

**TEST REPORT ON**  
**26 GA. PBR PANELS**  
**AT 5' 0" PURLIN SPACING**  
**WITH SEALED 'N' SAFE™ THERMAL BLOCKS**  
**USING 8" & 10" DEEP, 12 GA. ZEE PURLINS**  
**IN ACCORDANCE WITH AISI S908-08**

**TESTED FOR:**  
**Sealed 'N' Safe, LLC**  
**320 West 100 North**  
**Ephraim, Utah 84627**  
**Telephone: (435) 283-6550**  
**Fax: (435) 283-8326**

**TESTED BY:**  
**ENCON® Technology, Inc.**  
**1216 North Lansing Avenue, Suite C**  
**Tulsa, OK 74106**  
**Telephone: (918) 492-5992**  
**FAX: (866) 366-1543**

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

**TESTING DATE: January 26 & 27, February 1, 2, 3, 4, 5, 23 & 24, 2010**  
**REPORTING DATE: March 3, 2010**  
**ENCON® Project C1696-1**

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## TEST SUMMARY

### 1.1 SUMMARY

Tests were conducted on PBR metal roof panels at ENCON® Technology, Inc. Test Facility, Tulsa, Oklahoma. The purpose of the tests was to obtain the modification factor ' $R_t$ ' to be used in determining the nominal flexural strength of the purlin supporting the PBR roof system fastened to the purlins through blanket insulation and Sealed 'N' Safe™ thermal block. These tests meet the provisions of AISI S908-08 "*Base Test Method for Purlins Supporting a Standing Seam Roof System*". The tests are listed below according to their configurations and date tested.

- Test #1: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips and (2) bolts. Bracing option 1 was bolted to the purlins at midspan with 2 bolts. The gravity load test was conducted on January 26, 2010.
- Test #2: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips and (2) bolts. Bracing option 2 was bolted to the purlins at midspan with 2 bolts. The gravity load test was conducted on January 27, 2010.
- Test #3: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips and (2) bolts. Bracing option 3 was bolted to the purlins at midspan with 4 bolts. The gravity load test was conducted on January 27, 2010.
- Test #4: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips, plate and (2) bolts. Plate (7" x 5" x 0.25" thick) was inserted between purlin and anti-roll clip. Bracing option 3 was bolted to the purlins at midspan with 4 bolts. The gravity load test was conducted on February 1, 2010. Two more tests (#5 and #6) were conducted for above conditions and tested on February 2, 2010.
- Test #7: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips, plate and (2) bolts. Plate (7" x 5" x 0.25" thick) was inserted between purlin and anti-roll clip. Retrofit bracing option was fastened the bottom flange of the purlins at midspan with 2 screws per purlin. The gravity load test was conducted on February 3, 2010.
- Test #8: Nom. 8" x 2.5" x 14 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 27' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips and (2) bolts. No midspan bracing was used in this test. The gravity load test was conducted on February 4, 2010.

## TEST SUMMARY

Test #9: Nom. 8" x 2.5" x 16 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 27' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips and (2) bolts. No midspan bracing was used in this test. The gravity load test was conducted on February 4, 2010.

Test #10: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips, plate and (2) bolts. Plate (7" x 5" x 0.25" thick) was inserted between purlin and anti-roll clip. Bracing option 3 was bolted to the purlins at midspan with 4 bolts. The uplift load test was conducted on February 5, 2010.

Test #11: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips, plate and (2) bolts. Plate (7" x 5" x 0.25" thick) was inserted between purlin and anti-roll clip. Bracing option 3 was bolted to the purlins at midspan with 4 bolts. The 3" thick blanket insulation was not included between the thermal block and purlin. The gravity load test was conducted on February 23, 2010.

Test #12: Nom. 10" x 2.5" x 12 ga., 55 ksi zee purlin supporting PBR panel at 5' 0" purlin spacing and 30' 0" purlin span. The purlins were attached to the support beam with CO Building's anti-roll purlin clips, plate and (3) bolts. Plate (7" x 5" x 0.25" thick) was inserted between purlin and anti-roll clip. Bracing option 3 was bolted to the purlins at midspan with 4 bolts. The uplift load test was conducted on February 24, 2010.

The zee purlins were manufactured by CO Building Systems. The above defined tests were witnessed by Bala Sockalingam, Ph.D., P.E., of ENCON Technology.

