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**Evaluation of Wall Assemblies Under Racking Load Sheathed  
with Raw Gypsum Attached by PEMCO 5100 & PEMCO 3100**

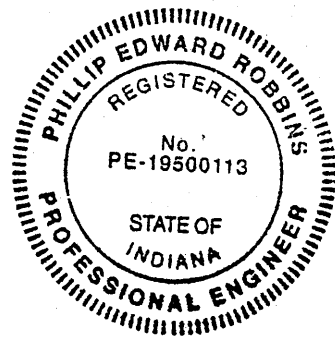
Prepared for

**Pemco Adhesives  
5210 Beck Drive  
Elkhart, IN 46516**

Test Report: NTA96-0212-4

Issued: February 27, 1996

Prepared By:



*Phillip E. Robbins*  
FEB 28 1996

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

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## 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 & 3100 adhesives 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 2 X 3 stud grade S.P.F.
4. Sheathing: 4' X 8' X 5/16" thick Gold Bond Raw Gypsum panels
5. Adhesive: PEMCO 5100 & PEMCO 3100

*should read 1"x3"  
Bottom Plate*

### 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 2-1/2" X 16 ga. staples per stud end.
3. One gypsum side attached to 2 X 3 studs with (2) 1/16" to 1/8" (average) beads of PEMCO 5100 adhesive. The other gypsum side attached with (1) 1/4" (average) bead of PEMCO 3100 adhesive.
4. Gypsum attached to 1 X 3 top plate with (1) 1/16" to 1/8" (average) bead of PEMCO 5100 adhesive on one side and the second side attached with (1) 1/4" average bead of PEMCO 3100 adhesive.
5. Gypsum attached to 2 X 3 bottom plate with (2) 1/16" (average) beads of PEMCO 5100 adhesive on one side and the second gypsum side attached with (1) 1/4" (average) bead of PEMCO 3100.
6. Gypsum attached to framing with 3/16" X 3/4" X 19 ga. staples at 6" o.c. edge fastening around entire perimeter of gypsum panels. Field fasteners were at 6" from top and bottom plates and 21" o.c. thereafter on field studs.

### 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.
3. The PEMCO 3100 adhesive was applied to the second side of the previously assembled frame from a tube.
4. The raw gypsum was placed on this side of the wall framing immediately after the PEMCO 3100 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 3" 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 and a second side with PEMCO 3100 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	9258 Lbs.	Gypsum shear at 1st bay of 2nd panel
#2	7937 Lbs.	Paper failure at last stud of 2nd panel
#3	9054 Lbs.	Paper failure at last stud of 2nd panel

Average Ultimate Load (lbs) = 8749.7 Lbs.

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

$$(8749.7 \text{ Lbs.})/[(8 \text{ ft.})(2.5)] = 437.5 \text{ PLF}$$

#### 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. top plate and 2 X 3 stud grade S.P.F. bottom plate with Gold Bond raw gypsum attached to both sides built as described in this report is:

**GOLD BOND GYPSUM ATTACHED TO BOTH SIDES WITH  
PEMCO 5100 & PEMCO 3100 = 437.5 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.

