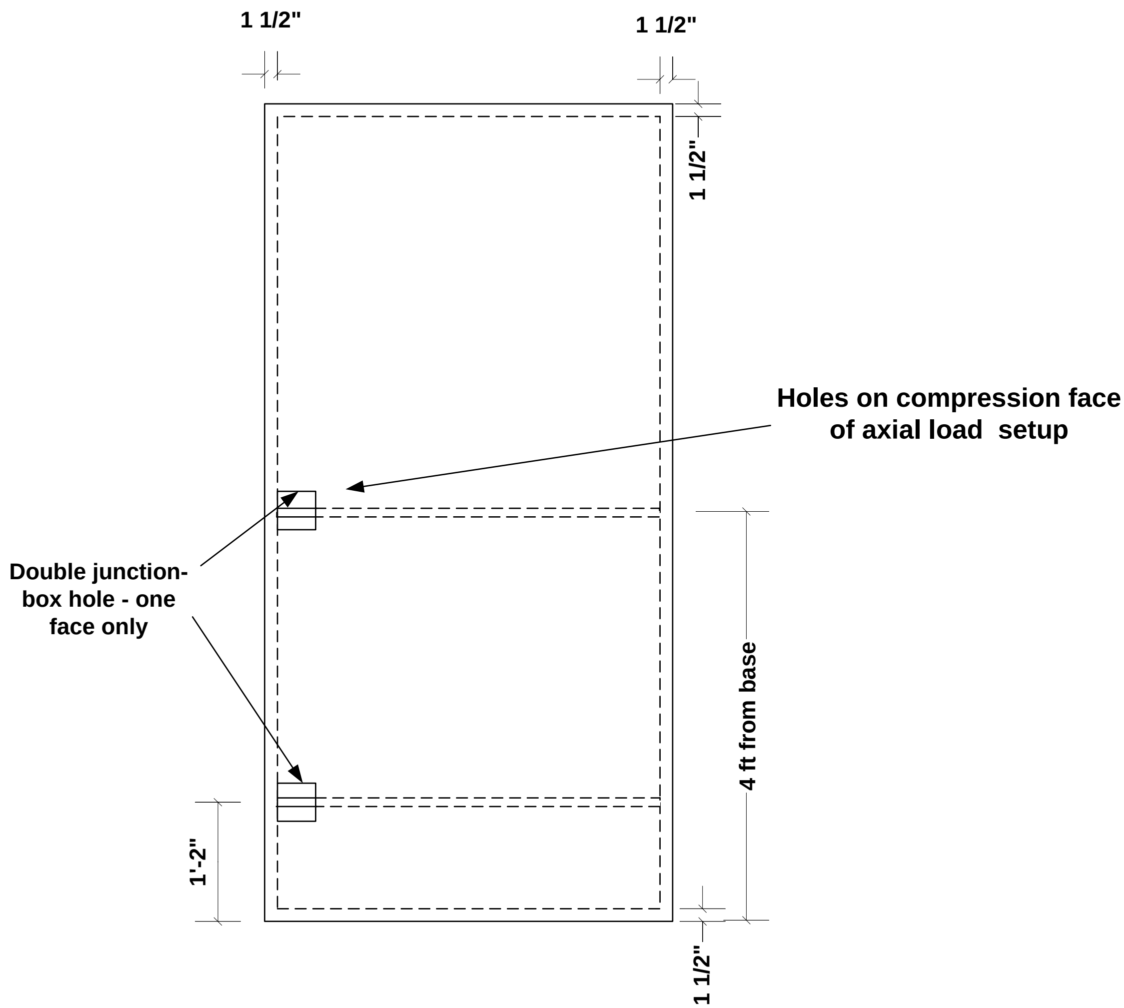


FIGURE B2. AXIAL (COMPRESSION) LOAD TEST SPECIMEN AND ASSEMBLY

