

TEST REPORT ON
26 GA. PBR PANELS
AT 5' 0" PANEL SPANS
WITH SEALED 'N' SAFE™ THERMAL BLOCKS
IN ACCORDANCE WITH ASTM E455-04
AND AISI TS-7-02

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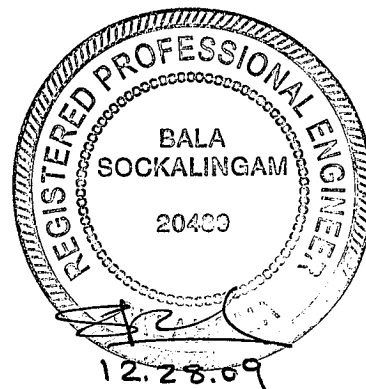
TEST WITNESSED BY:
Bala Sockalingam, Ph.D., P.E.

TESTING DATE: September 23 & 24, 2009
REPORTING DATE: October 7, 2009
REVISED DATE: December 23, 2009
ENCON® Project C1663-3



TABLE OF CONTENTS

SECTION I	TEST SUMMARY	Page Number
	1.1 Summary	1
	1.2 Panel System Description	1
	1.3 Test Results	1-2
	1.4 Panel System Details	3
SECTION II	DESCRIPTION OF TEST	
	2.1 Description of Test	4-5
	2.2 Calculations	5-6
SECTION III	TEST RESULTS	
	3.1 Specimen Identification	7
	3.2 Test #1: 26 ga., 80 ksi PBR Panels at three equal span of 5' 0"	8-9
	3.3 Test #2: 26 ga., 80 ksi PBR Panels at three equal span of 5' 0"	10-11
SECTION IV	TEST PHOTOGRAPHS	
	4.1 Test Photographs	12-14
SECTION V	APPENDIX	
	5.1 Test Drawings	15-18
	5.2 Yield Stress	19
	5.3 Test Conditions	20-21



**SECTION I
TEST SUMMARY**

TEST SUMMARY

1.1 SUMMARY

Tests were conducted on PBR Panels at ENCON[®] Technology, Inc. Test Facility, Tulsa, Oklahoma. The purpose of the tests was to determine the diaphragm shear strength and shear stiffness of PBR panel construction with Sealed 'N' Safe[™] thermal blocks under simulated loading conditions. These tests meet the provisions of ASTM E 455-04 and AISI TS-7-02. The tests are listed below according to date tested.

Test #1 & 2: PBR panels at three equal span of 5' 0". The panel fastener spacing was 12" o.c. at the end and intermediate supports. Tested on September 23 & 24, 2009.

The sidelap fasteners spacing for both tests was 30" o.c. The panels were fastened to the supports through 4" thick blanket insulation, thermal block and 3" thick blanket insulation. The above-defined tests were witnessed by Bala Sockalingam, Ph.D., P.E. of ENCON Technology, Inc.

1.2 PANEL SYSTEM DESCRIPTION

PBR panels are 26 ga., 1-1/4" high and 36" wide through fastened panels. Each panel consists of four major ribs spaced at 12" o.c. as shown on Page 3.

The panels were attached to nominal 16 ga. (0.060") Cee supports through the 4" thick blanket insulation, thermal block and 3" thick blanket insulation with #12 x 2" long hex head self-drilling screws with washers. Each panel spanned over three continuous spans of 5' 0" with 3" overhang. The sidelap fasteners were 1/4"-14 x 7/8" long hex head self-drilling screws with washers and were spaced at 30" o.c. The two sides of the panel assembly were attached to 14 ga. rake sections with #12 x 2" long hex head self-drilling screws with washers spaced at 30" o.c.

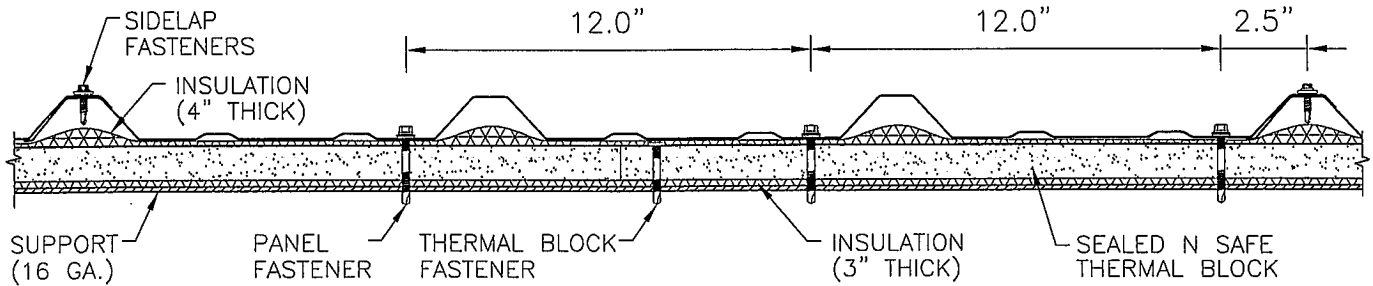
Sealed 'N' Safe[™] thermal blocks consisted of two 24 ga. steel plates with polyurethane foam injected between the plates to form a 1" thick block. The length and width of these thermal blocks were 72" and 5", respectively. The blocks were fastened to the supports through 3" thick blanket insulation with #12 x 1-5/8" long pancake head self-drilling screws located at each end of the blocks.

The panels, thermal blocks and fasteners for this testing were sampled at CO Building Systems' Ephraim facility on September 11, 2009, by Bala Sockalingam of ENCON. Each panel, each bundle of 12 thermal blocks and each bag of fasteners were permanently marked with an alphabet character and followed by rotation number.

1.3 TEST RESULTS

Load was applied incrementally and deflections of the test construction were recorded for 'no load' condition and at each load increment. The failure mode was the panel buckling at the fastener near the roller corner in Test #1 and the panel buckling at the fastener near the load corner in Test #2. The average ultimate shear strength from the two tests is 243.1 lb/ft and average shear stiffness is 9218.0 lb/in.

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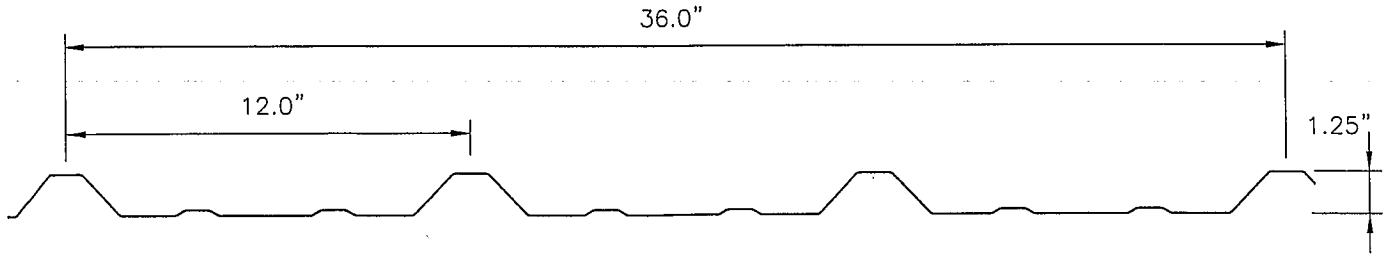
a. AT END & INTERMEDIATE SUPPORTS