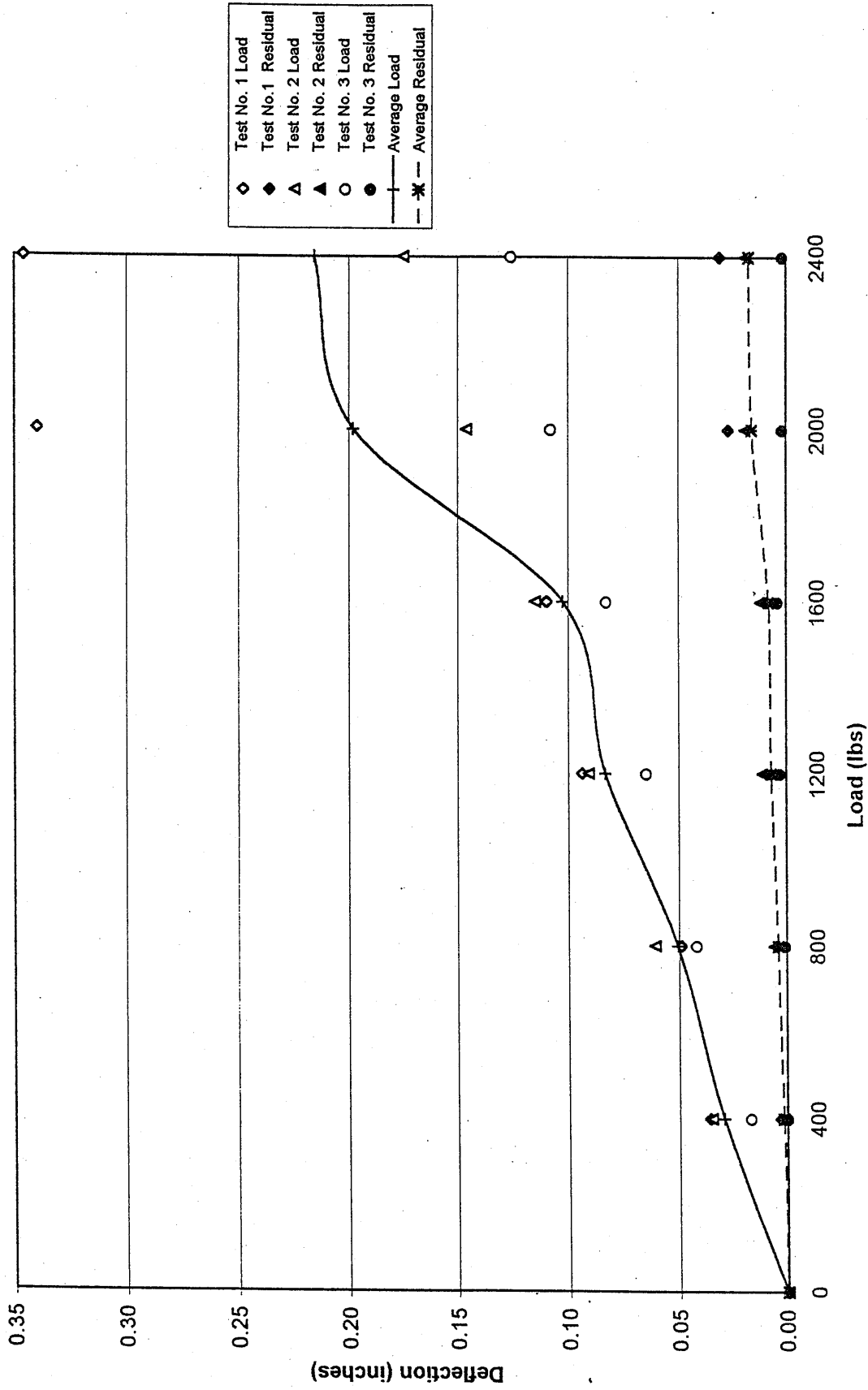
TEST WITNESSED BY: \_\_\_\_\_

*Jason C. McJury*  
Jason C. McJury

TEST REPORT REVIEWED BY: \_\_\_\_\_

*Phillip E. Robbins*  
Phillip Edward Robbins, P.E.

# Load Deflection Curves



PEMCO ADHESIVES  
 PEMCO 5100  
 GOLD BOND DOUBLE SIDED

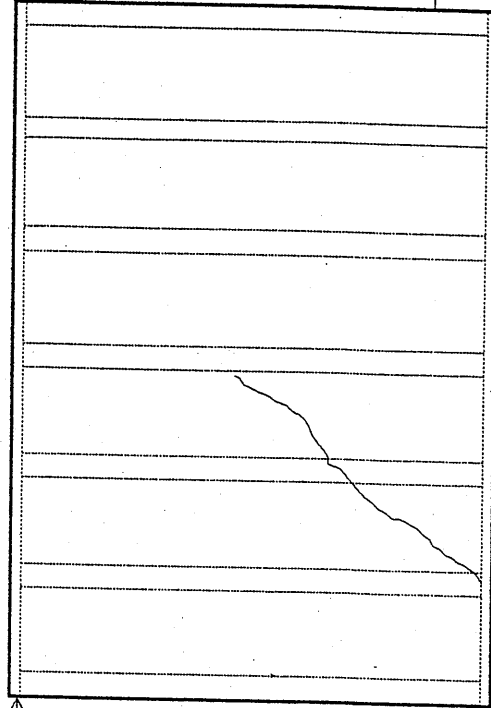
# NTC Inc. Double Sided Wall Rackin Test