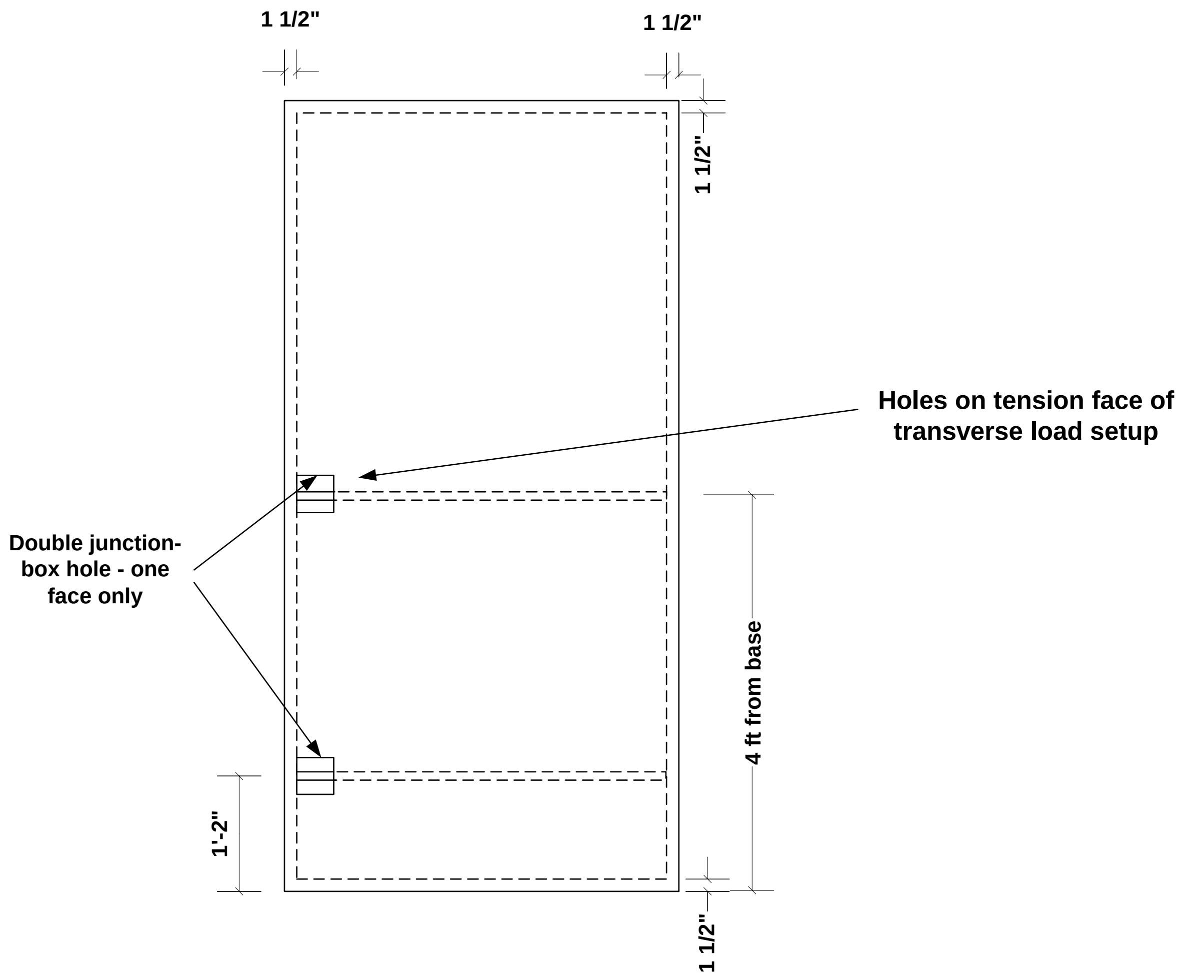


FIGURE B3. TRANSVERSE LOAD TEST SPECIMEN AND ASSEMBLY