## 1.2 ROOF 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 zee purlins through the 4" thick blanket insulation, Sealed 'N' Safe™ thermal block and 3" thick blanket insulation with #12 x 2" long hex head self-drilling screws with washers. The sidelap fasteners were 1/4"-14 x 7/8" long hex head self-drilling screws with washers and spaced at 12" o.c. for all tests. Each panel spanned over a simple span of 5' 0" with an overhang of 12" on either side. The purlin flanges faced the same direction and the top of the flange was not braced externally. Several types of midspan bracing were used in these testing.

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

## TEST SUMMARY

blanket insulation with #12 x 1-5/8" long pancake head self-drilling screws located at each end of the blocks.

### 1.3 TEST RESULTS

Load was applied incrementally and horizontal and vertical deflections of the test construction were recorded for 'no load' condition and at each load increment. The test results and the modification factor ' $R_t$ ' for above tests are as follows:

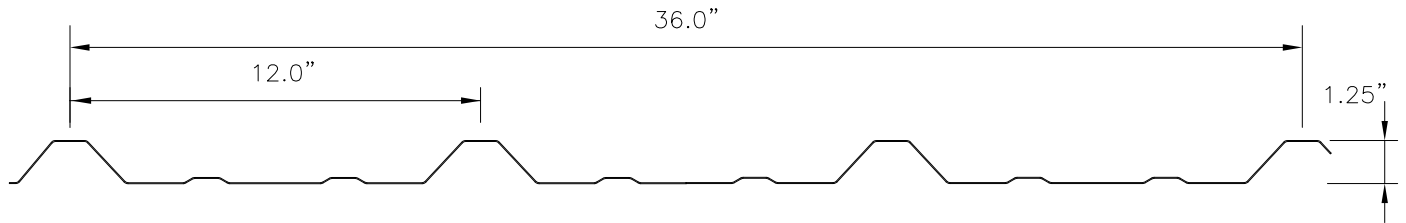
No.	Purlin	Span (ft)	Loading	Bracing	Purlin Attachment At Support	Failure Mode	Reduction Factor $R_t$
1	10Z12	30	Gravity	Bracing 1	PS1	Web bending at support	0.79
2	10Z12	30	Gravity	Bracing 2	PS1	Web bending at support	0.78
3	10Z12	30	Gravity	Bracing 3	PS1	Web bending at support	0.77
4	10Z12	30	Gravity	Bracing 3	PS2	Top flange buckled	0.92
5	10Z12	30	Gravity	Bracing 3	PS2	Top flange buckled	0.98
6	10Z12	30	Gravity	Bracing 3	PS2	Top flange buckled	0.96
7	10Z12	30	Gravity	Retro	PS2	Top flange buckled	0.87
8	8Z14	27	Gravity	None	PS1	Top flange buckled	0.80
9	8Z16	27	Gravity	None	PS1	Top flange buckled	0.83
10	10Z12	30	Uplift	Bracing 3	PS2	Bottom flange buckled	0.61
11	10Z12	30	Gravity	Bracing 3	PS2	Top flange buckled	0.92
12	10Z12	30	Uplift	Bracing 3	PS3	Bottom flange buckled	0.73

Notes:

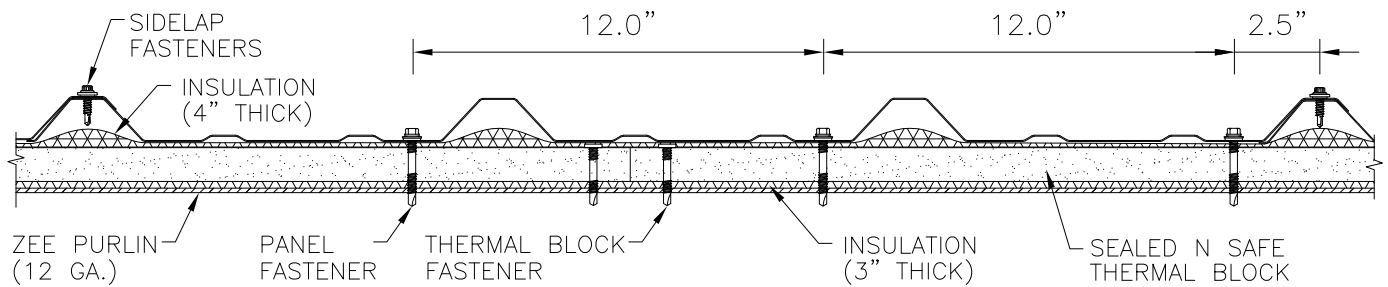
PS1: CO Building anti-roll purlin clip with 2 bolts.

PS2: CO Building anti-roll purlin clip and plate (7" x 5" x 0.25" thick) with 2 bolts.

