NTA INC.

ENGINEERS
PLANNERS
CONSULTANTS

305 NORTH OAKLAND AVENUE · P.O. BOX 490 · NAPPANEE, INDIANA 46550
PHONE: 219-773-7975
FAX: 219-773-2732

Evaluation of Double-Sided Wall Assemblies Under Racking Load Sheathed with 5/16" American Gypsum Wall Board

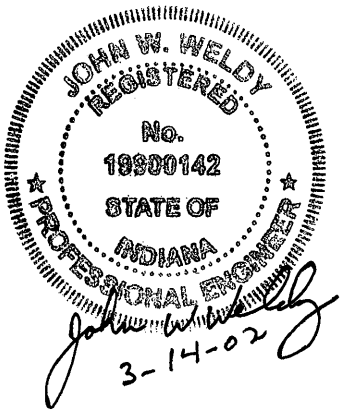
Bonded with:
Pemco 5100 Adhesive &
Pemco 3100
Manufactured By:
Alpha Systems, Inc.

Prepared For:

Alpha Systems
5120 Beck Drive
Elkhart, IN 46516

Test Report: NTA200217

Issued: March 13, 2002



Prepared By:

John Kirkwood
Director of Testing

Reviewed By:
John W. Weldy
Test Engineer

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1.0 INTRODUCTION

NTA, Inc. conducted racking load tests on wall assemblies at the NTA test facility in Nappanee, Indiana. The wall assemblies were tested based on ASTM E 72-80; Standard Methods of Conducting Strength Tests of Panels for Building Construction, Section 14, Racking Load -- Evaluation of Sheathing Materials on a Standard Wood Frame.

The purpose of this evaluation is to determine what the allowable design shear load is for wall assemblies constructed as described in this report, using 5/16" American Gypsum wall board attached vertically with Pemco 5100 and Pemco 3100 adhesives as manufactured by Alpha Systems when used in shear walls for manufactured housing.

2.0 TEST SPECIMEN DESCRIPTION

A. Materials

1. Studs: 2"x 3", Stud Grade SPF at 16" o.c.
2. Top Plate: Single 2" x 3", Stud Grade SPF.
3. Bottom Plate: Single 2" x 3", Stud Grade SPF.
4. Gypsum: 48" x 96", 5/16" American Gypsum Wall Board.
5. Adhesive: Pemco 5100 and Pemco 3100.

B. Fastening

- Top plate fastened to studs with Two (2) - 7/16" x 2-1/2" x 15 Ga. staples per stud.
- Bottom plate fastened to studs with Two (2) - 7/16" x 2-1/2" x 15 Ga. staples per stud.
- Gypsum bonded to 2"x 3" framing members Side "A" with Two (2) – 1/16"-1/8" (average) beads of "P5100" adhesive.
- Gypsum bonded to framing members Side "B" with (1) 1/4" Bead of "Pemco 3100" (Center Stud side "B" (2) 1/4" beads of "Pemco 3100").
- Gypsum bonded to 2" x 3" top and bottom plates Side "A" with Two (2) – 1/16"-1/8" (average) beads of "Pemco 5100" adhesive.
- Gypsum bonded to 2" x 3" top and bottom plates Side "B" with One (1) – 1/4" (average) bead of "Pemco 3100"adhesive.
- Gypsum fastened to framing with 3/16"x 3/4" x 19 Ga. staples at 6" o.c. around perimeter and 12"o.c. field fasteners. (Fastening schedule is same on both sides.)

C. Construction Steps

- Adhesives applied to the assembled walls with a glue bottle (P5100) and a caulking gun (Pemco 3100).
- The gypsum was placed vertically on both sides of the wall framing immediately after the adhesive was applied and then promptly fastened along all wall board perimeters to the framing members as described.

D. Cure Time

After construction, each of the wall assemblies was cured a minimum of seven (7) days before testing.

3.0 TEST SETUP AND PROCEDURE

The wall top plate was fastened to a steel load bar using four (4) - #10 wood screws into each stud bay adjacent to a panel edge for load application. The bottom plate was securely fastened to a structural tee with four (4) - #10 wood screws into each stud bay. The structural tee was then attached to the I-beam in order to secure the sample to the test rack.