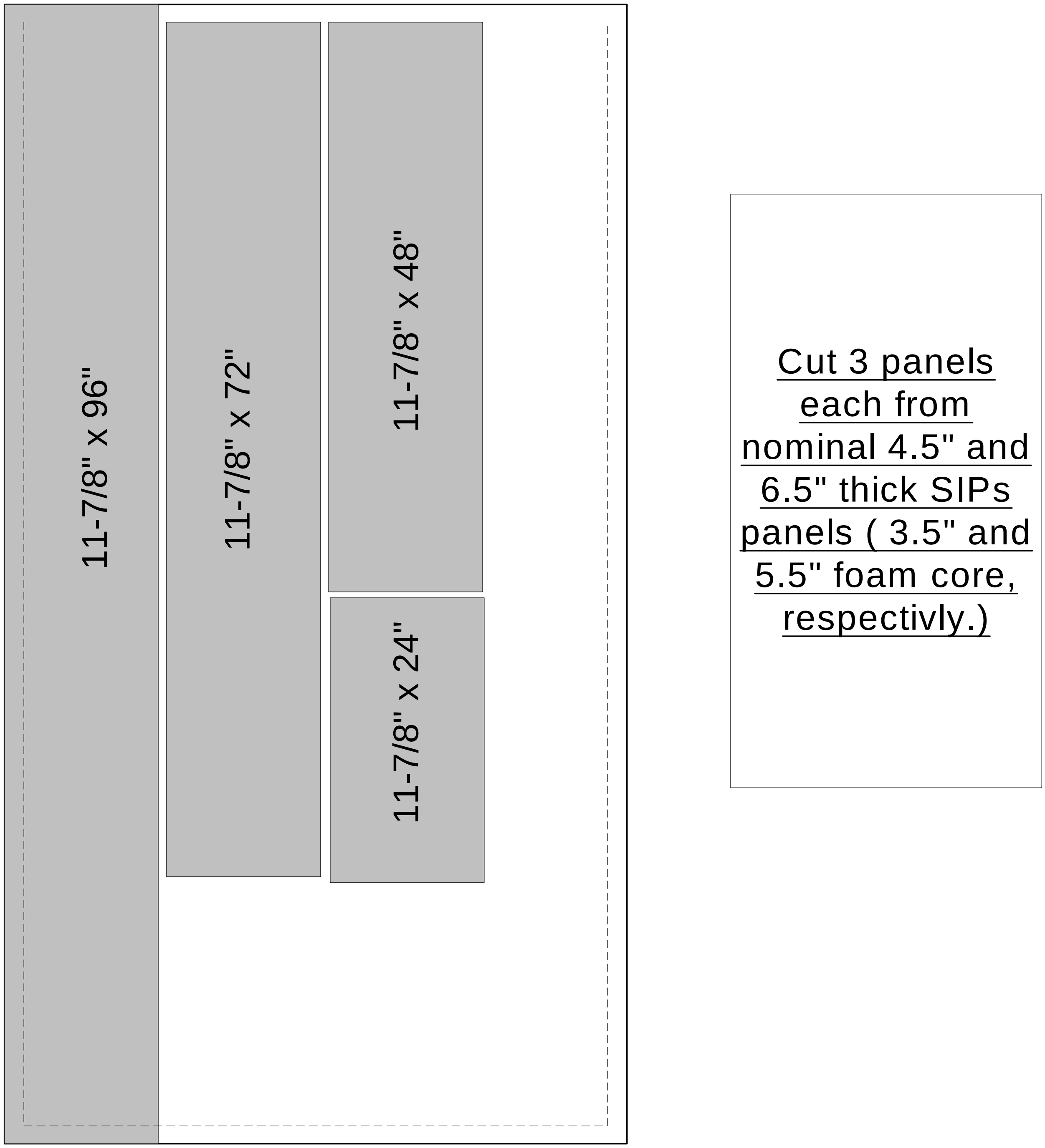


FIGURE B4. CUTSHEET FOR SIP LINTEL TEST

Appendix C: Test Assemblies (11 ages)