Date: 02/19/96

Test No.: 96-0212-4 Sample #1  
 Temperature: 72°F  
 Humidity: 30%  
 Average M C @ Construction:  
 Plates: 9%  
 Studs: 9%

Gypsum Type: 5/16" Gold Bond Gypsum  
 Adhesive: Pemco 5100 & Pemco 3100  
 Fastener Spec: 3/16"x3/4"x19Ga. Face Staples  
 Top Plate: 1x3 SPF utility  
 Bottom Plate: 2x3 SPF Stud grade  
 Fabric. Date: 2/12/96

TIME (sec)	LOAD (lbs)	INDICATOR #1 (in)		INDICATOR #2 (in)		INDICATOR #3 (in)		RESULTANT DEFLECTION (in)
		READING	DEFLECTION	READING	DEFLECTION	READING	DEFLECTION	
8:10 AM	0	0.144		0.100		0.360		0.036
8:11 AM	400	0.199	0.055	0.103	0.003	0.344	0.016	0.003
8:12 AM	0	0.149	0.005	0.101	0.001	0.359	0.001	0.049
8:14 AM	800	0.236	0.092	0.105	0.005	0.322	0.038	0.005
8:16 AM	0	0.153	0.009	0.102	0.002	0.358	0.002	0.094
8:19 AM	1200	0.305	0.161	0.106	0.006	0.299	0.061	0.007
8:22 AM	0	0.160	0.016	0.105	0.005	0.356	0.004	0.110
8:26 AM	1600	0.365	0.221	0.110	0.010	0.259	0.101	0.009
8:30 AM	0	0.165	0.021	0.105	0.005	0.353	0.007	0.340
8:35 AM	2000	0.590	0.446	0.112	0.012	0.266	0.094	0.027
8:40 AM	0	0.186	0.042	0.106	0.006	0.351	0.009	0.346
8:46 AM	2400	0.634	0.490	0.112	0.012	0.228	0.132	0.031
8:52 AM	0	0.193	0.049	0.108	0.008	0.350	0.010	



LOAD AT FAILURE: **9258 LBS**

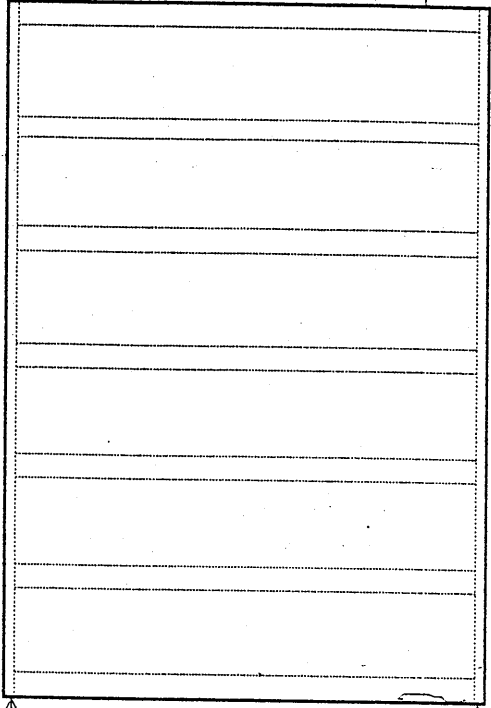
MODE OF FAILURE: Gypsum shear at 1st bay of 2nd panel diagonally from middle of center stud to 2nd stud in panel.