Load was applied horizontally to the load bar which was attached to the top plate of the wall. Dial indicators were placed on the top plate (Indicator #1) and on the bottom plate (Indicator #2) opposite the loaded end of the wall. An additional dial indicator was placed on the load end of the wall at the base of the rack at the first stud location (Indicator #3). See Figure #2 for details.

Load was applied in 395 pound increments, up to 2370 pounds, at a rate of approximately 790 pounds per two minutes (not less than). When each load increment was reached, deflection readings were taken while maintaining the load. The load was then reduced back to zero at an approximate rate of 790 pounds per two minutes. Zero load readings were taken after each load increment up to 2370 pounds. Finally, load was applied at the same approximate rate until failure occurred.

To determine the horizontal deflection of the panel, subtract the deflection readings from Indicators #2 and #3 from Indicator #1. Indicator #3, which is attached to the stud, will measure any rotation of the panel. Indicator #2 measures any slippage of the panel in the test rack. Indicator #1 measures the total of displacement of Indicators #2 and #3, as well as the deformation of the panel.

4.0 TEST RESULTS

A total of three (3) test samples were tested. Each sample had American Gypsum bonded to both sides using adhesives described above. The ultimate loads achieved and the types of failures that occurred are described below.

SAMPLE	ULTIMATE LOAD	FAILURE MODE
#1	9544 pounds	Gypsum shear.
#2	9834 pounds	Gypsum shear.
#3	9800 pounds	Gypsum shear.

Average Ultimate Load = 9726 pounds

Allowable Design Load = (Average Ultimate Load) / [(Wall Length)*(Safety Factor)]

(9726 pounds) / [(8 feet)*(2.5)] = 486.3 PLF

5.0 CONCLUSION

Based on the results of the tests conducted, the maximum allowable design load for a 96" tall shear wall built of 2 x 3 Stud Grade SPF studs at 16" o/c, 2 x 3, Stud Grade SPF top plates with 2 x 3 Stud Grade SPF bottom plates with American Gypsum wall board attached to both sides as described in this report is:

For 5/16" American Gypsum Wall Board
Bonded to Both Sides with
Pemco 5100 (Side A) and
Pemco 3100 (Side B) = 486.3 PLF

5.1 FOLLOW-UP TESTING

Follow-up testing will be in accordance with the NTA, Inc. follow-up testing procedures.

TEST REPORT BY: _____
John Kirkwood, NTA Inc.
Director of Testing

REPORT REVIEWED BY: _____
John W. Weldy, P.E.
Test Engineer

NTA, Inc.

WALL RACKING TEST

Test Procedure: ASTM E 72-80

Adhesive Manufacturer: Alpha Systems
Type of Adhesive: Side A: P 5100
Side B: P 3100

SAMPLE 1

Test Number:	200217
Test Date:	3/12/2002
Temperature:	70 F
Relative Humidity:	19%

Type of Gypsum: 5/16" American Gypsum

Gypsum Orientation:	Vertical
Block Fastening:	N/A
FASTENERS:	3/16" x3/4" x19 Gauge
Field Spacing:	12" o.c.
Top Plate Spacing:	6" o.c.
Bottom Plate Spacing:	6" o.c.
Vertical Edge Spacing:	6" o.c.
Adhesive Bead Size:	P5100 (2) 1/16"-1/8"
	P3100 (1) 1/4" Center (2) Beads