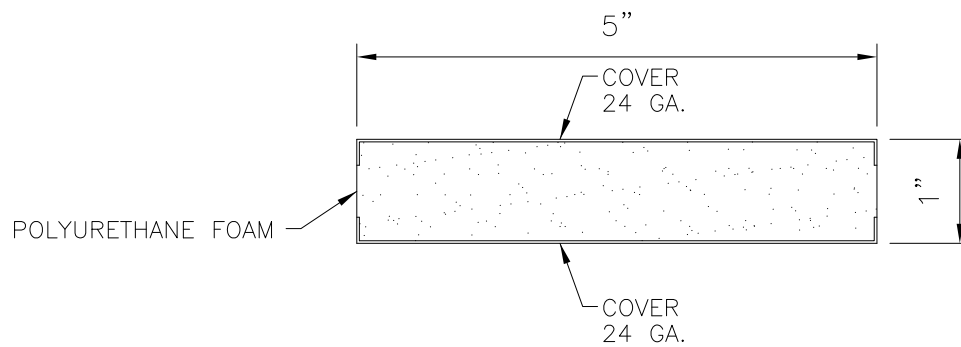
PS3: CO Building anti-roll purlin clip and plate (7" x 5" x 0.25" thick) with 3 bolts.



26 GA., PBR PANEL

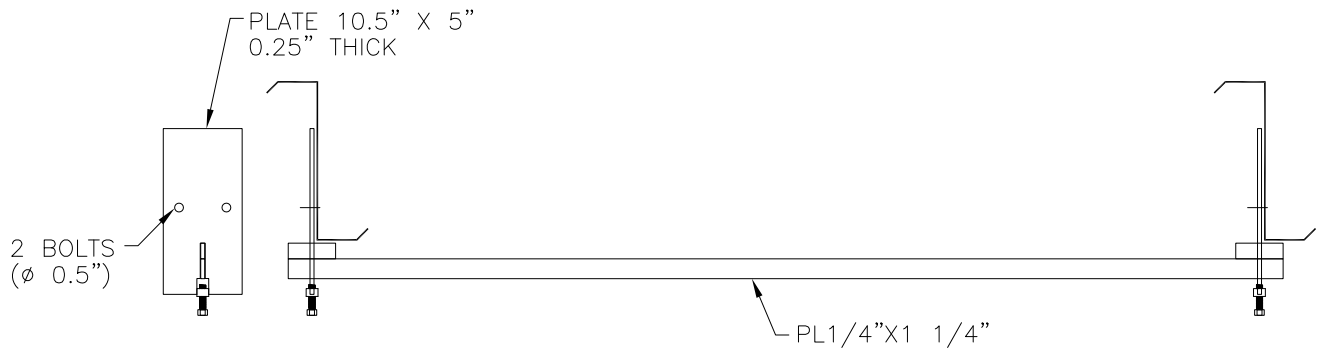


FASTENER PATTERN

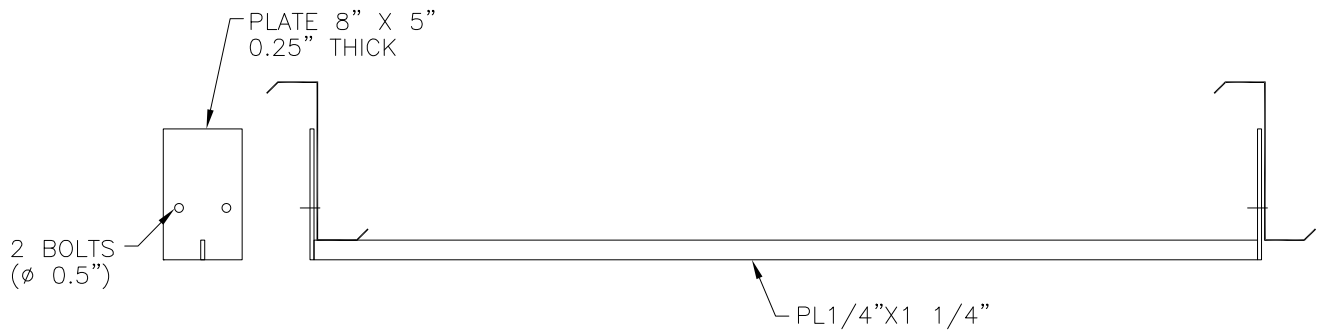


SEALED 'N' SAFE THERMAL BLOCKS

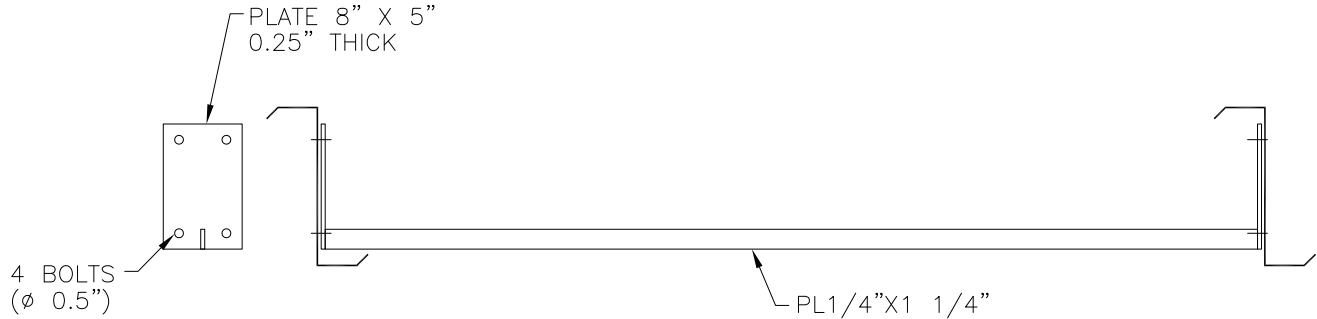
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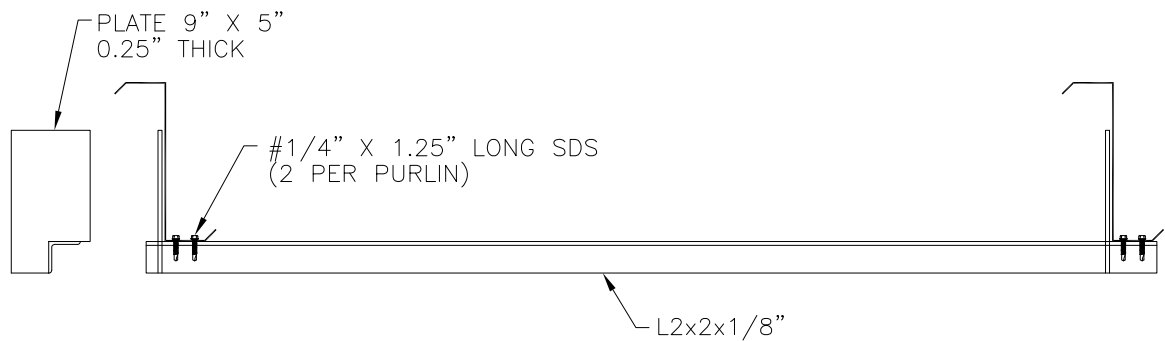
BRACING OPTION 1



BRACING OPTION 2

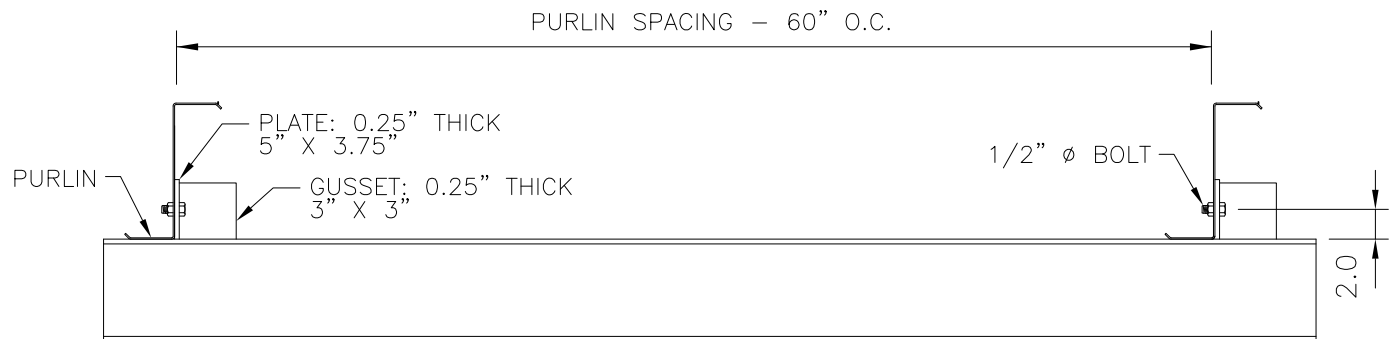


BRACING OPTION 3



RETRO-FIT

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ANTI-ROLL CLIP  
(USED IN TEST #1, 2, 3, 8 & 9)



ANTI-ROLL CLIP WITH PLATE  
(USED IN TEST #4, 5, 6, 7, 10 & 11)



ANTI-ROLL CLIP WITH PLATE  
(USED IN TEST #12)



## **DESCRIPTION OF TEST**

### **2.1 DESCRIPTION OF TEST**

#### **OBJECTIVES**

The purpose of this test is to obtain the reduction factor to be used in determining the nominal flexural strength of the purlin supporting a through fastened roof system. The test method consisted of the following:

1. assembling the test panels on two simply supported zee purlins;
2. loading the test panels 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. This test method applies to an assembly consisting of the standing seam panel, purlin and attachment devices used in the system being tested.