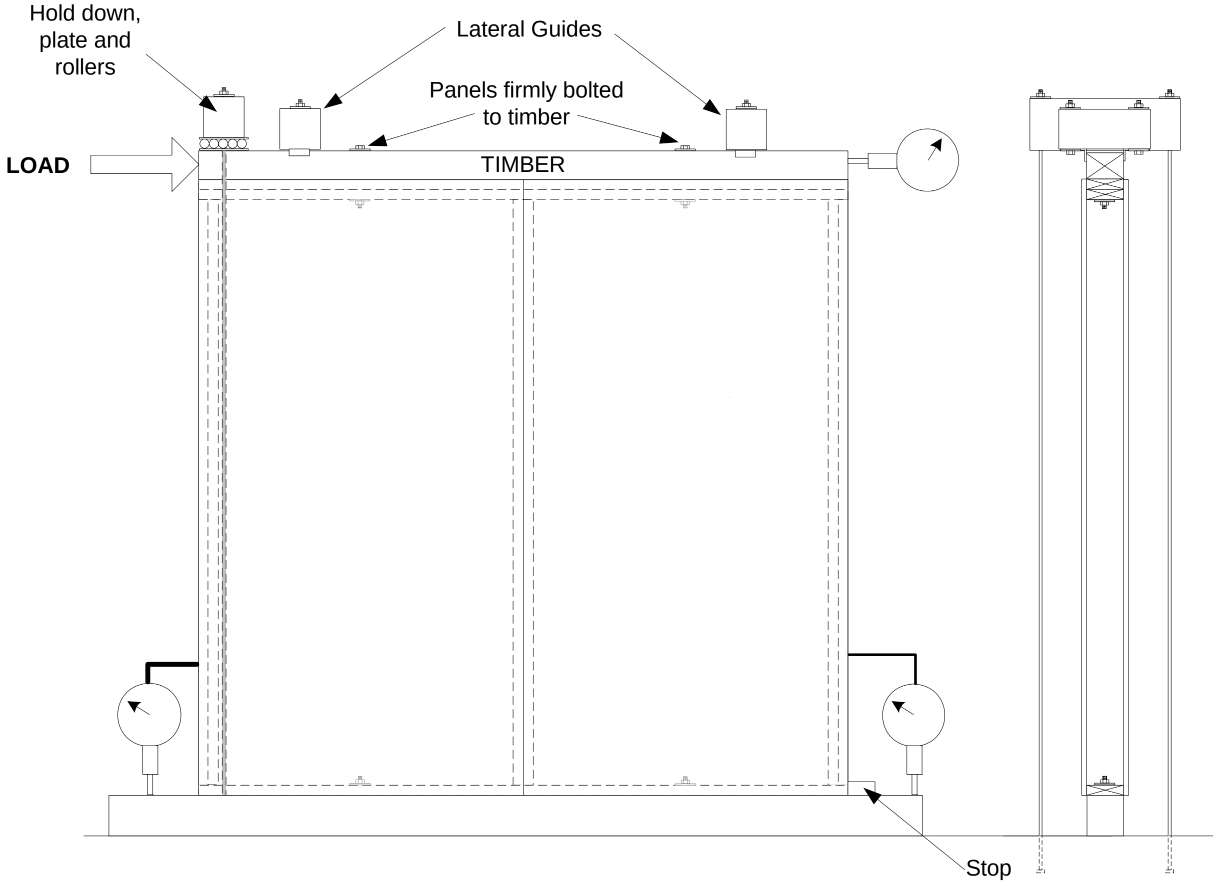


FIGURE C1. RACKING SHEAR TEST ASSEMBLY

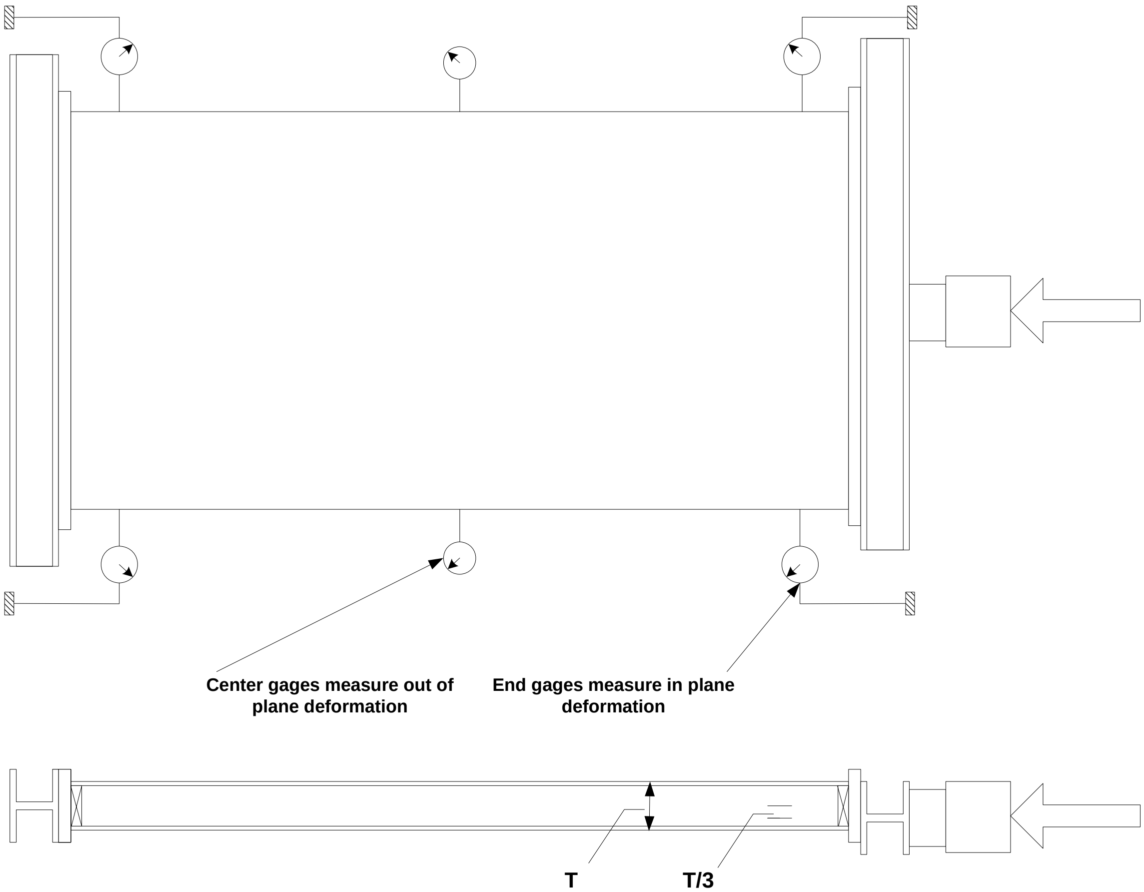


FIGURE C2. AXIAL (COMPRESSION) LOAD TEST ASSEMBLY

