

**ENGINEERS  
PLANNERS  
CONSULTANTS**

305 NORTH OAKLAND AVENUE · P.O. BOX 490 · NAPPANEE, INDIANA 46550

PHONE: 219-773-7975  
FAX: 219-773-2732

**Evaluation of Wall Assemblies Under Racking Load Sheathed  
with Raw Gypsum Attached by PEMCO 5100**

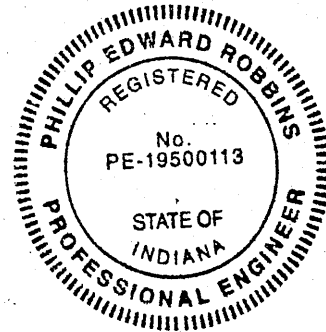
Prepared for

**Pemco Adhesives  
5120 Beck Drive  
Elkhart, IN 46516**

Test Report: NTA96-0212-1

Issued: February 27, 1996

Prepared By:



*Phillip E. Robbins*

MAR 1 1996

Phillip E. Robbins, P.E.  
NTA, Inc.

NTA, Inc. has issued this report for the exclusive use of the client to whom it is addressed. Any use or duplication of this report shall not be made without their consent.



## TABLE OF CONTENTS

	page #
1.0 INTRODUCTION	3
2.0 TEST SPECIMEN DESCRIPTION	3
3.0 TEST SETUP AND PROCEDURE	4
4.0 TEST RESULTS	4
5.0 CONCLUSION	5
5.1 FOLLOW-UP TESTING	5
6.0 APPENDIX	
6.1 TEST CHART AND TEST DATA	6
6.2 FIGURE 1: TEST SPECIMEN	10
6.3 FIGURE 2: TEST SET UP	11

## 1.0 INTRODUCTION

NTA, Inc. conducted racking load tests at the Alpha Systems test facility in Elkhart, IN on wall assemblies tested in substantial conformance to 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 was to determine what the allowable shear design load is for wall assemblies put together as described using PEMCO 5100 adhesive for use as shear walls in manufactured housing.

## 2.0 TEST SPECIMEN DESCRIPTION

### A. Materials

1. Studs: 2 X 3 stud grade S.P.F. at 16" o.c.
2. Top Plate: Single 1 X 3 utility grade S.P.F.
3. Bottom Plate: Single 1 X 3 utility grade S.P.F.
4. Sheathing: 4' X 8' X 5/16" thick Georgia Pacific Raw Gypsum panels
5. Adhesive: PEMCO 5100

### B. Fasteners

1. Top plate attached to studs with (2) 7/16" X 2" X 16 ga. staples per stud.
2. Bottom plate attached to studs with (2) 7/16" X 2" X 16 ga. staples per stud end.
3. Gypsum attached to 2 X 3 studs with (2) 1/16" to 1/8" (average) beads of PEMCO 5100 adhesive.
4. Gypsum attached to 1 X 3 top plate with (1) 1/16" to 1/8" (average) bead of PEMCO 5100 adhesive.
5. Gypsum attached to 1 X 3 bottom plate with (1) 1/16" (average) bead of PEMCO 5100 adhesive.
6. Gypsum attached to framing with 3/16" X 3/4" X 19 ga. staples at 6" o.c. along top and bottom plates. Gypsum was also edge secured 6" from plates at each stud and 1 fastener 6" above and below mid height of studs on gypsum perimeter. Stud field fasteners were placed at mid height of stud. See Figure #1 for representation.

### C. Construction Steps

1. The PEMCO 5100 adhesive was applied to the previously assembled wall framing with a squeeze bottle.
2. The raw gypsum was placed on one side of the wall framing immediately after

the PEMCO 5100 adhesive was applied and then promptly stapled along all framing members.

D. Cure Time

The wall assemblies were tested (7) days after construction.

3.0 TEST SET UP AND PROCEDURE

The top and bottom plates were attached to 4 X 4s with (3) - #8 X 2-1/2" screws per bay. The 4X4 was then secured by adding a 4X4 block between the 4x4 and the Vertical I-beam. The block and 4X4 were then secured to the horizontal I-beam using 2 C-clamps per end.