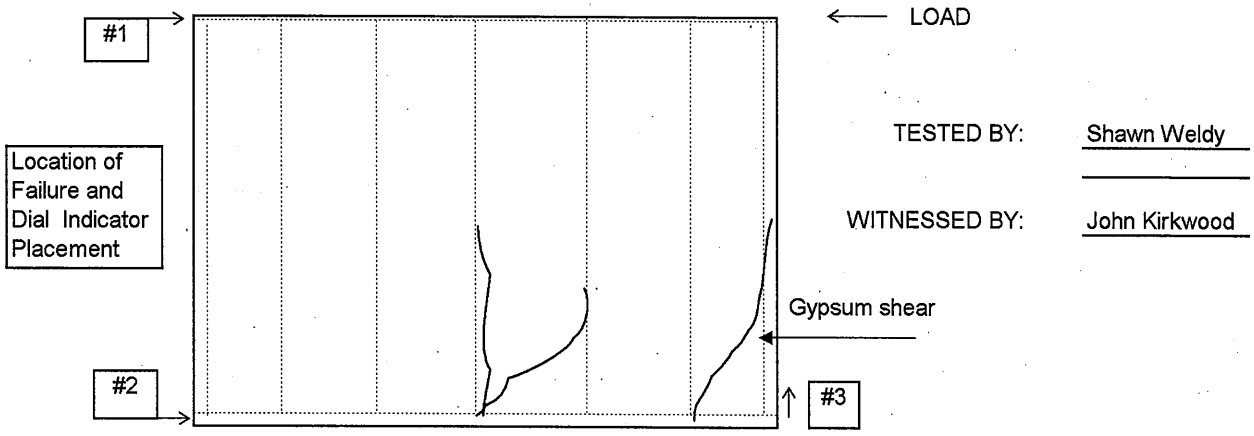
AVERAGE MOISTURE CONTENT
Plates: 10.00% (2x3, Stud Grade SPF)
Studs: 10.00% (2x3, Stud Grade SPF at 16" o.c.)

LOAD	INDICATOR #1 (in.)		INDICATOR #2 (in.)		INDICATOR #3 (in.)		RESULTANT DEFLECTION
(pounds)	READING	DEF.	READING	DEF.	READING	DEF.	(#1 - #2 - #3)
0	0.884		0.358		0.643		
395	0.943	0.059	0.360	0.002	0.633	0.010	0.047
0	0.888	0.004	0.358	0.000	0.642	0.001	0.003
790	0.994	0.110	0.361	0.003	0.624	0.019	0.088
0	0.895	0.011	0.359	0.001	0.642	0.001	0.009
1185	1.051	0.167	0.364	0.006	0.612	0.031	0.130
0	0.898	0.014	0.359	0.001	0.641	0.002	0.011
1580	1.145	0.261	0.368	0.010	0.590	0.053	0.198
0	0.904	0.020	0.359	0.001	0.639	0.004	0.015
1975	1.259	0.375	0.370	0.012	0.561	0.082	0.281
0	0.914	0.030	0.359	0.001	0.636	0.007	0.022
2370	1.332	0.448	0.372	0.014	0.544	0.099	0.335
0	0.921	0.037	0.359	0.001	0.635	0.008	0.028

LOAD AT FAILURE: 9544 LBS. **DATE FABRICATED:** 3/5/2002

MODE OF FAILURE: Gypsum Shear both sides

8' x 8' SAMPLE: GYPSUM ATTACHED TO BOTH SIDES.



TESTED BY: Shawn Weldy

WITNESSED BY: John Kirkwood

NTA, Inc.

WALL RACKING TEST

Test Procedure: ASTM E 72-80

Adhesive Manufacturer: Alpha Systems
Type of Adhesive: Side A: P 5100
Side B: P 3100

SAMPLE 2
Test Number: 200217
Test Date: 3/12/2002
Temperature: 70 F
Relative Humidity: 19%

Type of Gypsum: 5/16" American Gypsum

Gypsum Orientation: Vertical
Block Fastening: N/A
FASTENERS: 3/16" x3/4" x19 Gauge
Field Spacing: 12" o.c.
Top Plate Spacing: 6" o.c.
Bottom Plate Spacing: 6" o.c.
Vertical Edge Spacing: 6" o.c.
Adhesive Bead Size: P5100 (2) 1/16"-1/8"
P3100 (1) 1/4" Center (2) Beads