FIGURE C3. AXIAL (COMPRESSION) LOAD TEST ASSEMBLY

FIGURE C4. AXIAL (COMPRESSION) LOAD TEST ASSEMBLY – LOAD HEAD WITH INSTRUMENTATION

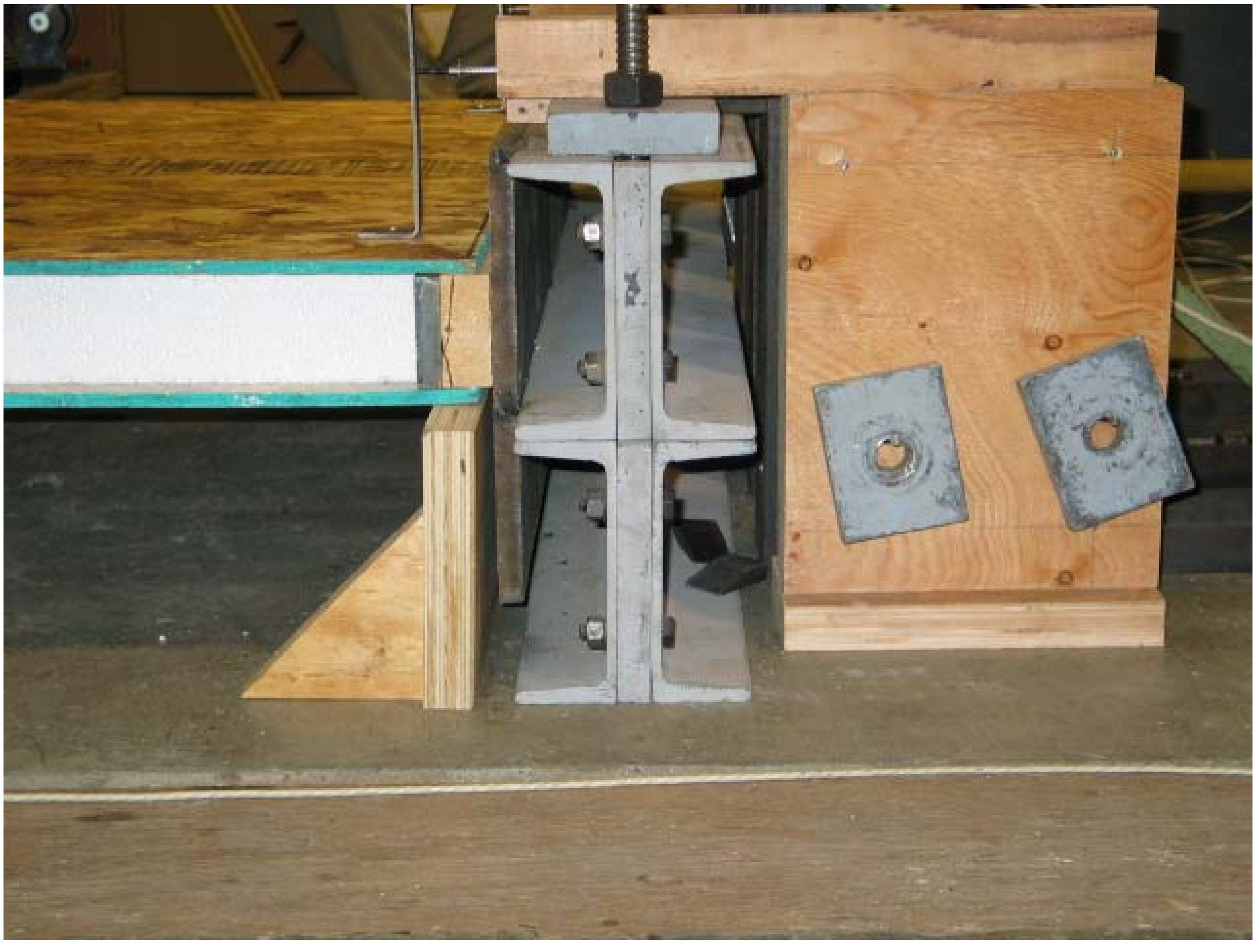