# NTC Inc. Double Sided Wall Racking Test

Date: 02/22/96

Test No.: 96-0212-4 Sample #2  
 Temperature: 69°F  
 Humidity: 35%  
 Average M C @ Construction:  
 Plates: 9%  
 Studs: 9%  
 Gypsum Type: 5/16" Gold Bond Gypsum  
 Adhesive: Pemco 5100 & Pemco 3100  
 Fastener Spec: 3/16"x3/4"x19Ga. Face Staples  
 Top Plate: 1x3 SPF utility  
 Bottom Plate: 2x3 SPF Stud grade  
 Fabric, Date: 2/15/96

TIME (sec)	LOAD (lbs)	INDICATOR #1 (in)		INDICATOR #2 (in)		INDICATOR #3 (in)		RESULTANT DEFLECTION (in)
		READING	DEFLECTION	READING	DEFLECTION	READING	DEFLECTION	
10:15 AM	0	0.255		0.173		0.524		ALL INDICATORS
10:16 AM	400	0.305	0.050	0.175	0.002	0.511	0.013	0.035
10:17 AM	0	0.260	0.005	0.173	0.000	0.521	0.003	0.002
10:19 AM	800	0.348	0.093	0.178	0.005	0.497	0.027	0.061
10:21 AM	0	0.268	0.013	0.174	0.001	0.518	0.006	0.006
10:24 AM	1200	0.396	0.141	0.181	0.008	0.482	0.042	0.091
10:27 AM	0	0.275	0.020	0.174	0.001	0.516	0.008	0.011
10:31 AM	1600	0.437	0.182	0.182	0.009	0.466	0.058	0.115
10:35 AM	0	0.280	0.025	0.174	0.001	0.512	0.012	0.012
10:40 AM	2000	0.486	0.231	0.183	0.010	0.449	0.075	0.146
10:45 AM	0	0.292	0.037	0.175	0.002	0.508	0.016	0.019
10:51 AM	2400	0.537	0.282	0.186	0.013	0.430	0.094	0.175
10:57 AM	0	0.296	0.041	0.176	0.003	0.505	0.019	0.019



#1

#2

#3

LOAD AT FAILURE: 7937 LBS

MODE OF FAILURE: Paper failure at last stud in 2nd panel at bottom left corner of sample.

Location of Failure and Dial Indicator Placement



# NTC Inc. Double Sided Wall Racking Test

Date: 02/22/96

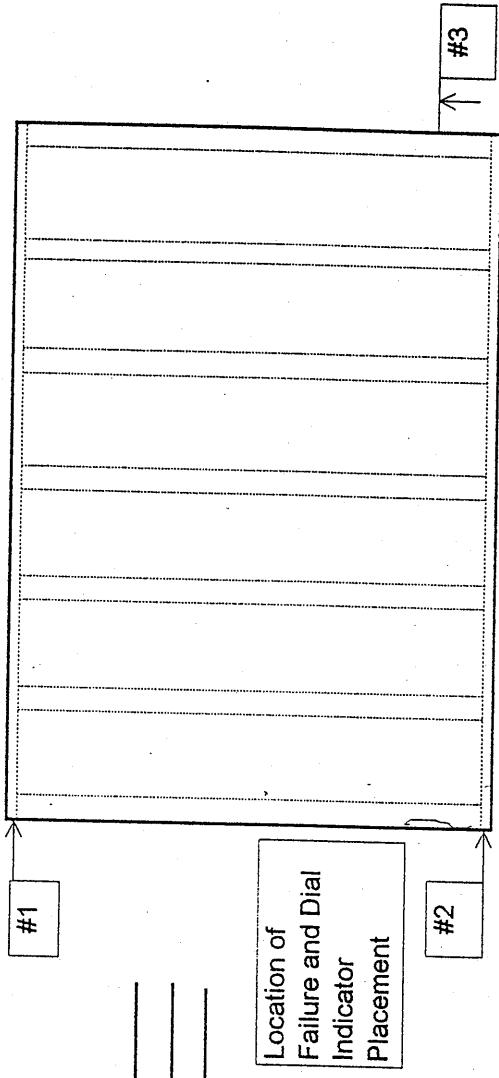
Test No.: 96-0212-4 Sample #3  
 Temperature: 69°F  
 Humidity: 35%  
 Average M C @ Construction:  
 Plates: 9%  
 Studs: 9%