Load was applied horizontally to the 4 X 4 attached to the top plate of the wall. Dial indicators were placed on the top plate (indicator #1) and bottom plate (indicator #2) opposite the loaded end of the wall. An additional dial indicator was placed at the load end of the wall at the base of the rack on the first stud (indicator #3). See figure #2 for details.

Load was applied in 400 pound increments, up to 2400 pounds, at a rate of approximately 400 lbs/minute. When each load increment was reached, deflection readings were taken while holding at that load and then the load was reduced back to zero at a rate of approximately 400 lbs/minute. Zero load reading were taken after each load increment up to 2400 pounds. Load was then applied at the same rate of 400 lbs/minute until failure was reached.

To determine the horizontal deflection of the panel, deflection readings from indicator #2 and #3 were subtracted from indicator #1. Indicator #3 which is attached to the stud measures any rotation of the panel. Indicator #2 measures any slippage of the panel in the test rack. Indicator #1 measures the total of indicators #2 and #3 plus the deformation of the panel.

4.0 TEST RESULTS

A total of three (3) specimens with gypsum attached to one side with PEMCO 5100 were tested. The ultimate loads achieved and the types of failures are described below.

<u>TEST SAMPLE</u>	<u>MAX. LOAD</u>	<u>FAILURE MODE</u>
#1	6170 Lbs.	Gypsum shear at 3rd bay of 1st panel
#2	6058 Lbs.	Gypsum shear at 2nd bay of 2nd panel
#3	6776 Lbs.	Gypsum shear at 1st bay of 2nd panel

Average Ultimate Load (lbs) = 6334.7 Lbs.

Allowable design Load (PLF) = (Ave. Ult. load)/[(wall length)(safety factor)]

(6334.7 Lbs.)/[(8 ft.)(2.5)] = 316.7 PLF

## 5.0 CONCLUSION

Based on the results of the tests conducted the maximum allowable design shear wall load built with 2 X 3 STUD grade S.P.F. studs spaced 16" o.c. and 1 X 3 utility grade S.P.F. bottom plate and 1 X 3 utility grade S.P.F. top plate with Georgia Pacific raw gypsum attached to one side built as described in this report is:

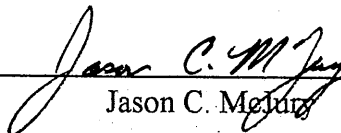
### **GEORGIA PACIFIC GYPSUM ATTACHED ONE SIDE WITH PEMCO 5100 = 316.7 PLF**

This design value is only applicable for Manufactured Housing built under the Manufactured Home Construction and Safety Standards and is not intended for use with other model building codes.