TEST SERIES	PANEL SPANS (ft)	FASTENER PATTERN	SPAN a (ft)	DEPTH b (ft)	MAX. LOAD P_u (lb)	SHEAR STRENGTH S_u (lb/ft)	0.4 P_u (lb)	DEFL. AT 0.4 P_u (in)	SHEAR STIFFNESS G' (lb/in)
1	5.0-5.0-5.0	1	15.5	16.25	4000	246.2	1600	0.163	9362.9
2	5.0-5.0-5.0	1	15.5	16.25	3900	240.0	1560	0.164	9073.2
AVERAGE						243.1	AVERAGE		9218.0

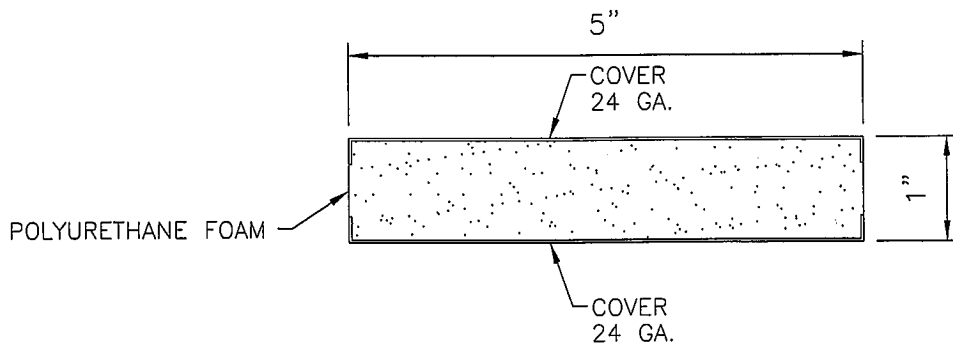
NOTES:

- PANEL THICKNESS IS 26 GA. AND YIELD STRESS IS 80 KSI.
- PANEL TO SUPPORT FASTENER IS #12 X 2" LONG SDS.
- PANEL TO PANEL FASTENER IS 1/4"-14 X 7/8" LONG SDS.
- PANEL TO PANEL FASTENER SPACING 30" OC.
- PANEL FASTENED TO SUPPORTS THROUGH 4" THICK INSULATION, THERMAL BLOCKS AND 3" THICK INSULATION
- THERMAL BLOCKS FASTENED TO SUPPORTS THROUGH 3" THICK INSULATION WITH #12 X 1-5/8" LONG PANCAKE HEAD SDS AT EACH END OF THE THERMAL BLOCK.

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26 GA., PBR PANEL



SEALED 'N' SAFE THERMAL BLOCKS

SECTION II
DESCRIPTION OF TEST

DESCRIPTION OF TEST

2.1 DESCRIPTION OF TEST

OBJECTIVES

Tests were conducted to determine shear strength and shear stiffness of the panels under simulated loading conditions. The test method consisted of the following:

1. assembling the test panel on an interior test frame to form a typical roof or wall construction;
2. loading the test frame incrementally; and
3. observing, measuring, and recording the deflections, deformations, and nature of any failures of principal or critical elements of the test construction.

The increments of load application were chosen such that a sufficient number of readings were obtained to determine the load deformation curve of the system.

TEST SETUP

The test setup consisted of an exterior reaction truss and interior panel support frame as shown in the applicable drawings in the appendix. The L-shaped reaction truss was constructed of two built-up tube sections with cross-braced angle sections to form a truss. The panel support frame was constructed of cold-formed Cee sections having equal or lower strength and stiffness than that intended for use in the typical constructions. All the connections in the interior frame were pinned.

Both the truss and frame lay in the same horizontal plane. The reaction frame was supported by short columns, which rested on the laboratory floor. Two corners of the interior frame were connected to the exterior frame with a hinge and roller. The side opposite to these corners was held up by columns with roller bases. The intermediate girts were attached to the side post with pinned connections.

LOADING DEVICE

Load was applied using a 10 kip capacity hydraulic ram and manual pump. The load was monitored with a calibrated 10 kip capacity load cell and associated instrumentation. The accuracy of the load cell was estimated to be ± 0.01 kips. The hydraulic ram was attached to the reaction truss and the load cell was attached to the interior frame. The load was applied parallel to and in close proximity to one of the points of contact between the diaphragm web and frame.

DEFLECTION MEASUREMENT

Deflection measurements were taken by means of dial indicators calibrated to 1/1000 of an inch. Deflections were measured at locations as shown on the drawings in the appendix. The deflection locations are based on AISI TS-7-02.

DESCRIPTION OF TEST

DIAPHRAGM SIZE

The overall dimension of each construction was in excess of 16' 3" x 15' 6". The panels covered three equal spans of 5' 0". The construction width contained five full panels. The panels were attached to the end and intermediate Cee girt sections with self-drilling screws. The panels were not attached to the side member of the interior frame. The details of the methods of construction are depicted in the enclosed test drawings. All the material used in the construction represented a typical construction.

NUMBER OF TESTS

Minimum of two panel assemblies was tested to determine the value of a given construction.

TEST PROCEDURE

Prior to the diaphragm construction, the interior frame was loaded to determine its bare frame stiffness. The bare frame stiffness was insignificant, deflecting 1" under a 10-lb load. The loading procedure on the completed diaphragm construction consisted of loads applied in increments. The diaphragm was loaded to 20% of the anticipated ultimate load and unloaded. Deflection measurements were recorded at 'no load' conditions. The diaphragm was loaded in 300-lb increments until failure for Test #1 & #2. Deflection measurements were recorded at every load increment.

TEST DURATION

The test was stopped when the test specimen was unable to carry additional load or visual failure of one or more components of the diaphragm occurred.

2.2 CALCULATIONS

The ultimate shear strength S_u (lb/ft) of a given construction is where

$$S_u = \frac{P_u}{b}$$

P_u = maximum applied load in the cantilever beam test (lb),

b = depth of diaphragm (ft).

The net shear deflections (Δ) at any load level in the cantilever beam test is

$$\Delta = \Delta_3 - \left[\Delta_2 + \frac{a}{b} (\Delta_1 + \Delta_4) \right]$$

where Δ_1 , Δ_2 , Δ_3 and Δ_4 are measured deformations with appropriate signs at locations shown in the test drawings.

DESCRIPTION OF TEST

The apparent shear stiffness G' (lb/in) of a given construction is where

$$G' = \frac{P}{\Delta} \left(\frac{a}{b} \right)$$

P = $0.4P_u$ in the cantilever beam test (lb),

a = span of diaphragm (ft).

Δ = Net shear deflection of diaphragm (in) at $0.4P_u$ load.

The shear stiffness calculation is based on AISI TS-7-02.

**SECTION III
TEST RESULTS**

TEST RESULTS

3.1 SPECIMEN IDENTIFICATION

Panel Manufacturer: CO Building Systems, Inc.

Model Type: PBR Panel

Dimensions: 1.25" high, 36" wide coverage

Panel Thickness: 26 ga.

Base Metal Thickness: 0.017"

Panel Yield Stress: 80 ksi (114 ksi tested)

Panel Fasteners: #12 x 2" long hex head self-drilling screws with washers (DB Building Fasteners, Inc.)

Sidelap Fasteners: 1/4"-14 x 7/8" long hex head self-drilling screws with washers

Sidelap Fasteners Spacing: 30" o.c.

Thermal Blocks: Sealed 'N' Safe™ - consisted of two 24 ga. steel plates with polyurethane foam injected between the plates to form a 1" thick block. The length and width of the thermal block were 72" and 5", respectively. Polyurethane foam was manufactured by Utah Foam and designated as X10324.