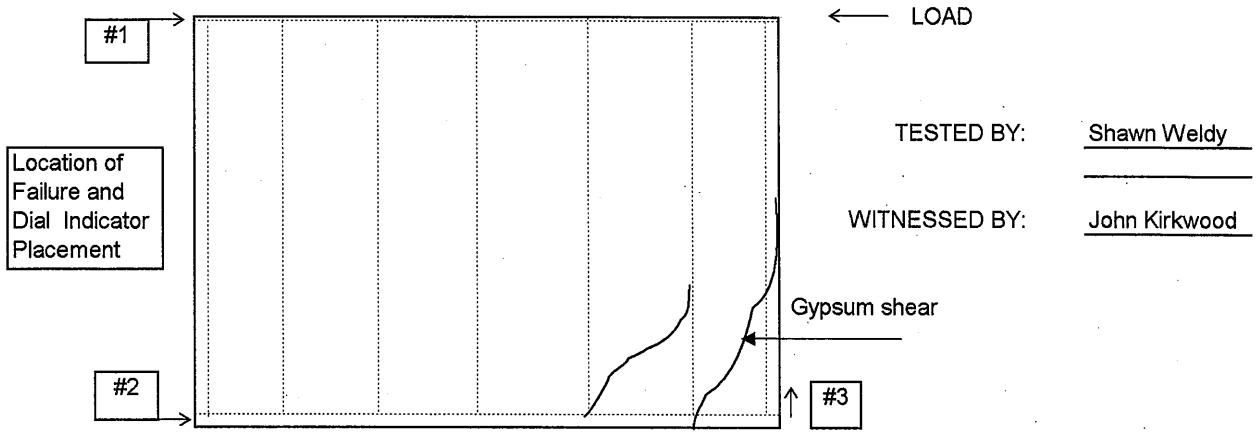
AVERAGE MOISTURE CONTENT
Plates: 10.00% (2x3, Stud Grade SPF)
Studs: 10.00% (2x3, Stud Grade SPF at 16" o.c.)

LOAD (pounds)	INDICATOR #1 (in.)		INDICATOR #2 (in.)		INDICATOR #3 (in.)		RESULTANT DEFLECTION (#1 - #2 - #3)
	READING	DEF.	READING	DEF.	READING	DEF.	
0	0.601		0.398		0.672		
395	0.664	0.063	0.401	0.003	0.662	0.010	0.050
0	0.609	0.008	0.398	0.000	0.671	0.001	0.007
790	0.711	0.110	0.404	0.006	0.653	0.019	0.085
0	0.615	0.014	0.399	0.001	0.670	0.002	0.011
1185	0.799	0.198	0.407	0.009	0.632	0.040	0.149
0	0.622	0.021	0.399	0.001	0.668	0.004	0.016
1580	0.848	0.247	0.409	0.011	0.620	0.052	0.184
0	0.625	0.024	0.399	0.001	0.667	0.005	0.018
1975	0.940	0.339	0.415	0.017	0.593	0.079	0.243
0	0.632	0.031	0.399	0.001	0.665	0.007	0.023
2370	1.020	0.419	0.418	0.020	0.571	0.101	0.298
0	0.638	0.037	0.399	0.001	0.663	0.009	0.027

LOAD AT FAILURE: 9834 LBS.
DATE FABRICATED: 3/5/2002

MODE OF FAILURE: Gypsum Shear both sides.

8' x 8' SAMPLE: GYPSUM ATTACHED TO BOTH SIDES.



NTA, Inc.

WALL RACKING TEST

Test Procedure: ASTM E 72-80

Adhesive Manufacturer: Alpha Systems
Type of Adhesive: Side A: P 5100
Side B: P 3100

SAMPLE 3
Test Number: 200217
Test Date: 3/12/2002
Temperature: 70 F
Relative Humidity: 19%

Type of Gypsum: 5/16" American Gypsum

Gypsum Orientation: Vertical
Block Fastening: N/A
FASTENERS: 3/16" x3/4" x19 Gauge
Field Spacing: 12" o.c.
Top Plate Spacing: 6" o.c.
Bottom Plate Spacing: 6" o.c.
Vertical Edge Spacing: 6" o.c.
Adhesive Bead Size: P5100 (2) 1/16"-1/8"
P3100 (1) 1/4" Center (2) Beads