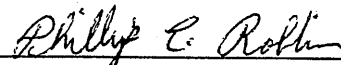
## 5.1 FOLLOW-UP TESTING

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

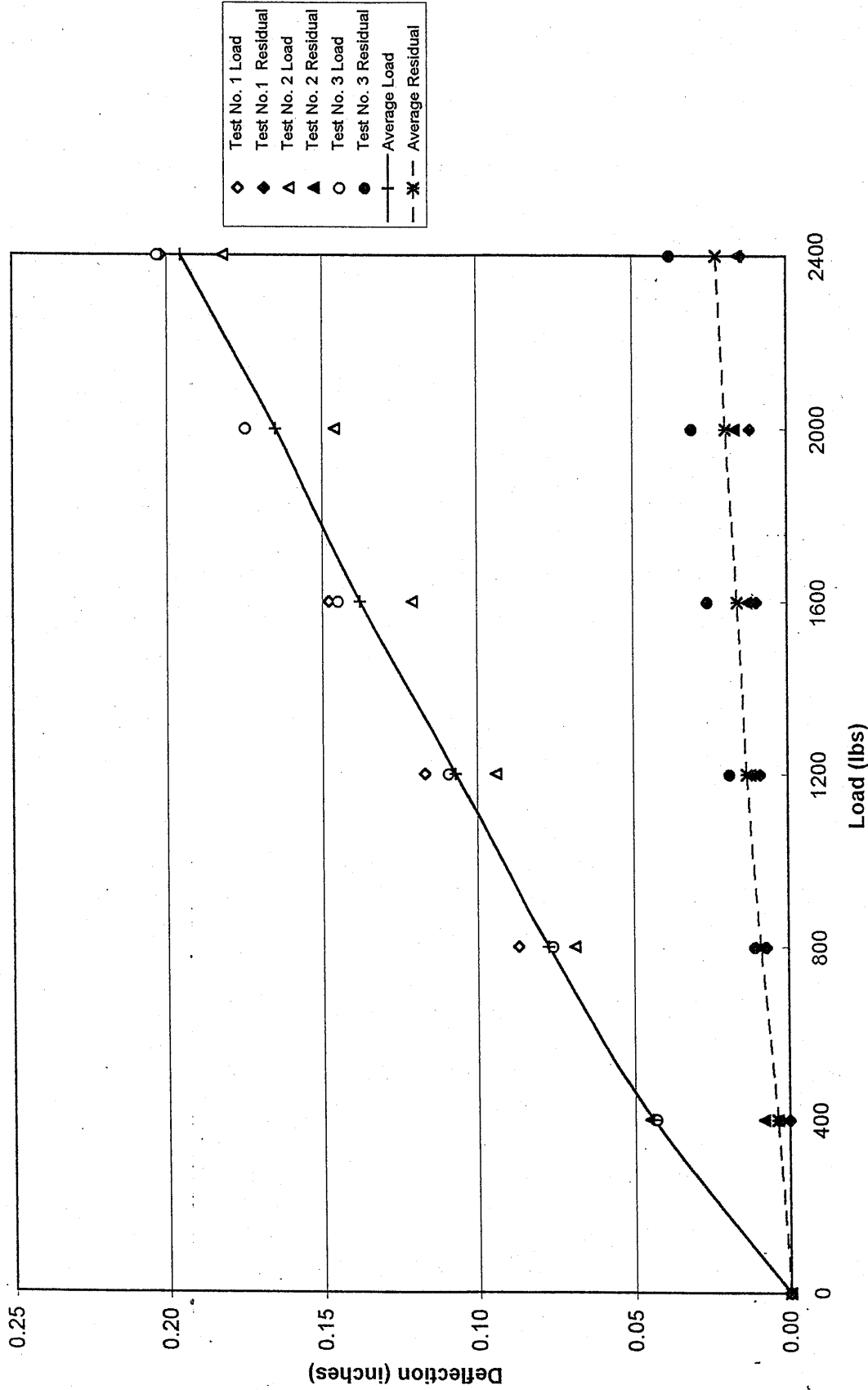
TEST WITNESSED BY:

  
Jason C. Melius

TEST REPORT REVIEWED BY:

  
Phillip Edward Robbins, P.E.