Thermal Blocks Fasteners: #12 x 1-5/8" long pancake head self-drilling screws (DB Building Fasteners, Inc.)

Insulation: 4" thick and 3" thick blanket insulation

Support Thickness: 16 ga.

TEST RESULTS

3.2 TEST #1: 26 Ga., 80 KSI PBR PANELS WITH THERMAL BLOCKS AT THREE EQUAL SPANS OF 5' 0"

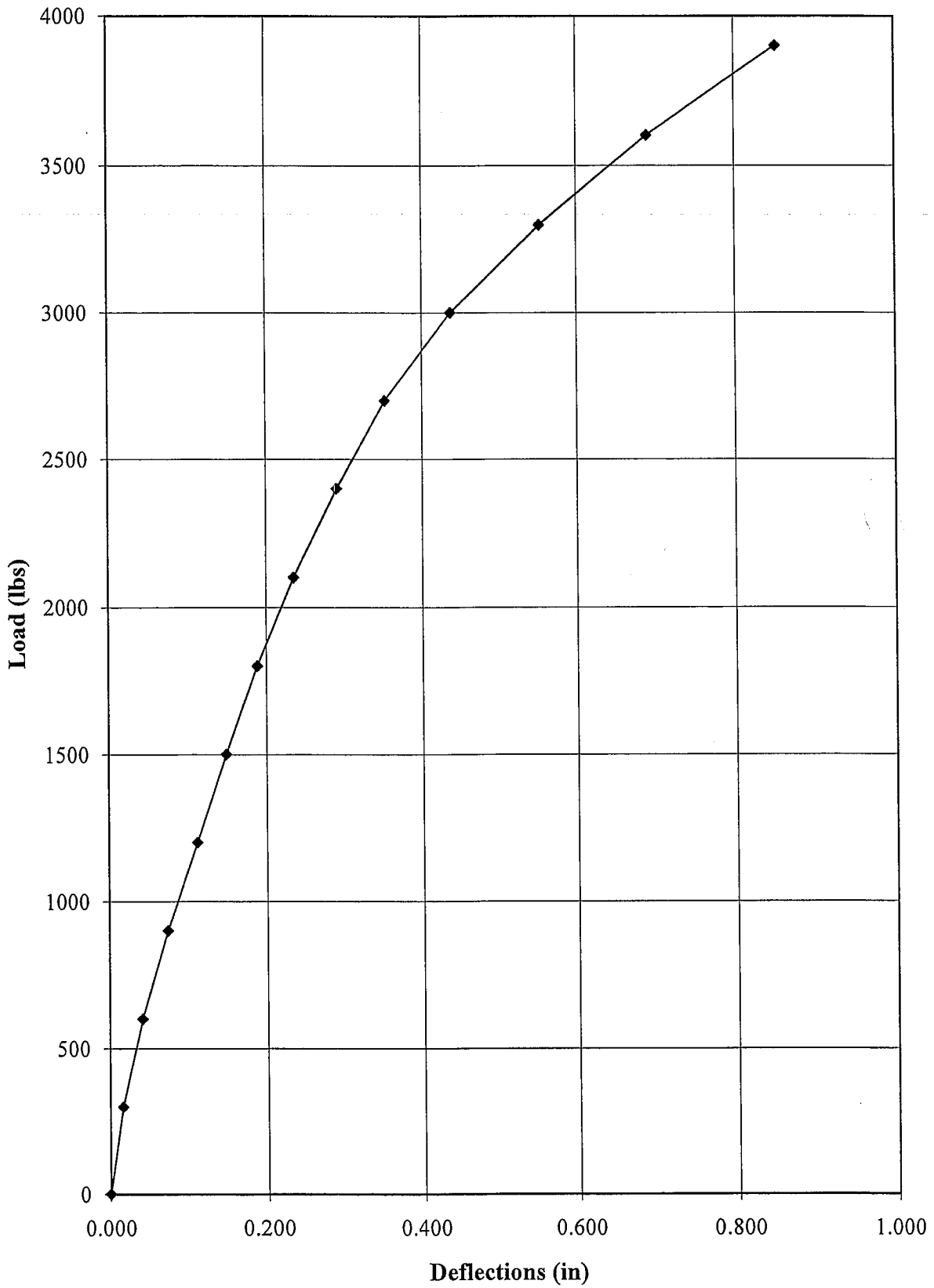
Date:	9.23.09
Panel Type:	CO Building PBR panel
Gauge:	26 ga.
Thickness:	0.017"
Panel Width:	36"
Support Spacing:	5' 0"-5' 0"-5' 0"
Type of Structural Fastener:	#12 x 2" long SDS
Fastener Spacing at End Supports:	12" o.c.
Fastener Spacing at Intermediate Supports:	12" o.c.
Insulation	4" thick blanket, Sealed N Safe and 3" thick blanket
Type of Sidelap Fastener:	1/4-14 x 7/8" long SDS
Sidelap Fastener Spacing	30" o.c
a = span length of diaphragm (ft):	15.50
b = depth of diaphragm (ft):	16.25

Load (lb)	Dial Indicator Reading (in)				Shear Deformation Δ (in)
	1	2	3	4	
0	0.000	0.000	0.000	0.000	0.000
300	0.014	0.045	0.150	0.079	0.016
600	0.030	0.067	0.261	0.130	0.041
900	0.024	0.079	0.340	0.172	0.074
1200	0.023	0.086	0.418	0.207	0.113
1500	0.023	0.103	0.514	0.251	0.150
1800	0.016	0.115	0.581	0.275	0.188
2100	0.010	0.125	0.655	0.300	0.234
2400	0.013	0.132	0.738	0.319	0.289
2700	0.024	0.142	0.841	0.340	0.352
3000	0.034	0.150	0.955	0.352	0.437
3300	0.047	0.165	1.121	0.376	0.553
3600	0.060	0.177	1.299	0.393	0.690
3900	0.070	0.198	1.515	0.417	0.852
4000					

Failure Mode:	Panel buckling at roller corner		
Duration of test:	> 10 minutes		
	Temperature (F)	Relative Humidity (%)	
At construction:	73.4	44	
At testing	73.4	44	

TEST RESULTS

Load vs Deflection (Test #1)