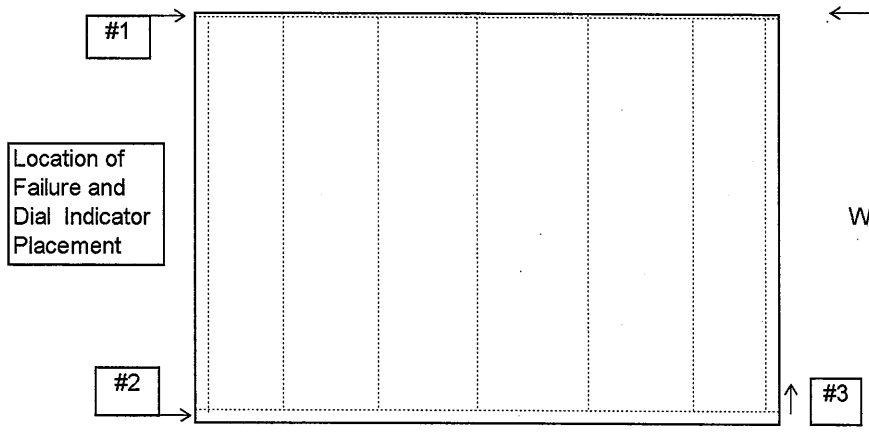
AVERAGE MOISTURE CONTENT
Plates: 10.00% (2x3, Stud Grade SPF)
Studs: 10.00% (2x3, Stud Grade SPF at 16" o.c.)

LOAD (pounds)	INDICATOR #1 (in.)		INDICATOR #2 (in.)		INDICATOR #3 (in.)		RESULTANT DEFLECTION (#1 - #2 - #3)
	READING	DEF.	READING	DEF.	READING	DEF.	
0	0.839		0.199		0.608		
395	0.883	0.044	0.201	0.002	0.601	0.007	0.035
0	0.845	0.006	0.199	0.000	0.607	0.001	0.005
790	0.950	0.111	0.202	0.003	0.588	0.020	0.088
0	0.851	0.012	0.199	0.000	0.606	0.002	0.010
1185	0.994	0.155	0.204	0.005	0.579	0.029	0.121
0	0.855	0.016	0.199	0.000	0.606	0.002	0.014
1580	1.089	0.250	0.207	0.008	0.557	0.051	0.191
0	0.862	0.023	0.199	0.000	0.604	0.004	0.019
1975	1.162	0.323	0.209	0.010	0.537	0.071	0.242
0	0.873	0.034	0.199	0.000	0.601	0.007	0.027
2370	1.227	0.388	0.211	0.012	0.520	0.088	0.288
0	0.881	0.042	0.199	0.000	0.600	0.008	0.034