# Load Deflection Curves



PEMCO ADHESIVES  
 PEMCO 5100  
 GEORGIA PACIFIC SINGLE SIDED

# NTA Inc. Single Sided Wall Racking Test

Date: 02/21/96

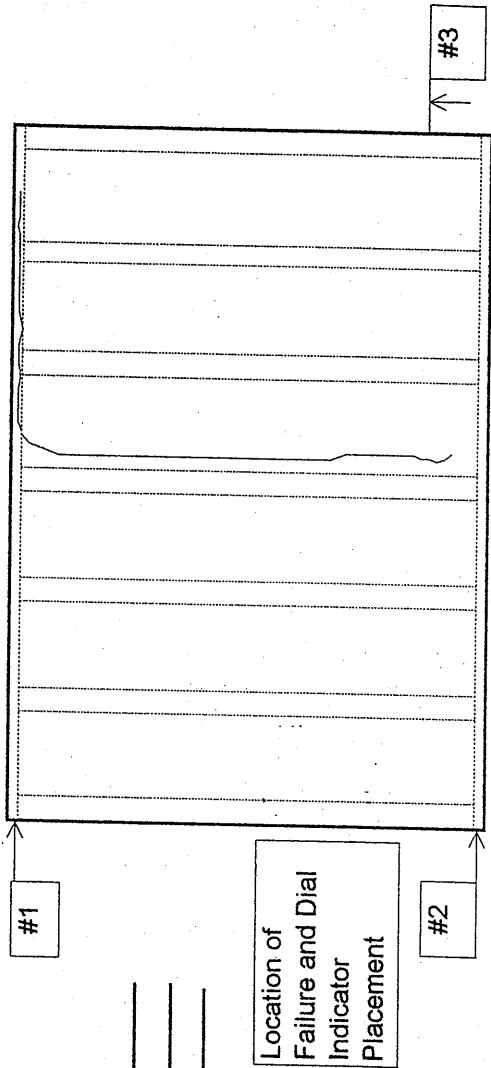
Test No.: 96-0212-1 Sample #1  
 Temperature: 69°F  
 Humidity: 36%  
 Average M C @ Construction:  
 Plates: 9%  
 Studs: 9%

Gypsum Type: 5/16" Georgia Pacific Gypsum  
 Adhesive: Pemco 5100  
 Fastener Spec: 3/16"x3/4"x19Ga. Face Staples  
 Top Plate: 1x3 SPF utility  
 Bottom Plate: 1x3 SPF utility  
 Fabric. Date: 2/14/96

TIME (sec)	LOAD (lbs)	INDICATOR #1 (in)		INDICATOR #2 (in)		INDICATOR #3 (in)		RESULTANT DEFLECTION (in)
		READING	DEFLECTION	READING	DEFLECTION	READING	DEFLECTION	
10:30 AM	0	0.100		0.064		0.166		ALL INDICATORS
10:31 AM	400	0.152	0.052	0.063	0.001	0.159	0.007	0.044
10:32 AM	0	0.102	0.002	0.064	0.000	0.164	0.002	0.000
10:34 AM	800	0.204	0.104	0.062	0.002	0.151	0.015	0.087
10:36 AM	0	0.110	0.010	0.065	0.001	0.164	0.002	0.007
10:39 AM	1200	0.245	0.145	0.059	0.005	0.143	0.023	0.117
10:42 AM	0	0.113	0.013	0.065	0.001	0.163	0.003	0.009
10:46 AM	1600	0.283	0.183	0.059	0.005	0.136	0.030	0.148
10:50 AM	0	0.116	0.016	0.066	0.002	0.162	0.004	0.010
10:55 AM	2000	0.319	0.219	0.059	0.005	0.127	0.039	0.175
11:00 AM	0	0.120	0.020	0.067	0.003	0.161	0.005	0.012
11:06 AM	2400	0.355	0.255	0.059	0.005	0.118	0.048	0.202
11:12 AM	0	0.124	0.024	0.067	0.003	0.160	0.006	0.015

LOAD AT FAILURE: **6170 LBS**

MODE OF FAILURE: Gypsum Shear at 3rd bay of 1st panel near center stud.