FIGURE C5. AXIAL (COMPRESSION) LOAD TEST ASSEMBLY – REACTION BEAM

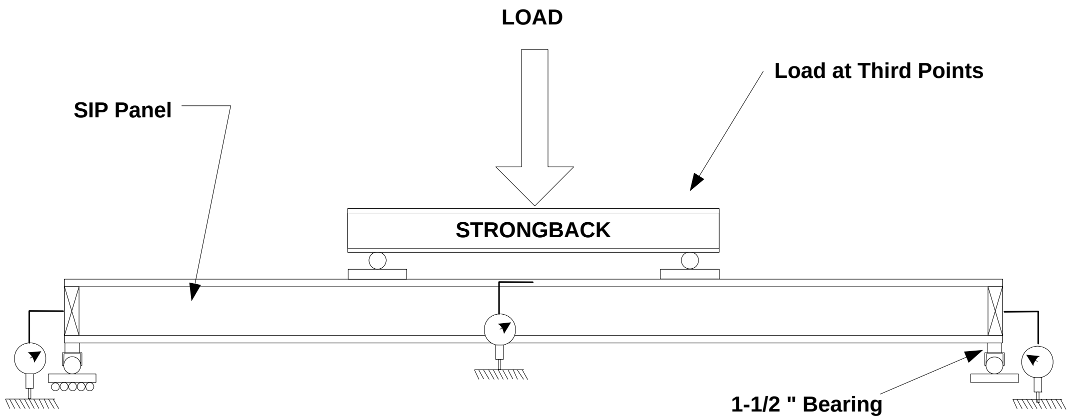


FIGURE C6. TRANSVERSE LOAD TEST ASSEMBLY

FIGURE C7. TRANSVERSE LOAD TEST ASSEMBLY