TEST RESULTS

3.3 TEST #2: 26 GA., 80 KSI PBR PANELS WITH THERMAL BLOCKS AT THREE EQUAL SPANS OF 5' 0"

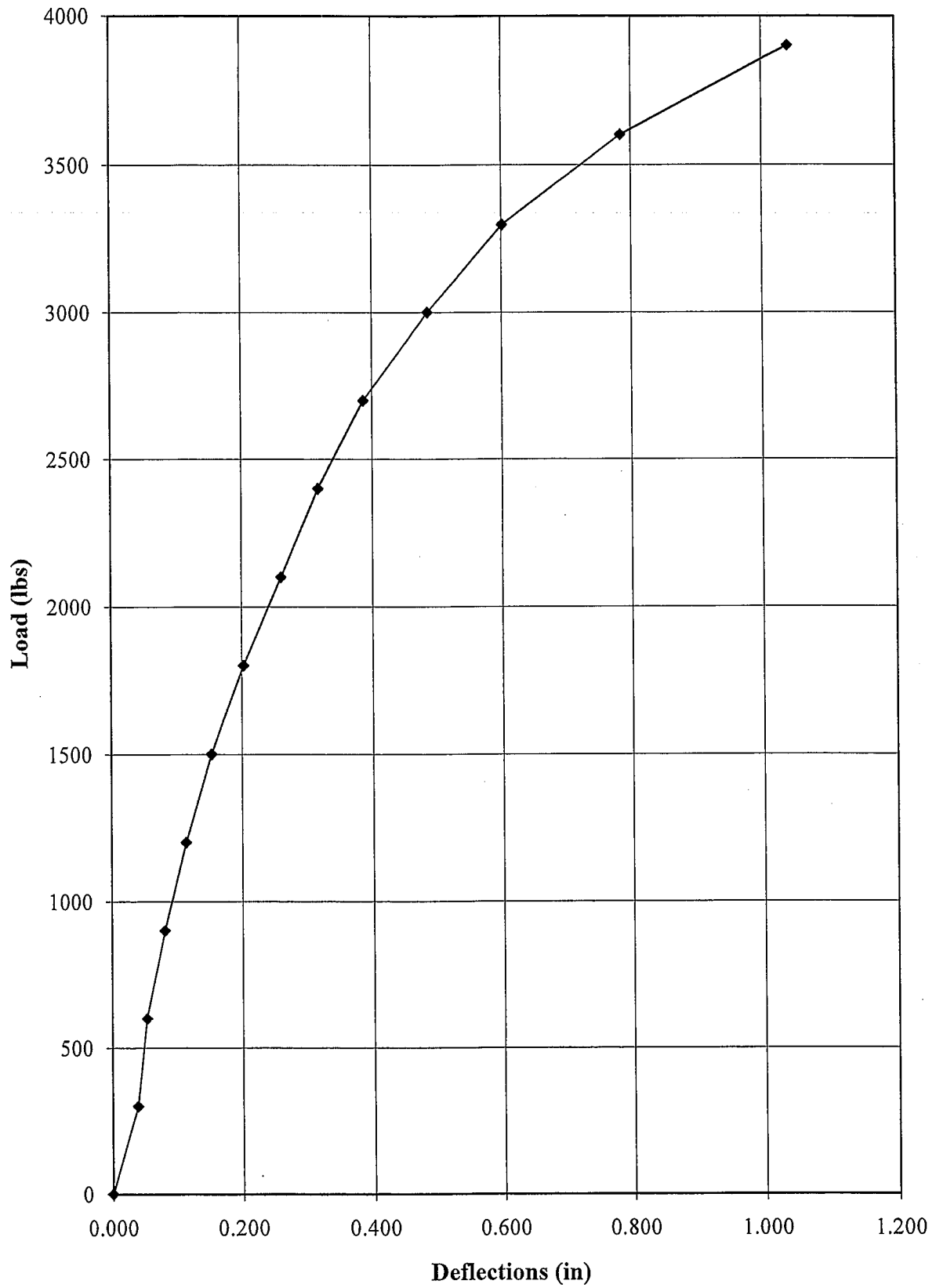
Date:	9.24.09
Panel Type:	CO Building PBR panel
Gauge:	26 ga.
Thickness:	0.017"
Panel Width:	36"
Support Spacing:	5' 0"-5' 0"-5' 0"
Type of Structural Fastener:	#12 x 2" long SDS
Fastener Spacing at End Supports:	12" o.c.
Fastener Spacing at Intermediate Supports:	12" o.c.
Insulation	4" thick blanket, Sealed N Safe and 3" thick blanket
Type of Sidelap Fastener:	1/4-14 x 7/8" long SDS
Sidelap Fastener Spacing	30" o.c
a = span length of diaphragm (ft):	15.50
b = depth of diaphragm (ft):	16.25

Load (lb)	Dial Indicator Reading (in)				Shear Deformation Δ (in)
	1	2	3	4	
0	0.000	0.000	0.000	0.000	0.000
300	0.020	0.042	0.183	0.087	0.039
600	0.037	0.060	0.275	0.132	0.054
900	0.032	0.073	0.354	0.177	0.082
1200	0.028	0.082	0.421	0.207	0.115
1500	0.022	0.091	0.490	0.235	0.154
1800	0.016	0.098	0.564	0.260	0.203
2100	0.009	0.112	0.654	0.286	0.261
2400	0.016	0.125	0.754	0.310	0.318
2700	0.013	0.123	0.817	0.309	0.387
3000	0.021	0.131	0.942	0.320	0.486
3300	0.025	0.138	1.073	0.325	0.601
3600	0.028	0.149	1.288	0.344	0.784
3900	0.032	0.169	1.592	0.370	1.040

Failure Mode:	Panel buckling at load corner	
Duration of test:	> 10 minutes	
	Temperature (F)	Relative Humidity (%)
At construction:	74.3	43
At testing	74.3	46

TEST RESULTS

Load vs Deflection (Test #2)



**SECTION IV
PHOTOGRAPHS**

PHOTOGRAPHS

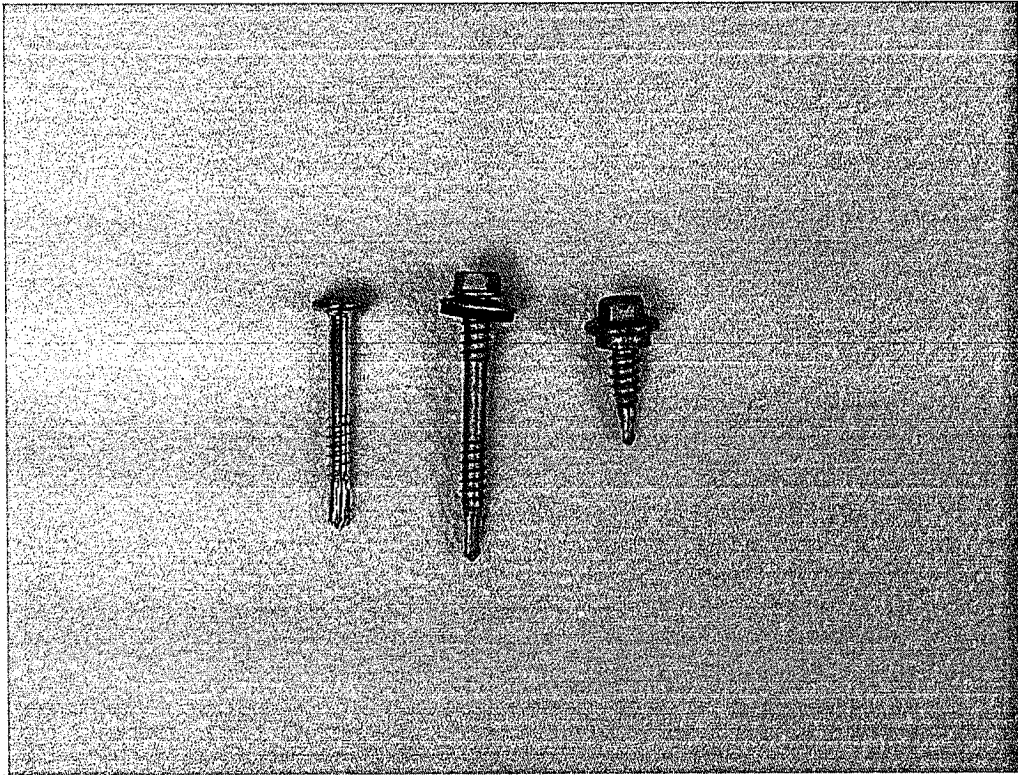


PHOTO 1 View of the Sealed 'N' Safe™ thermal blocks, panel and sidelap fasteners (left to right). (DSC00072)