# NOA Inc. Single Sided Wall Racking Test

Date: 02/21/96

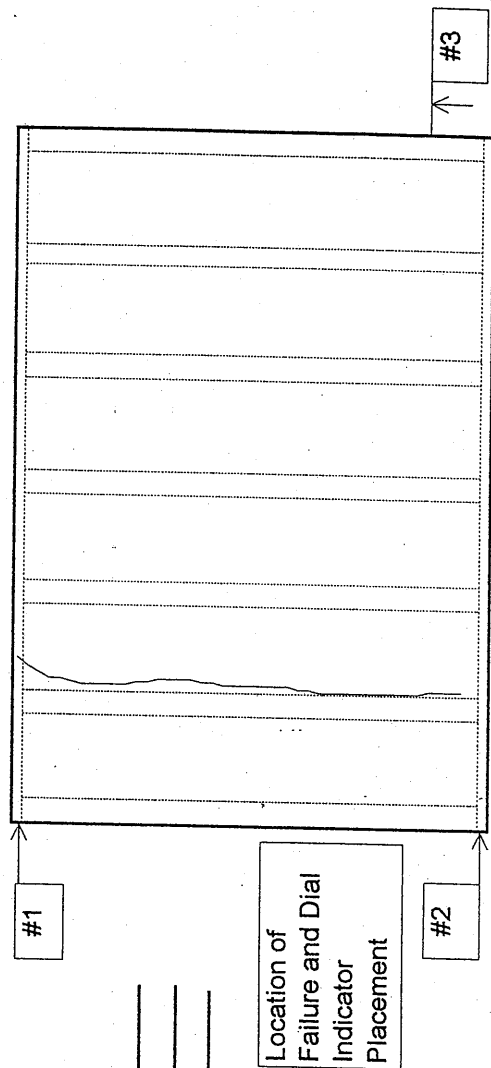
Test No.: 96-0212-1 Sample #2  
 Temperature: 69°F  
 Humidity: 36%  
 Average M C @ Construction:  
 Plates: 9%  
 Studs: 9%

Gypsum Type: 5/16" Georgia Pacific Gypsum  
 Adhesive: Pemco 5100  
 Fastener Spec: 3/16"x3/4"x19Ga. Face Staples  
 Top Plate: 1x3 SPF utility  
 Bottom Plate: 1x3 SPF utility  
 Fabric. Date: 2/14/96

TIME (sec)	LOAD (lbs)	INDICATOR #1 (in)		INDICATOR #2 (in)		INDICATOR #3 (in)		RESULTANT DEFLECTION (in)
		READING	DEFLECTION	READING	DEFLECTION	READING	DEFLECTION	
12:48 PM	0	0.112		0.483		0.269		0.045
12:49 PM	400	0.168	0.056	0.482	0.001	0.259	0.010	0.008
12:50 PM	0	0.121	0.009	0.483	0.000	0.268	0.001	0.069
12:52 PM	800	0.197	0.085	0.481	0.002	0.255	0.014	0.009
12:54 PM	0	0.125	0.013	0.481	0.002	0.267	0.002	0.094
12:57 PM	1200	0.230	0.118	0.479	0.004	0.249	0.020	0.012
1:00 PM	0	0.131	0.019	0.480	0.003	0.265	0.004	0.121
1:04 PM	1600	0.264	0.152	0.478	0.005	0.243	0.026	0.013
1:08 PM	0	0.135	0.023	0.477	0.006	0.265	0.004	0.146
1:13 PM	2000	0.302	0.190	0.476	0.007	0.232	0.037	0.017
1:18 PM	0	0.143	0.031	0.476	0.007	0.262	0.007	0.182
1:24 PM	2400	0.350	0.238	0.476	0.007	0.220	0.049	0.016
1:30 PM	0	0.149	0.037	0.472	0.011	0.259	0.010	

LOAD AT FAILURE: **6058 LBS**

MODE OF FAILURE: Gypsum Shear at 2nd bay of 2nd panel along stud.



Location of Failure and Dial Indicator Placement



# NTC Inc. Single Sided Wall Racking Test

Date: 02/21/96

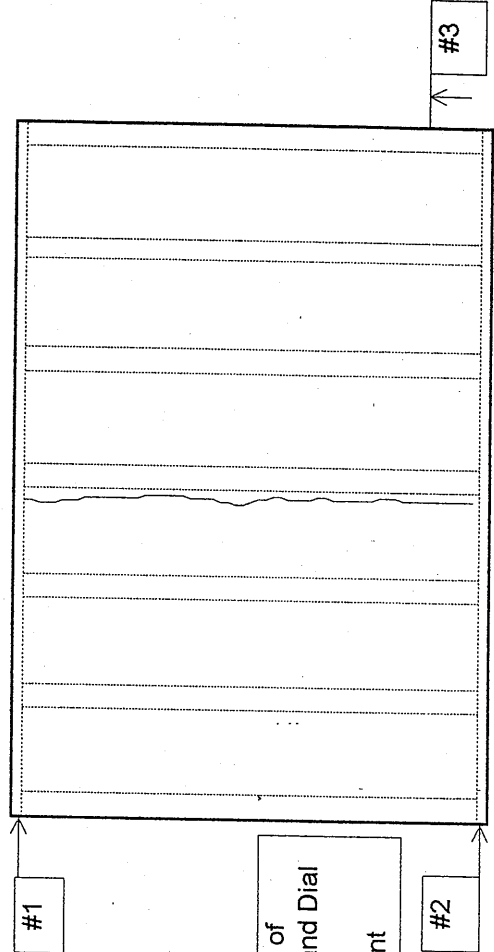
Test No.: 96-0212-1 Sample #3  
 Temperature: 69°F  
 Humidity: 36%  
 Average M C @ Construction:  
 Plates: 9%  
 Studs: 9%