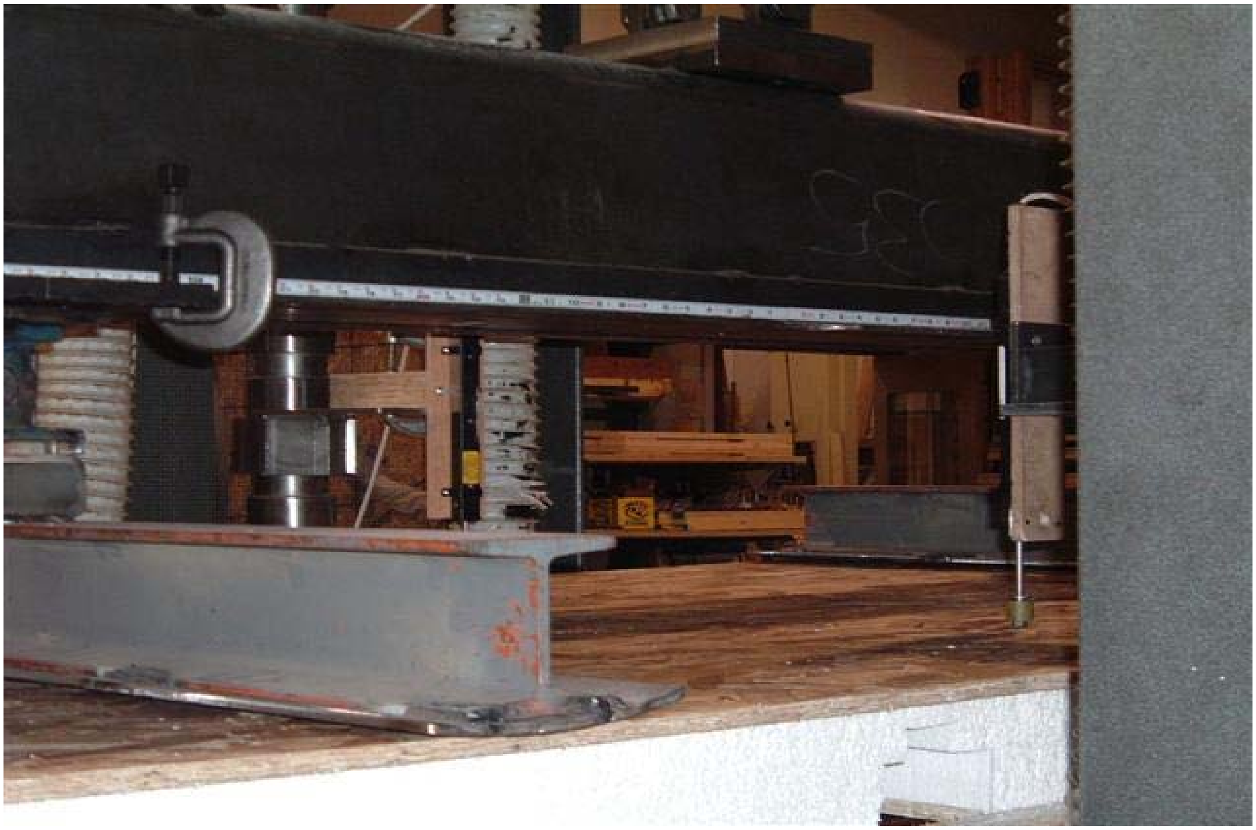
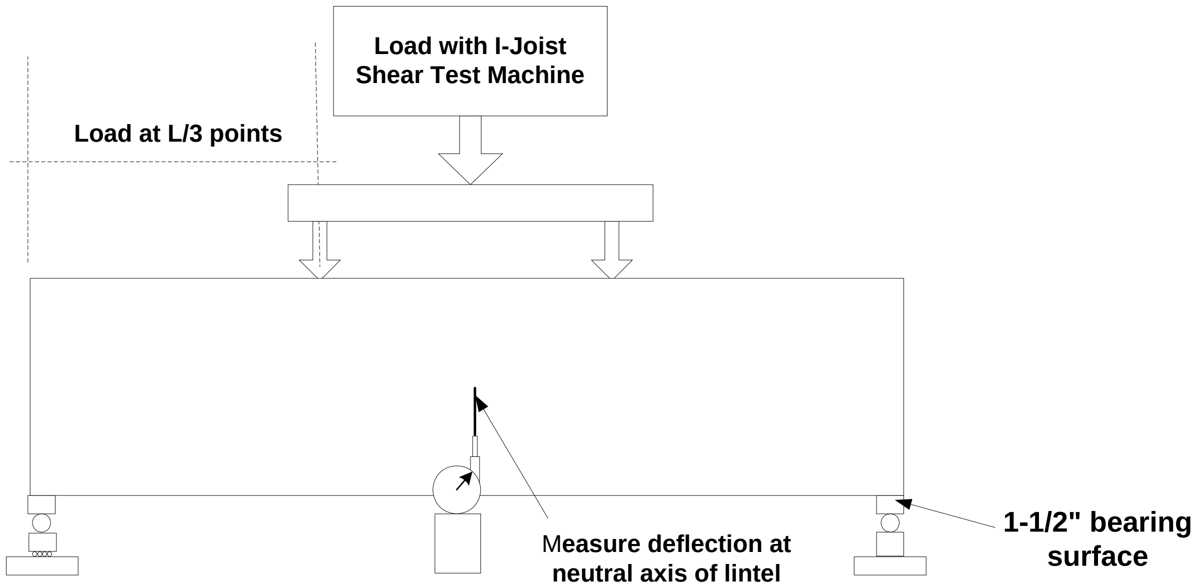


FIGURE C8. TRANSVERSE LOAD TEST ASSEMBLY –THIRD-POINT LOADING APPARATUS WITH INSTRUMENTATION



(48" shown for example only)