Gypsum Type: 5/16" Gold Bond Gypsum  
 Adhesive: Pemco 5100 & Pemco 3100  
 Fastener Spec: 3/16"x3/4"x19Ga. Face Staples  
 Top Plate: 1x3 SPF utility  
 Bottom Plate: 2x3 SPF Stud grade  
 Fabric. Date: 2/15/96

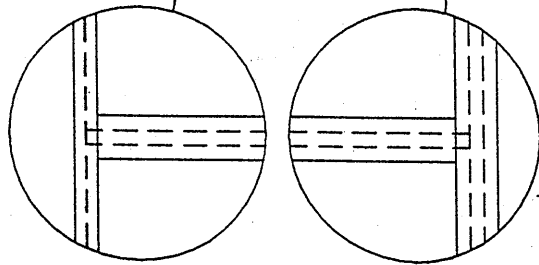
TIME (sec)	LOAD (lbs)	INDICATOR #1 (in)		INDICATOR #2 (in)		INDICATOR #3 (in)		RESULTANT DEFLECTION (in)
		READING	DEFLECTION	READING	DEFLECTION	READING	DEFLECTION	
11:20 AM	0	0.272		0.370		0.108		ALL INDICATORS
11:21 AM	400	0.295	0.023	0.369	0.001	0.103	0.005	0.017
11:22 AM	0	0.273	0.001	0.370	0.000	0.107	0.001	0.000
11:24 AM	800	0.326	0.054	0.369	0.001	0.097	0.011	0.042
11:26 AM	0	0.275	0.003	0.370	0.000	0.106	0.002	0.001
11:29 AM	1200	0.359	0.087	0.374	0.004	0.090	0.018	0.065
11:32 AM	0	0.278	0.006	0.370	0.000	0.105	0.003	0.003
11:36 AM	1600	0.383	0.111	0.374	0.004	0.084	0.024	0.083
11:40 AM	0	0.280	0.008	0.371	0.001	0.105	0.003	0.004
11:45 AM	2000	0.413	0.141	0.372	0.002	0.077	0.031	0.108
11:50 AM	0	0.281	0.009	0.373	0.003	0.104	0.004	0.002
11:56 AM	2400	0.440	0.168	0.374	0.004	0.070	0.038	0.126
12:02 PM	0	0.283	0.011	0.373	0.003	0.102	0.006	0.002

LOAD AT FAILURE: 9054 LBS

MODE OF FAILURE: Paper failure at last stud in 2nd panel at bottom left corner of sample.