Gypsum Type: 5/16" Georgia Pacific Gypsum  
 Adhesive: Pemco 5100  
 Fastener Spec: 3/16"x3/4"x19Ga. Face Staples  
 Top Plate: 1x3 SPF utility  
 Bottom Plate: 1x3 SPF utility  
 Fabric. Date: 2/14/96

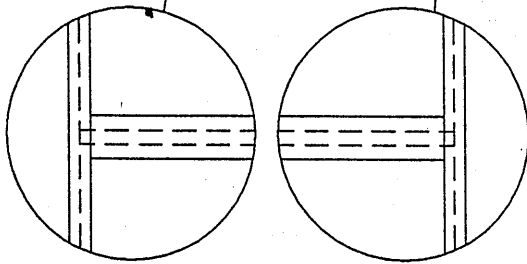
TIME (sec)	LOAD (lbs)	INDICATOR #1 (in)		INDICATOR #2 (in)		INDICATOR #3 (in)		RESULTANT DEFLECTION (in)
		READING	DEFLECTION	READING	DEFLECTION	READING	DEFLECTION	
2:50 PM	0	0.092		0.142		0.334		ALL INDICATORS
2:51 PM	400	0.139	0.047	0.142	0.000	0.330	0.004	0.043
2:52 PM	0	0.100	0.008	0.146	0.004	0.333	0.001	0.003
2:54 PM	800	0.181	0.089	0.146	0.004	0.325	0.009	0.076
2:56 PM	0	0.111	0.019	0.148	0.006	0.332	0.002	0.011
2:59 PM	1200	0.222	0.130	0.148	0.006	0.319	0.015	0.109
3:02 PM	0	0.121	0.029	0.149	0.007	0.331	0.003	0.019
3:06 PM	1600	0.265	0.173	0.149	0.007	0.313	0.021	0.145
3:10 PM	0	0.129	0.037	0.150	0.008	0.331	0.003	0.026
3:15 PM	2000	0.306	0.214	0.152	0.010	0.305	0.029	0.175
3:20 PM	0	0.136	0.044	0.150	0.008	0.329	0.005	0.031
3:26 PM	2400	0.345	0.253	0.152	0.010	0.294	0.040	0.203
3:32 PM	0	0.142	0.050	0.149	0.007	0.329	0.005	0.038

LOAD AT FAILURE: **6776 LBS**

MODE OF FAILURE: Gypsum Shear at 1st bay of 2nd panel along center stud.



TOP PLATE FASTENED WITH  
(2) 7/16" x 2" x 16ga  
STAPLES AT EACH STUD END.