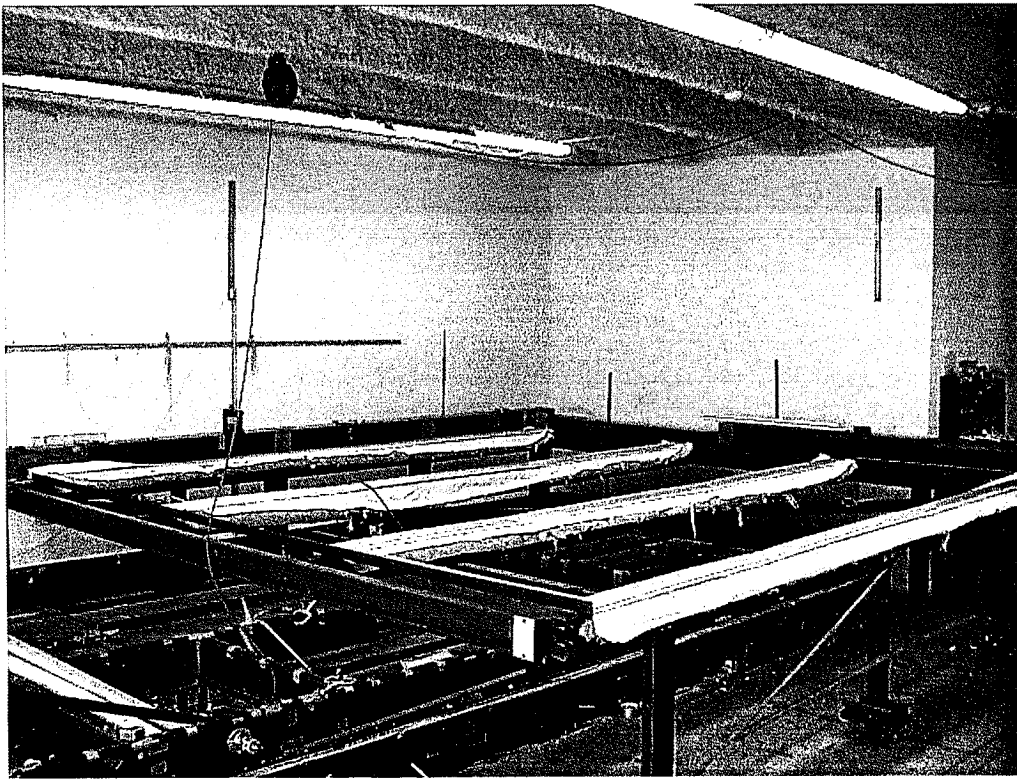


PHOTO 2 View of the Sealed 'N' Safe™ thermal blocks fastened through 3" thick blanket insulation to the supports. (DSC00067)

PHOTOGRAPHS

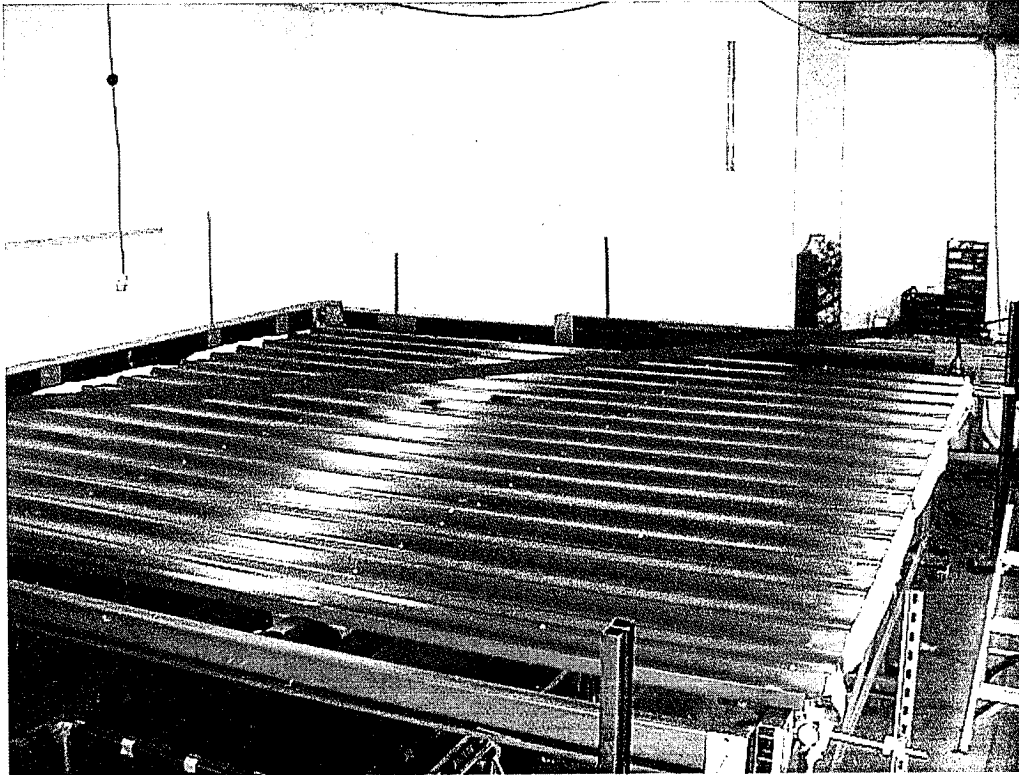


PHOTO 3 Overview of the diaphragm test setup of the PBR panels.
(DSC00068)



PHOTO 4 View of the panel fasteners at end and intermediate supports.
(DSC00069)

PHOTOGRAPHS

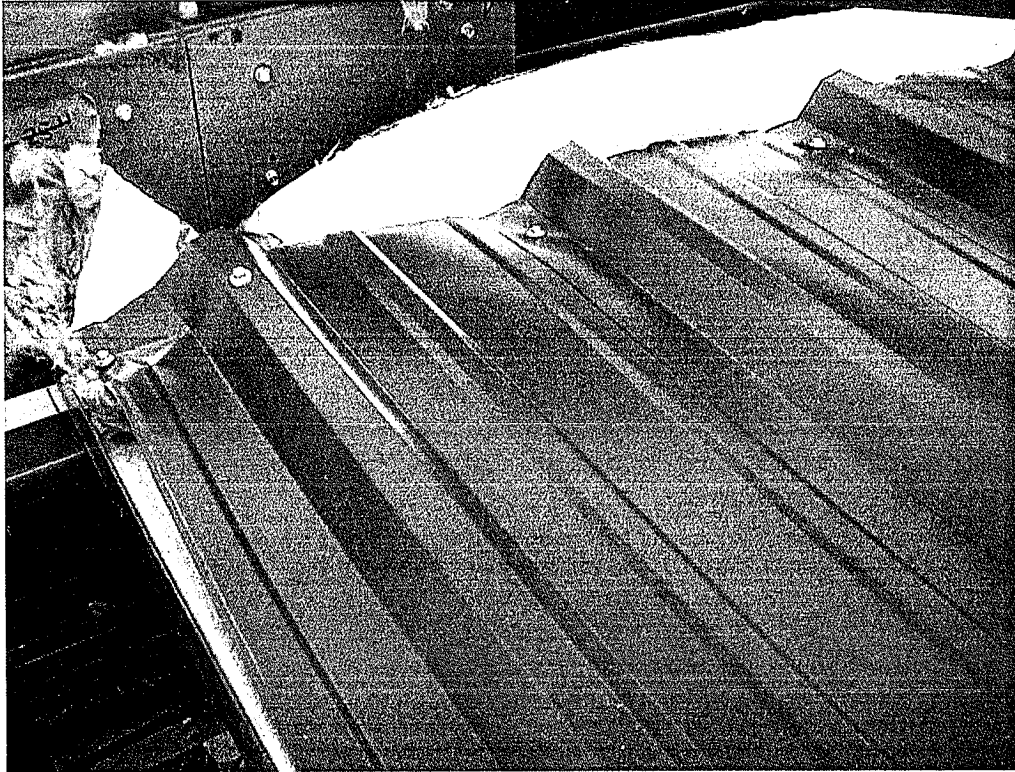


PHOTO 5 View of panel buckling near the roller corner in Test #1.
(DSC00073)