LOAD AT FAILURE: 9800 LBS.
DATE FABRICATED: 3/5/2002

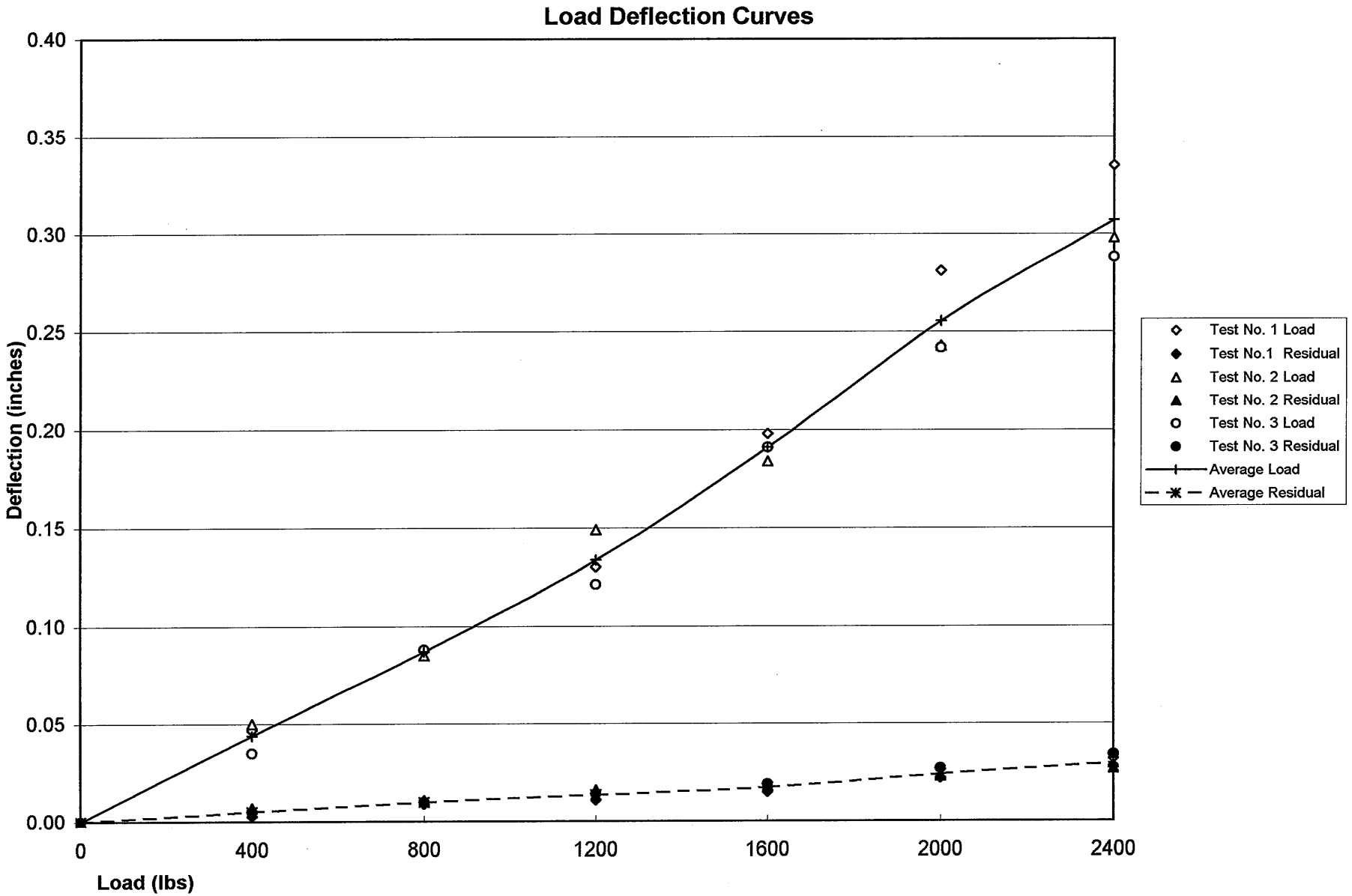
MODE OF FAILURE: Bottom