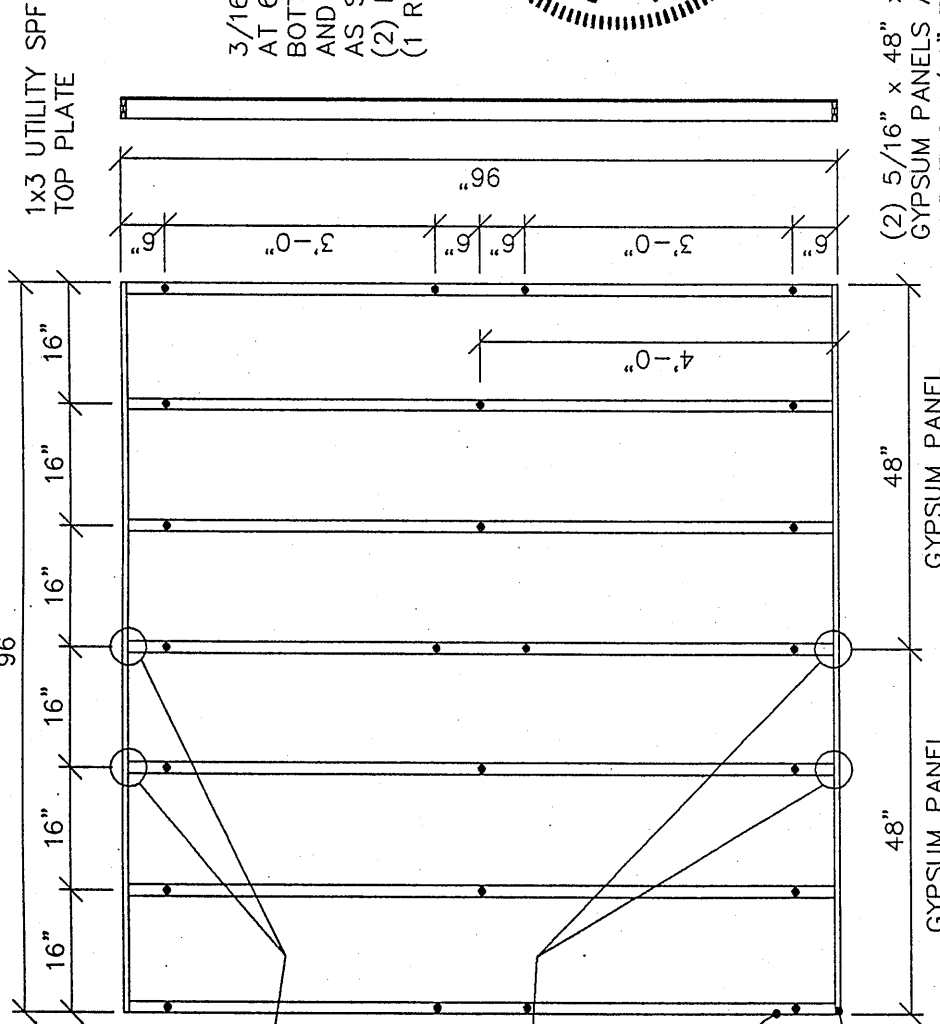


TYPICAL ADHESIVE PATTERN

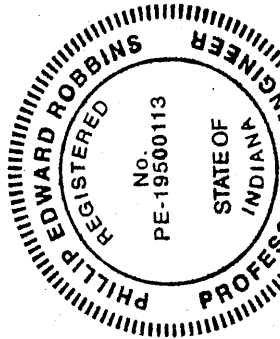
2x3 STUD GRADE  
SPF STUDS 16" O.C.

1x3 UTILITY SPF  
BOTTOM PLATE

BOTTOM PLATE FASTENED WITH  
(2) 7/16" x 2" x 16ga  
STAPLES AT EACH STUD END.



3/16" x 3/4" x 19ga STAPLES  
AT 6" O.C. ALONG TOP AND  
BOTTOM PLATES. PERIMETER  
AND FIELD FASTENING FOR STUDS  
AS SHOWN. CENTER STUD HAS  
(2) ROWS OF FASTENERS  
(1 ROW PER PANEL).



*Phillip E. Robbins*  
MAR 1 1996

(2) 5/16" x 48" x 96" GEORGIA-PACIFIC  
GYPSUM PANELS ATTACHED WITH STAPLES  
AND TWO 1/16" TO 1/8" BEADS OF ADHESIVE  
ALL STUDS AND ONE BEAD OF ADHESIVE  
ON TOP AND BOTTOM PLATES.