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



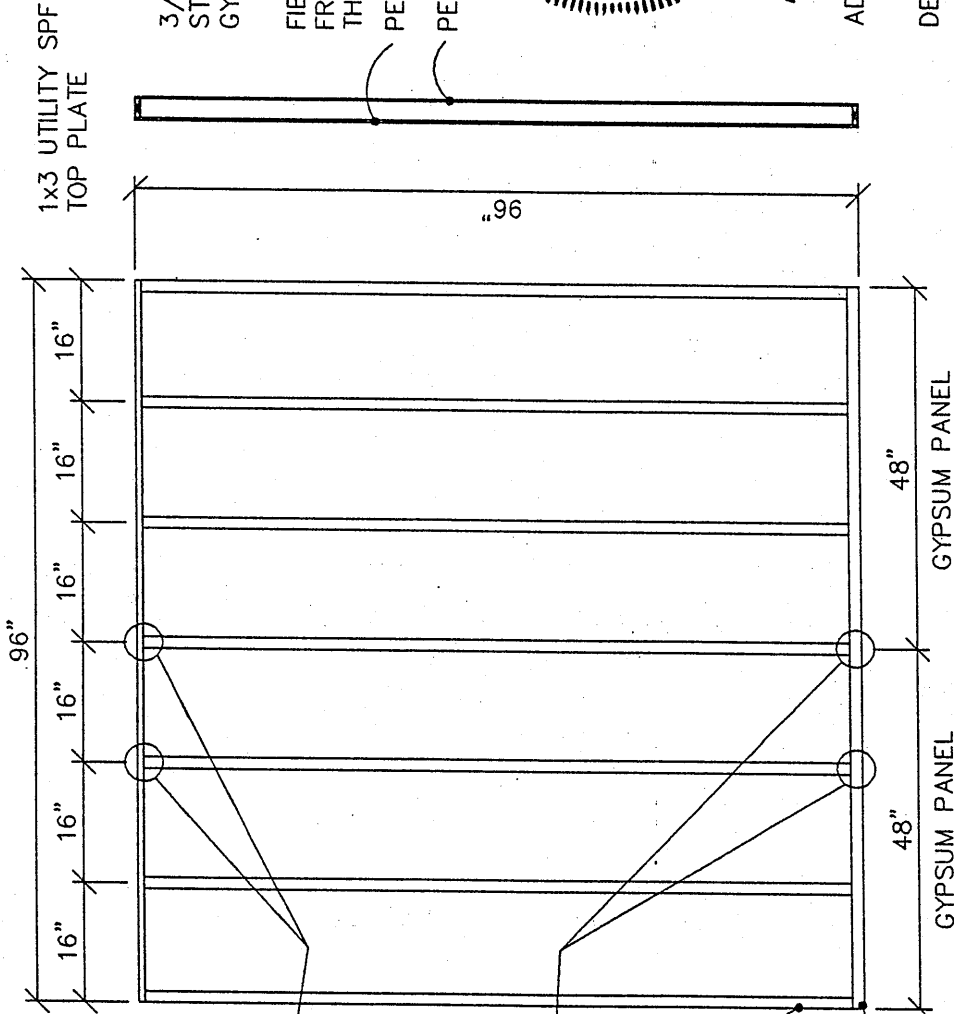
TYPICAL ADHESIVE PATTERN

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

2x3 STUD GRADE SPF  
BOTTOM PLATE

BOTTOM PLATE FASTENED WITH  
(2) 7/16" x 2 1/2" x 16ga  
STAPLES AT EACH STUD END.

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

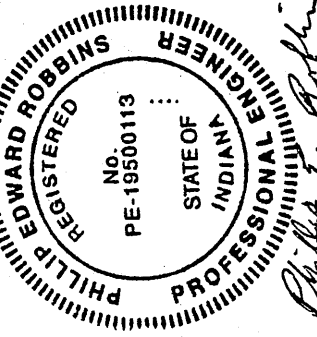


3/16" x 3/4" x 19ga  
STAPLES - 6" O.C. AROUND  
GYPSUM PERIMETER.

FIELD FASTENING AT 6" O.C.  
FROM PLATES AND 21" O.C.  
THEREAFTER.

PEMCO 5100 (SIDE "A")

PEMCO 3100 (SIDE "B")