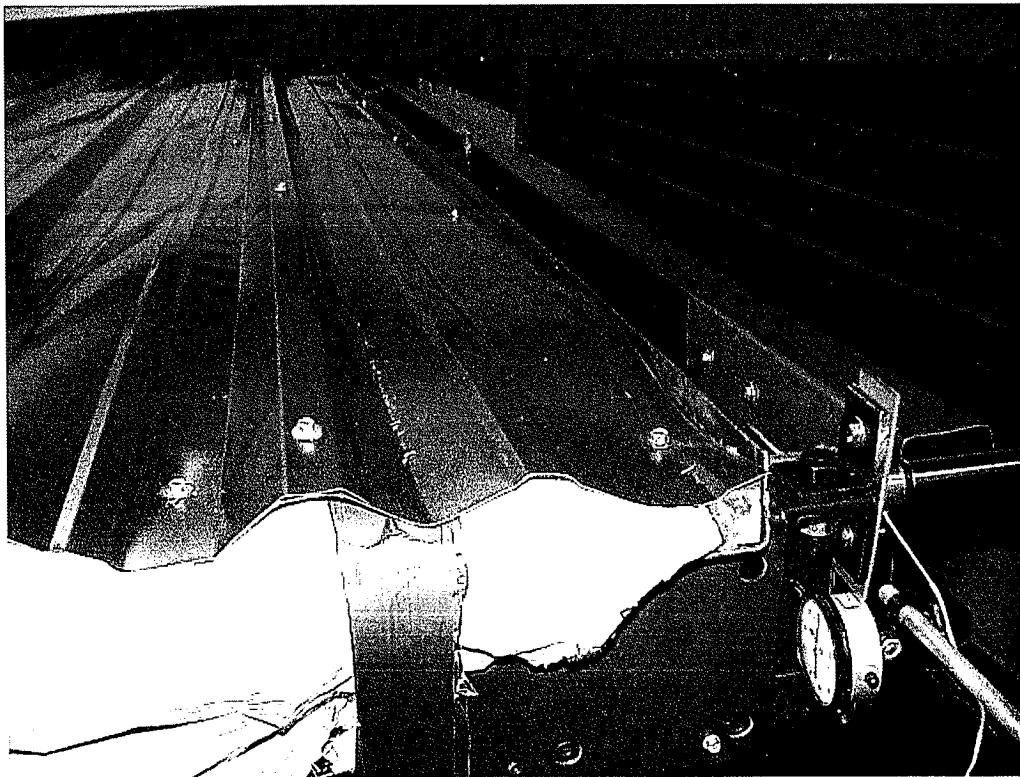
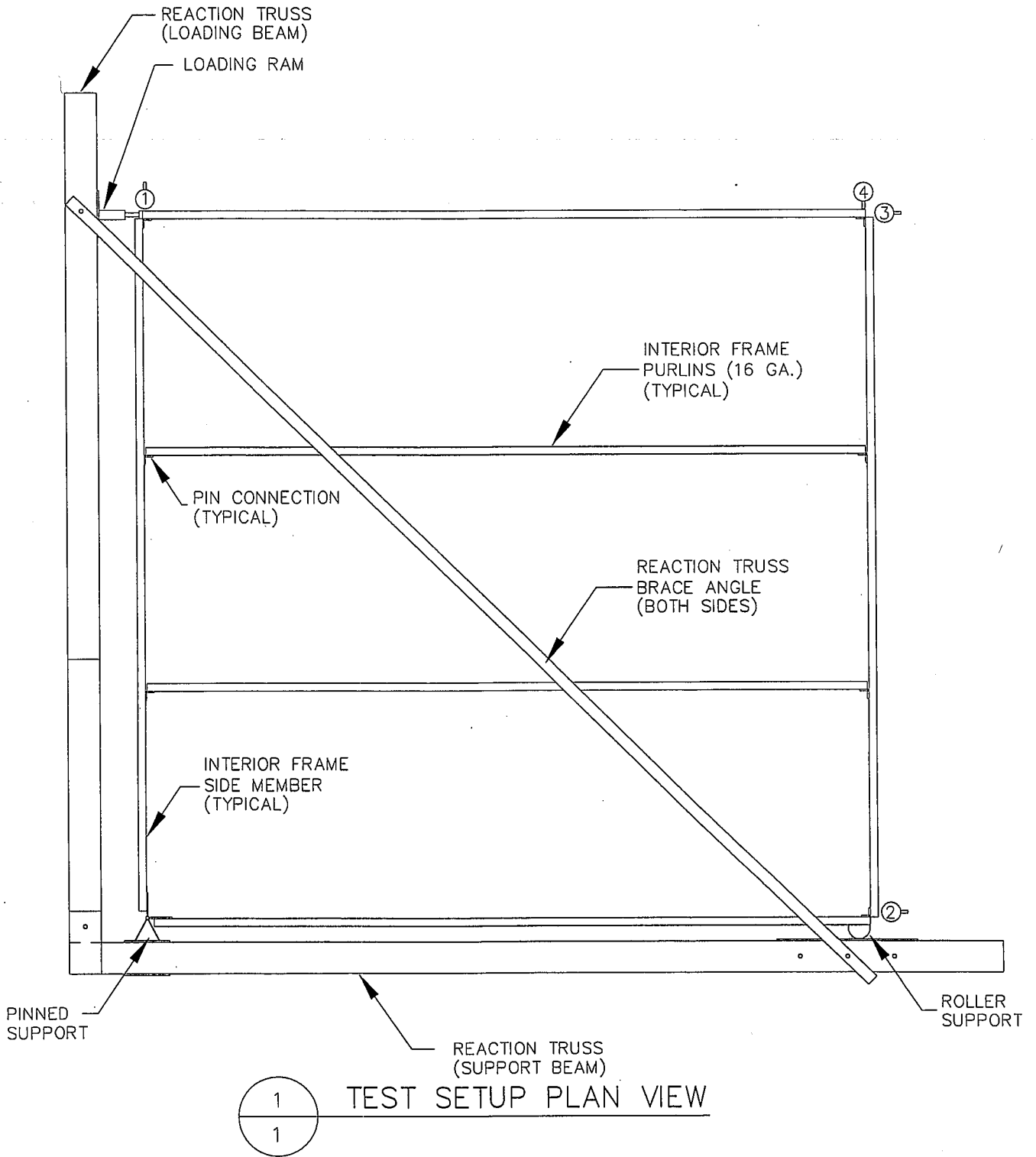


PHOTO 6 View of panel buckling near the loaded corner in Test #2.
(DSC00079)