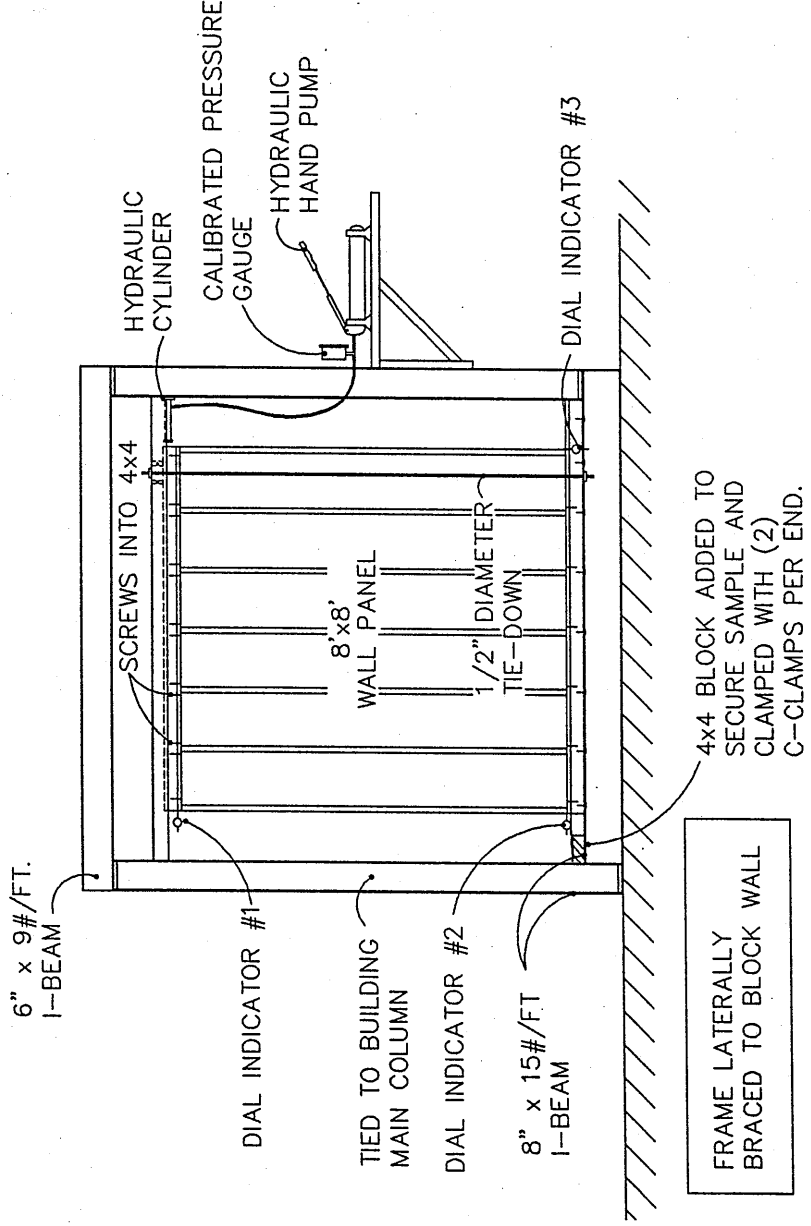
ADHESIVE = PEMCO 5100

DESIGN SHEAR = 316.7 PLF

6.2 PAGE 10 of 11

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

REVISIONS:	SCALE: N.T.S.	APPROVED BY:
	DATE: 02/26/96	PROJECT NO: NTA96-0212-1
	DRAWN BY: P.N.	DRAWING NO: FIGURE #1
<b>NTA, INC.</b>		
<b>305 NORTH OAKLAND AVENUE, NAPPANEE, IN. 46550</b>		
MODEL: W212-1GP	TITLE: WALL PANEL	



REVISIONS:	SCALE: N.T.S.	APPROVED BY:
	DATE: 02/27/96	PROJECT NO: NTA96-0212-1
	DRAWN BY: P.N.	DRAWING NO: FIGURE #2
<b>NTA, INC.</b>		
<b>305 NORTH OAKLAND AVE., NAPPANEE, IN. 46550</b>		
MODEL:	TITLE: RACKING TEST FIXTURE	
R212_1-6		