ADHESIVE = PEMCO 5100 &  
PEMCO 3100

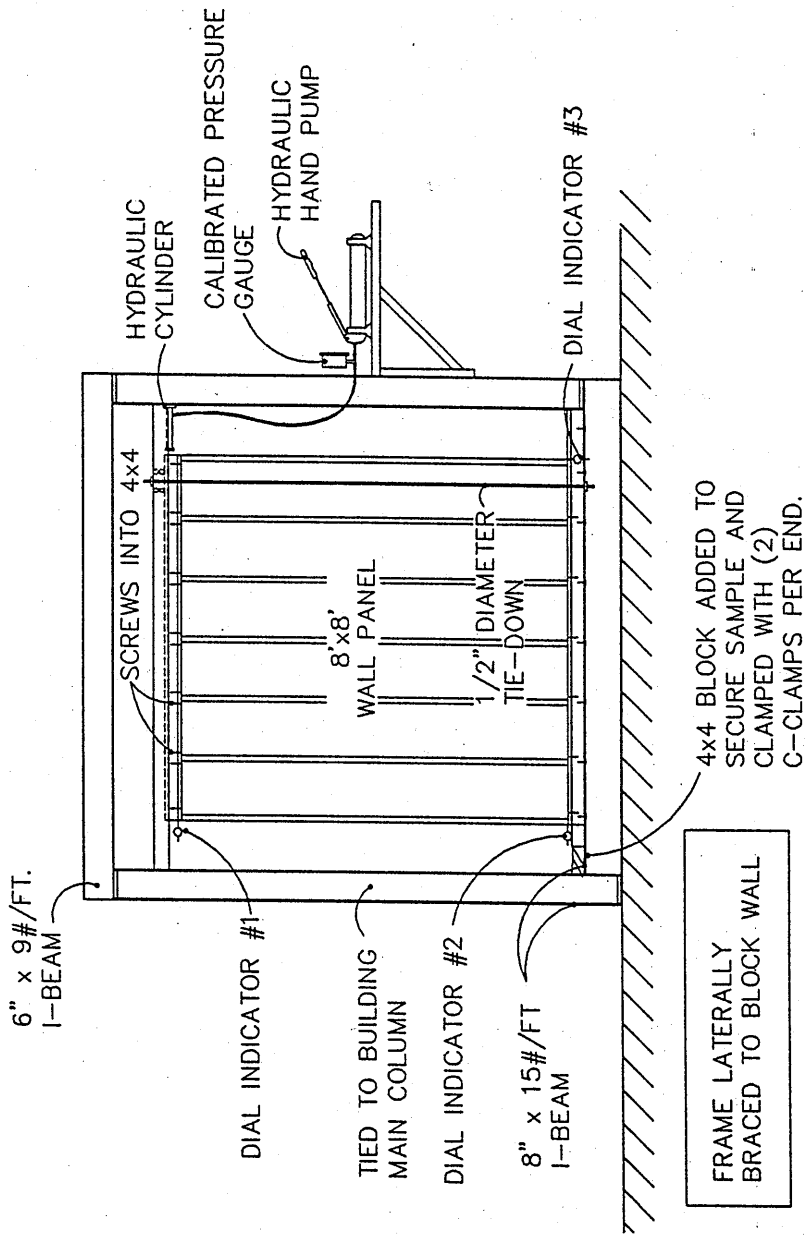
DESIGN SHEAR = 437.5 PLF

SIDE "A" - (2) 5/16"x48"x96" GOLD BOND GYPSUM PANELS ATTACHED WITH  
STAPLES AND (2) 1/16" TO 1/8" BEADS OF PEMCO 5100 ON ALL STUDS AND  
BOTTOM PLATE AND ONE BEAD ON THE TOP PLATE.

SIDE "B" - (2) 5/16"x48"x96" GOLD BOND GYPSUM PANELS ATTACHED WITH  
STAPLES AND (1) 1/4" BEAD OF PEMCO 3100 ON ALL STUDS AND TOP AND  
BOTTOM PLATES. TWO (2) 1/4" BEADS APPLIED TO CENTER STUD AT PANEL JOINT.

6.2 PAGE 10 of 11

REVISIONS:	NTA, INC.		
	SCALE:	N.T.S.	APPROVED BY:
	DATE:	02/26/96	PROJECT NO: NTA96-0212-4
	DRAWN BY:	P.N.	DRAWING NO:
W212-4GB	TITLE:	WALL PANEL	FIGURE #1
	305 NORTH OAKLAND AVENUE, NAPPANEE, IN. 46550		



6.3 PAGE 11 OF 11

REVISIONS:	SCALE:	N.T.S.	APPROVED BY:
	DATE:	02/27/96	PROJECT NO: NTA96-0212-4
R212_1-6	MODEL:	P.N.	DRAWING NO: FIGURE #2
TITLE: RACKING TEST FIXTURE		NTA, INC. 305 NORTH OAKLAND AVE., NAPPANEE, IN. 46550	