#### **TEST CHAMBER**

The test chamber consisted of a box as shown in the applicable drawings in the appendix. It contains one open surface in which the test specimen is installed. Two static pressure taps are located at corners to measure the chamber pressure in such a manner that the readings are not affected by the velocity of the air supply to or from the chamber or other air movement. The air supply openings into the chamber are arranged so that the air does not impinge directly on the test specimen with significant velocity.

#### **AIR SYSTEM**

The suction air supply consists of a number of individual units capable of maintaining a constant suction pressure difference for the required test period. A water manometer is used to measure the test pressure difference with accuracy of 1/100."

#### **DEFLECTION MEASUREMENT**

Vertical measurements at the midspan of both purlins were taken by means of a level and staffs calibrated to 1/100 of an inch. Horizontal measurements were taken by means of dial gauge calibrated to 1/1000 of an inch, at the seam joint nearest the center of the test specimen.

#### **PANEL LENGTH**

The length of the panels was 7' 0", which provided the necessary length for purlin spacing of 5' 0" with an overhang of 12" on either side.

## DESCRIPTION OF TEST

### TEST SPECIMEN

The purlins were connected to the supporting beams with anti-roll purlin clips. There were no external discrete bracings used in these tests. The panels were attached to the purlins with standard fastener system. The overall dimension of the specimen was in excess of 7' x 28' for 8" deep purlins and in excess of 7' x 31' for 10" deep purlins

Plastic sheeting (max 6 mil thick) was used to keep the air pressure chamber airtight. The sheeting was placed on top of the panels for gravity load tests and between the panel and insulation for uplift load test. The sheeting between panel ribs was pleated to allow the sheeting to conform to into the panel sidelap when pressure was applied to the panels.

### TEST PROCEDURE

An initial load equal to 5 psf was applied and removed to record the zero readings. The loading procedure on the test system consisted of suction pressure applied in increments. Deflection measurements and pressures were recorded at every pressure interval. Pressure intervals did not exceed 20% of the anticipated failure load.

### TEST DURATION

The test was stopped when the test system was unable to carry additional load or buckling failure of purlins occurred. The pressure at which the system fails was recorded as the failure load of the system.

## 2.2 CALCULATIONS

For Z purlins tested with the flange facing the same direction and with the top flanges of the purlins not braced externally, then

$$\begin{aligned} w_{ts} &= (p_{ts} \pm p_d)s + 2P_L(d/B) && \text{if the eave purlin fails and} && (1) \\ &= (p_{ts} \pm p_d)s && \text{if the ridge purlin fails} && (2) \end{aligned}$$

where

- $w_{ts}$  = failure load (lb/ft) of the single span purlins tested,
- $p_{ts}$  = failure load (psf) of the single span purlins tested,
- $p_d$  = weight of the specimen (psf),
- $s$  = tributary width of purlins tested (ft),
- $d$  = purlin depth (in),
- $B$  = maximum anticipated purlin spacing (in).
- $P_L$  = lateral anchorage force (lb/ft) in accordance with Section D6.3.1 of the AISI Specifications,

$$0.5 \left( \frac{C_2}{1000} \frac{I_{xy} L}{I_x d} + C_3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s \quad (3)$$

## DESCRIPTION OF TEST

b = flange width of the purlin (in),  
t = purlin thickness (in),  
 $I_x$  = moment of inertia of full unreduced section (in<sup>4</sup>):  
 $I_{xy}$  = product moment of inertia of full unreduced section (in<sup>4</sup>):  
L = purlin span (in)  
C2 = 8.3  
C3 = 33.

From the single span failure load,  $W_{ts}$ , the maximum single span failure moment  $M_{ts}$  is calculated as

$$M_{ts} = w_{ts} L^2/8 \quad (4)$$

Using Section C3.1.1(a) of the AISI Specification, the flexural strength of each tested purlin,  $M_{nt}$ , of a fully constrained beam is calculated as

$$M_{nt} = S_{et} F_{yt} \quad (5)$$

where  $S_{et}$  is the section modulus of the effective section calculated using the measured cross-sectional dimensions and  $F_{yt}$  is the measured yield strength.