plate paper failure.

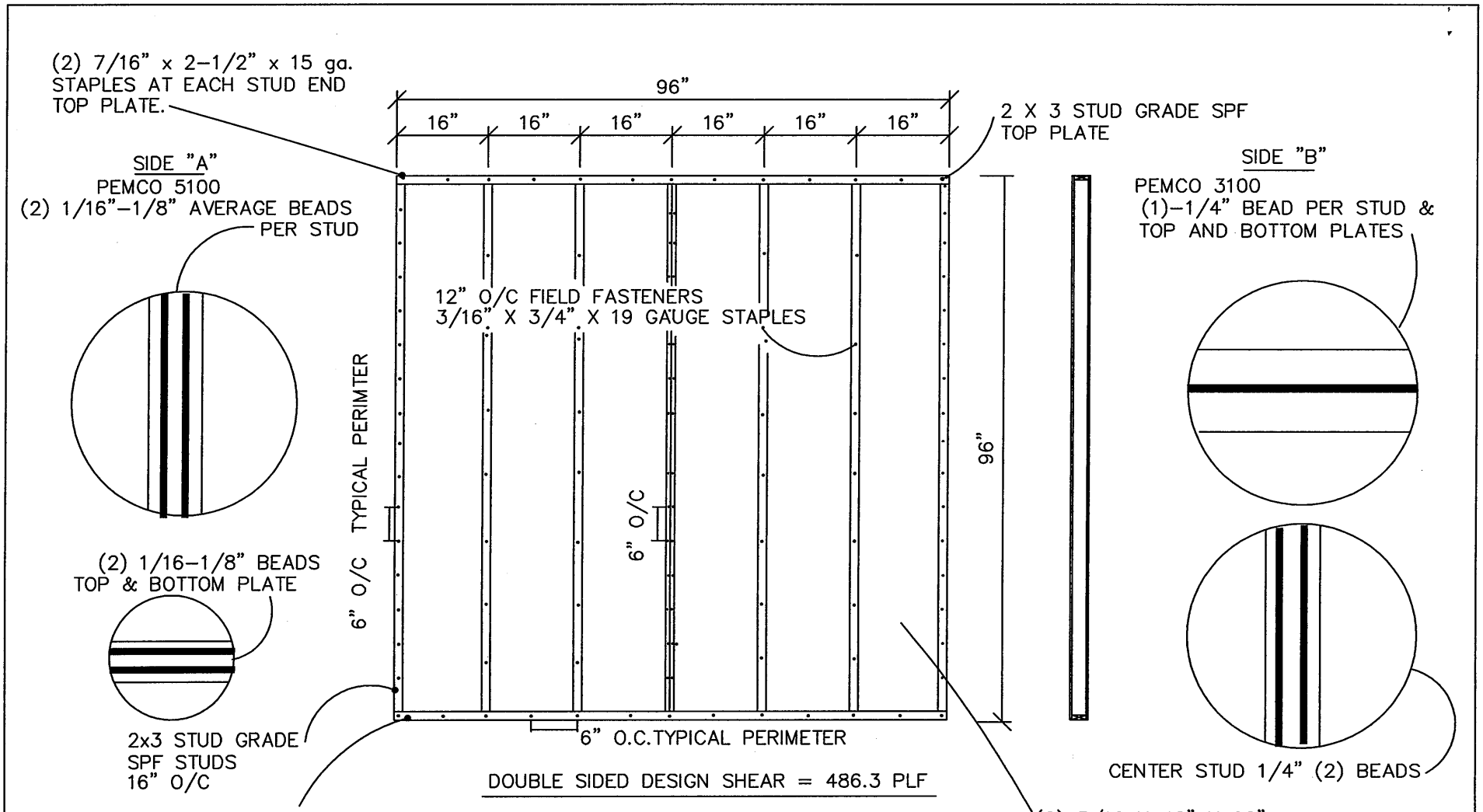
8' x 8' SAMPLE: GYPSUM ATTACHED TO BOTH SIDES.