FIGURE C9. LINTEL LOAD TEST ASSEMBLY

FIGURE C10. LINTEL LOAD TEST ASSEMBLY

FIGURE C11. LINTEL LOAD TEST ASSEMBLY – END VIEW

Appendix D: Failure Modes of Test Assemblies (5 pages)

FIGURE D1. RACKING SHEAR TEST FAILURE
(Nails tear away from center spline)

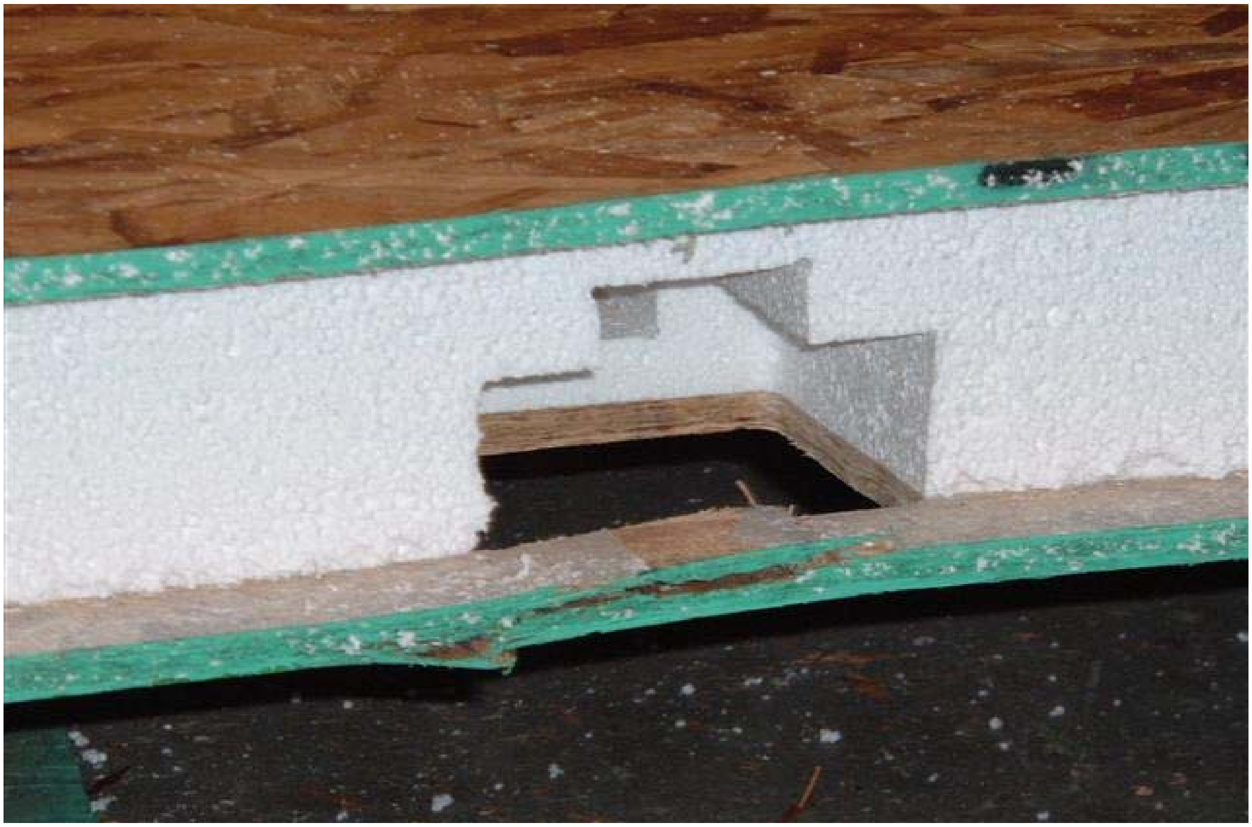


FIGURE D2. AXIAL LOAD (COMPRESSION) TEST
(Buckling failure on compression side through electrical chase holes)

FIGURE D3. AXIAL LOAD (COMPRESSION) TEST
(Shear failure through foam propagated from horizontal electrical chase at bottom edge of panel)

FIGURE D4. TRANSVERSE LOAD TEST
(Failure on tension side at electrical chase holes)

FIGURE D5. LINTEL BENDING TEST
(Tension failure of OSB skins at one-of-two load points)