The modification factor,  $R_t$ , is calculated for each purlin tested as

$$R_t = M_{ts}/M_{nt} \quad (6)$$

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## TEST RESULTS

### 3.1 SPECIMEN IDENTIFICATION

Panel Manufacturer:	CO Building Systems, Inc.
Model Type:	PBR Panel
Dimensions:	36" wide with 1.25" high major ribs at 12" o.c.
Panel Gauge:	26 ga.
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:	12" 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
Purlin Manufacturer:	CO Building Systems, Inc.
Purlin Profile:	Z 8" or 10" x 2.5" (Typical)
Purlin Thickness:	12, 14 and 16 ga.

## TEST RESULTS

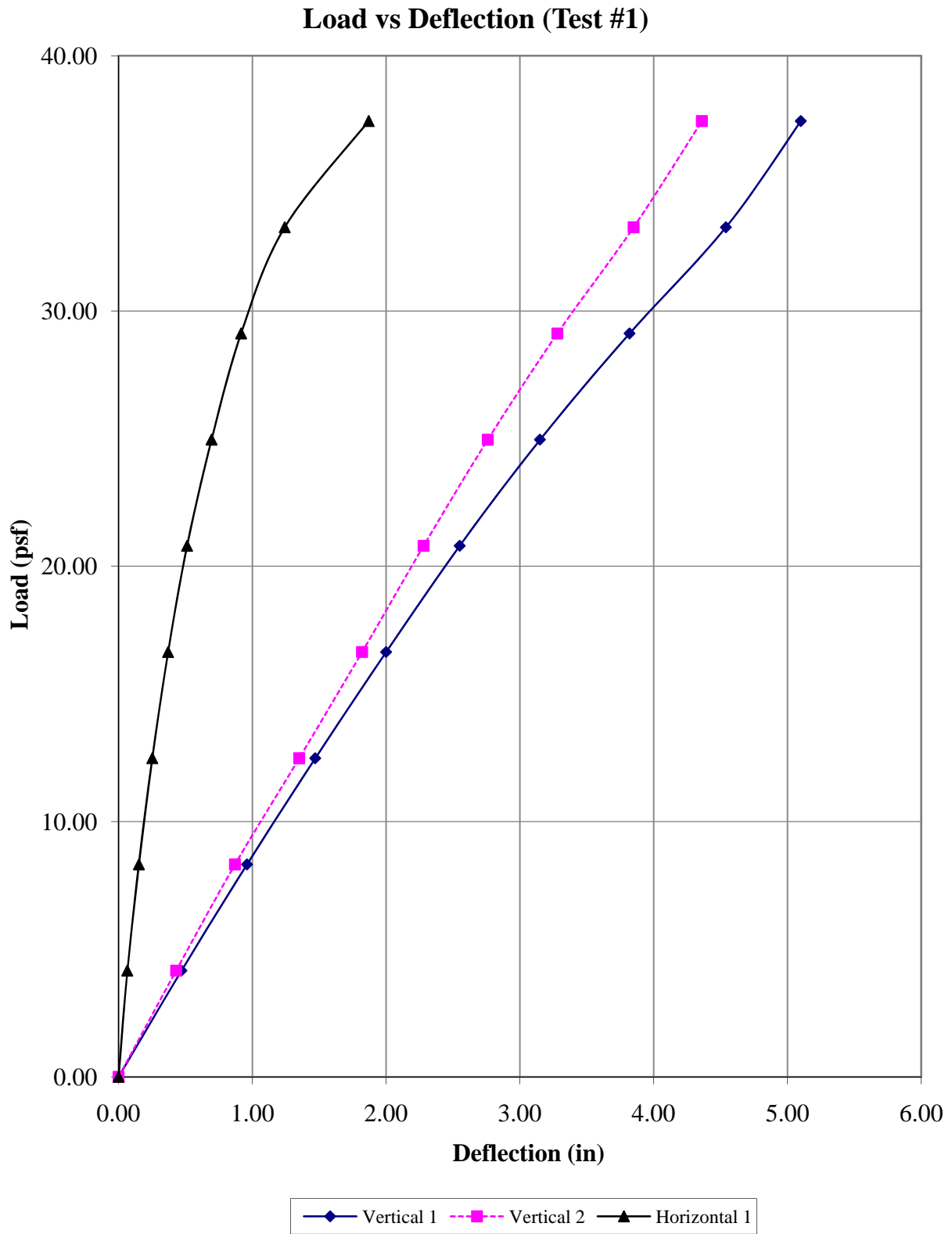
### 3.2 Test #1: 10Z12 with bracing 1

Date: 1.26.10  
 Test Number: 1  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 68.5  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.37  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 1 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	4.16	0.47	0.43	0.065	
3	8.32	0.96	0.87	0.152	
4	12.48	1.47	1.35	0.252	
5	16.64	2.00	1.82	0.370	
6	20.80	2.55	2.28	0.512	
7	24.96	3.15	2.76	0.695	
8	29.12	3.82	3.28	0.916	
9	33.28	4.54	3.85	1.242	
10	37.44	5.10	4.36	1.870	
11	41.60				Failure Load