TESTED BY: Shawn Weldy

WITNESSED BY: John Kirkwood


Load Deflection Curves
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Deflection (inches)
0
400
800
1200
1600
2000
2400
Load (lbs)
Test No. 1 Load
Test No.1 Residual
Test No. 2 Load
Test No. 2 Residual
Test No. 3 Load
Test No. 3 Residual
Average Load
Average Residual



NOTE:
SEE THE ATTACHED TEST REPORT
FOR EXACT CONSTRUCTION PROCEDURE.

SIDE "A" ADHESIVE = PEMCO 5100

SIDE "B" PEMCO 3100

REVISIONS:	NTA, INC.		SCALE: N.T.S.	APPROVED BY:
	305 N. OAKLAND AVENUE, NAPPANEE, IN. 46550		DATE: 03/04/02	PROJECT NO: NTA200217
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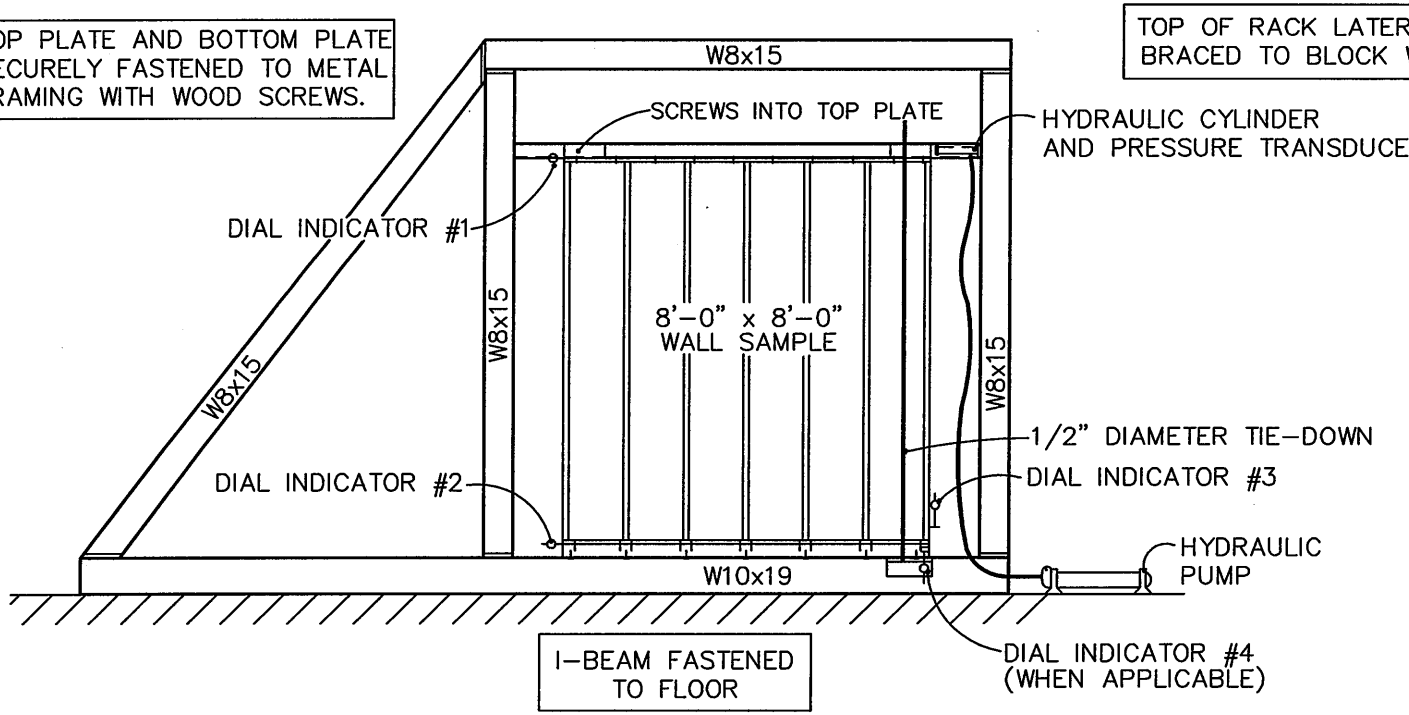
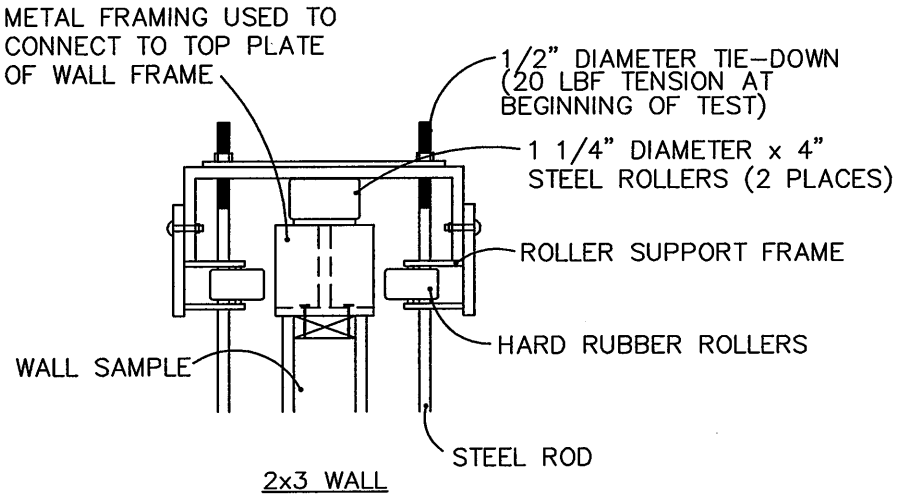
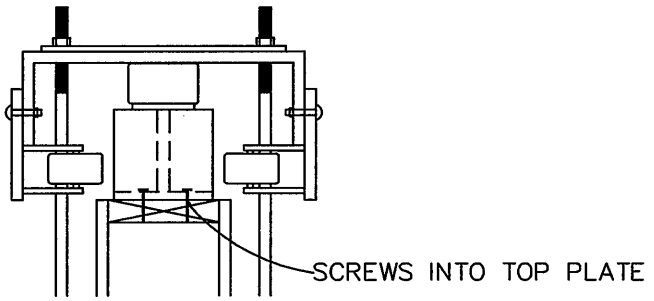




2x3 WALL



2x4 WALL

REVISIONS:	NTA, INC.		SCALE: N.T.S.	APPROVED BY:
	305 N.OAKLAND AVE., NAPPANEE, IN. 46550		DATE: 03/04/02	PROJECT NO: NTA200217
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