SECTION V
APPENDIX

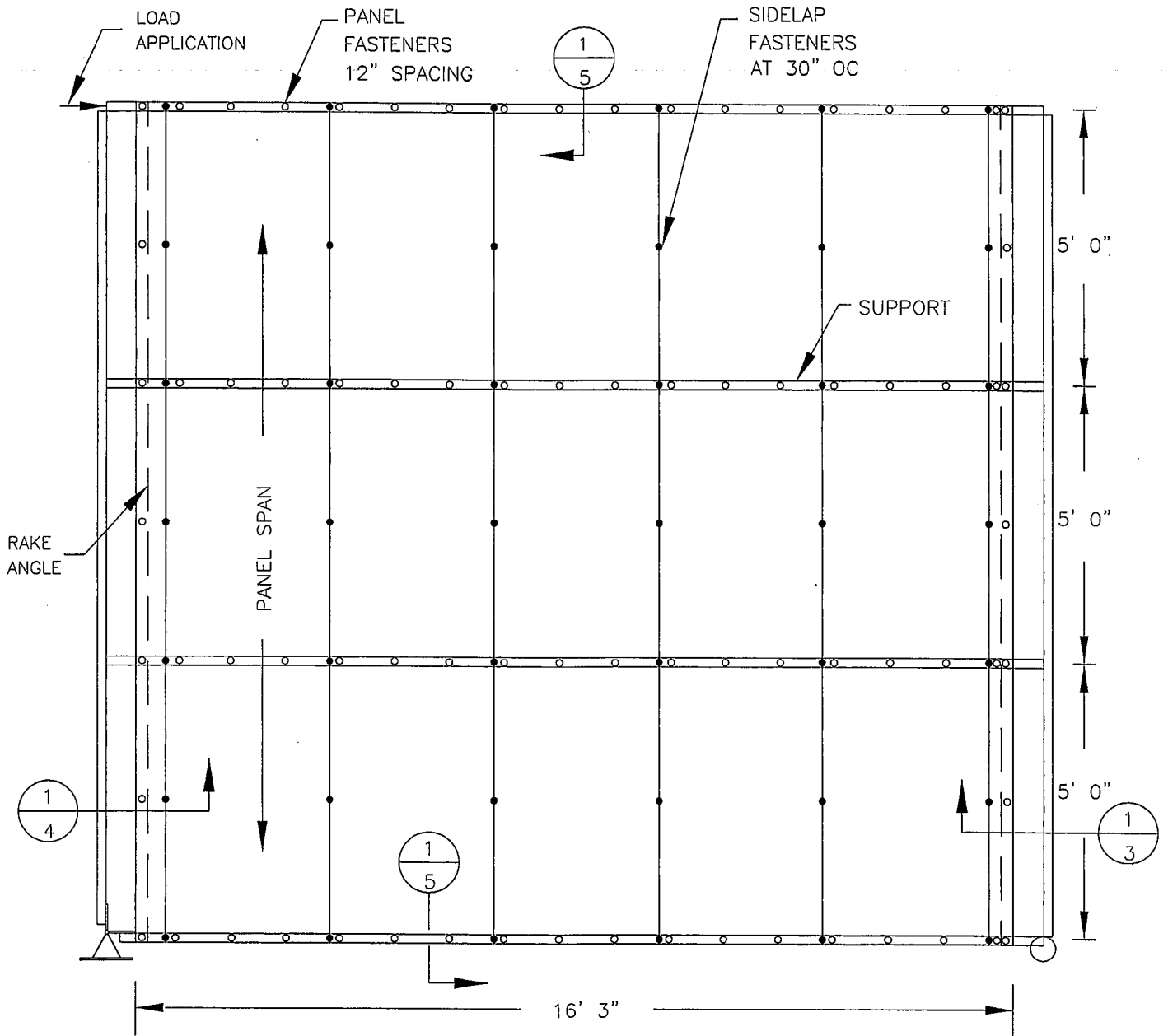
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NOTES:

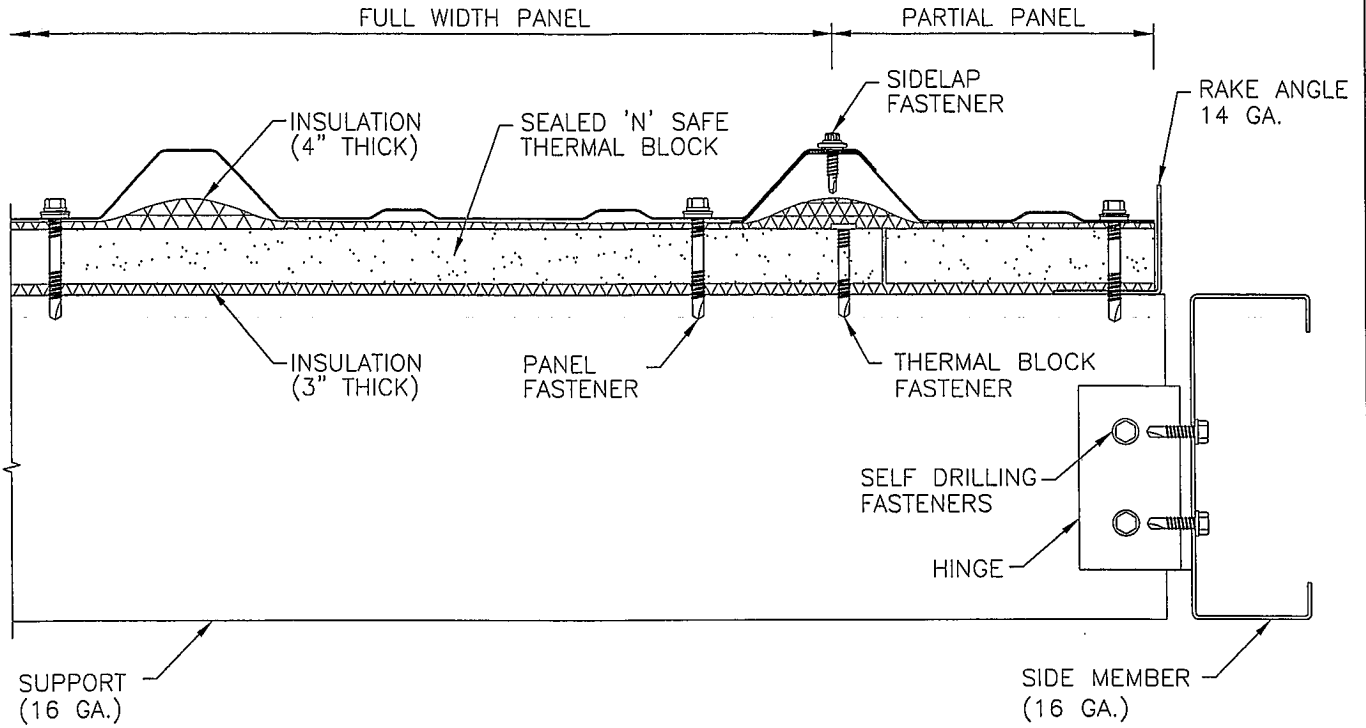
① DIAL INDICATOR LOCATION

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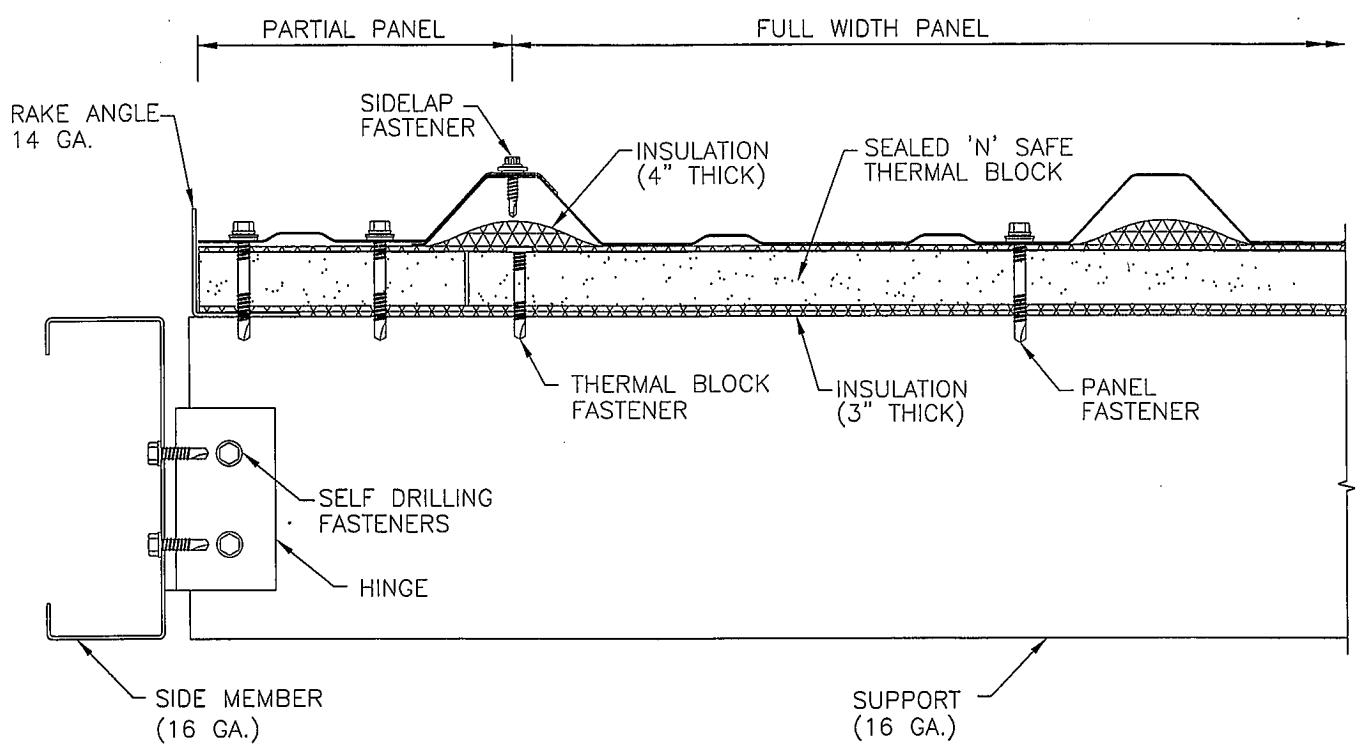
1 PLAN VIEW OF TEST PANEL SETUP
2

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1
3

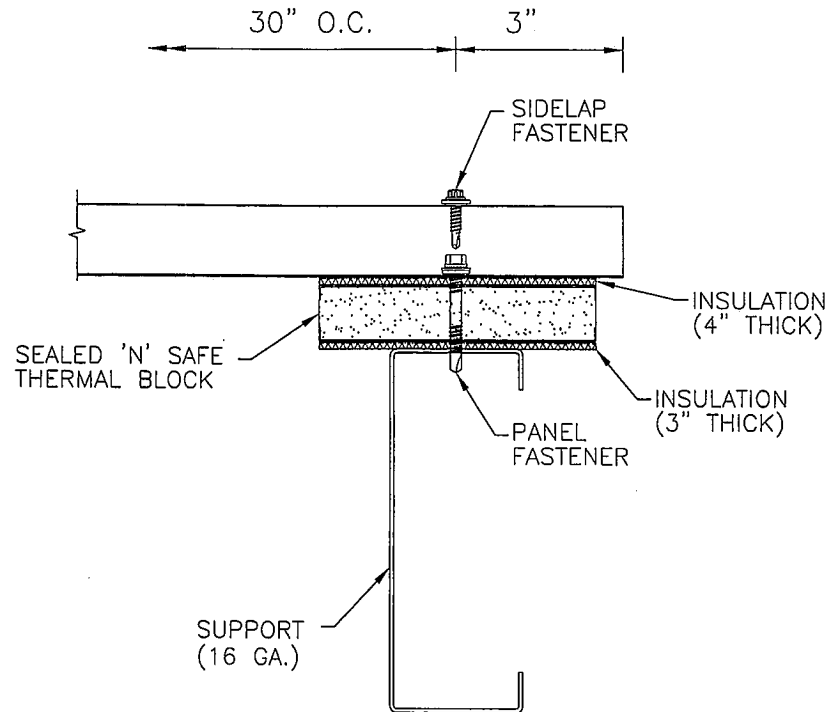
DETAILS OF "STARTER RAKE" OF TEST ROOF



1
4

DETAILS OF "FINISHED RAKE" OF TEST ROOF

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1
5

DETAILS OF "END SUPPORTS" OF TEST ROOF



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LABORATORY REPORT

Attn: Bala Sockalingam
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Report No.: 09091068-001 v2-Amended
Date Received: 9/25/2009
Date Reported: 9/30/2009
P.O. No.: Verbal

Sample Description: (1) Test Sample, CO Building PBR(26ga.), Part No.: 1

Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Thickness, inch	0.017
Width, inch	0.501
Tensile Strength, psi	114,000
Yield Strength, psi at 0.2% offset	* 1
Elongation in 2 inches, %	2.2

*Specimen fractured before achieving offset yield.

Approved by: Maurice Cochran
Maurice Cochran, Supervisor of Mechanical Testing
Sherry Laboratories

¹Amended: Yield strength results, 10-06-09.

APPENDIX

5.3 TEST CONDITIONS

A. OWNERSHIP OF ENCON WORK PRODUCT

All test results developed as a part of this work shall be CUSTOMER's property. All samples submitted to ENCON for testing shall become the property of ENCON. CUSTOMER understands that any test program including procedures and test machines incorporated as a part of this work is a result of continuing long-term research and development by ENCON and because of this all ENCON test procedures, test drawings and other intellectual property relating to this work is and shall remain the property of ENCON. Test samples were disposed of shortly after completion of the tests unless other arrangements were agreed to in writing prior to the test.

ENCON will use its normal procedures to retain copies of the information developed as a part of this test for a period of three years from the date the work was done. This material may be routinely destroyed thereafter.

B. ENCON GUARANTEE

ENCON guarantees it used its best effort to accomplish this test work. Work done by ENCON was carefully completed by personnel believed to be competent. ENCON tests were based on what was currently believed to be good engineering practices in use at the time of the test.

The safety factors used are generally accepted as suitable to produce safe results. However, good engineering practices and applicable codes and insurance requirements must be taken into consideration in determining if a test procedure is satisfactory for a specific end use. Applicable specifications, good engineering practices and applicable safety factors may change in the future. CUSTOMER should be alert to these changes.

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If any doubt exists as to the proper means of interpreting or using the test results contained herein, contact ENCON for clarification. CUSTOMER should assure themselves through careful evaluations that test results are suitable for those end uses to which CUSTOMER intends to put them.

APPENDIX

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