Failure Mode: Purlin web bending at support

## TEST RESULTS



## TEST RESULTS

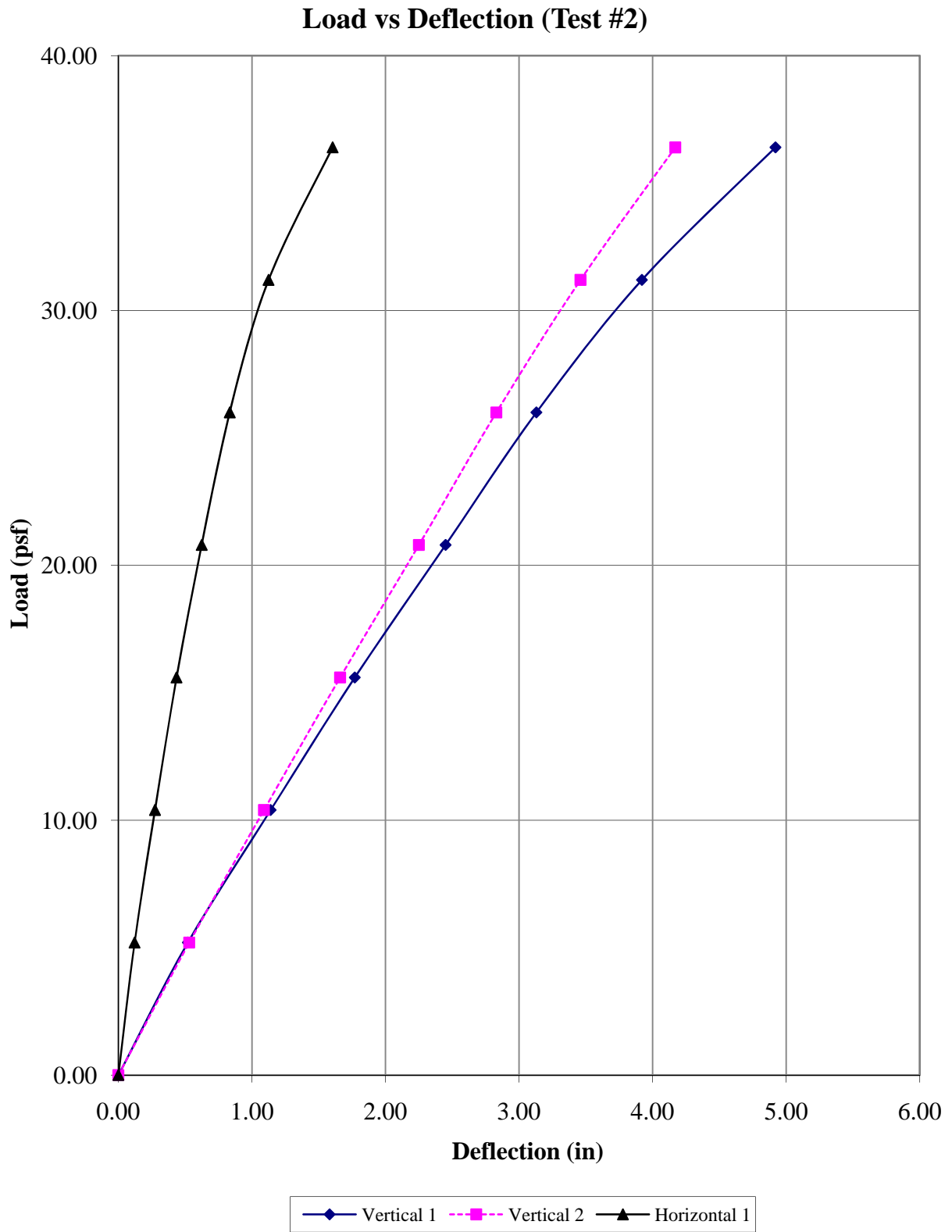
### 3.3 Test #2: 10Z12 with bracing 2

Date: 1.27.10  
 Test Number: 2  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 67.5  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.41  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 2 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.52	0.53	0.121	
3	10.40	1.14	1.09	0.274	
4	15.60	1.77	1.66	0.435	
5	20.80	2.45	2.25	0.624	
6	26.00	3.13	2.83	0.834	
7	31.20	3.92	3.46	1.124	
8	36.40	4.92	4.17	1.604	
9	40.09				Failure Load

Failure Mode: Purlin web bending at support

## TEST RESULTS





## TEST RESULTS

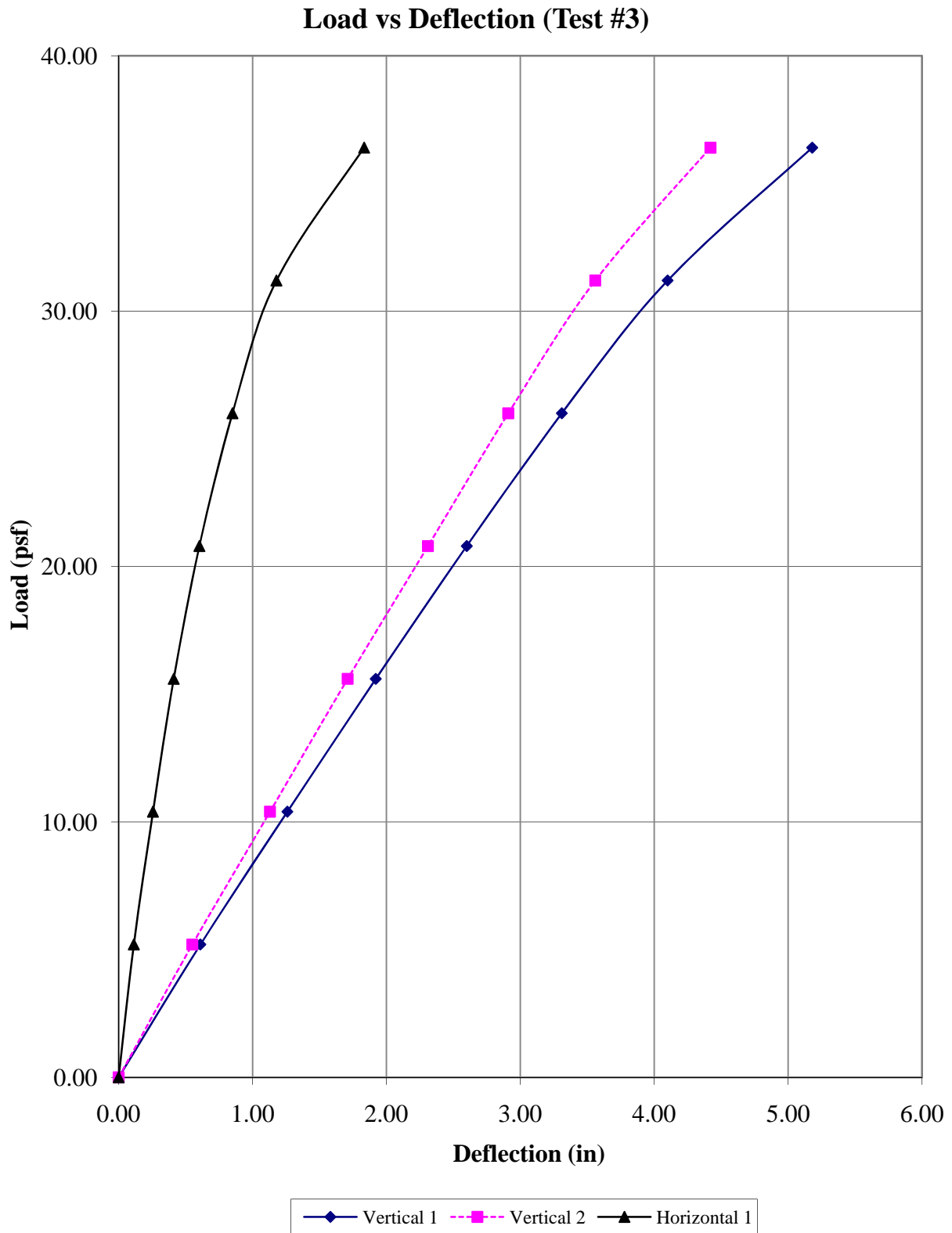
### 3.4 Test #3: 10Z12 with bracing 3

Date: 1.27.10  
 Test Number: 3  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 67  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.43  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.61	0.55	0.113	
3	10.40	1.26	1.13	0.256	
4	15.60	1.92	1.71	0.411	
5	20.80	2.60	2.31	0.603	
6	26.00	3.31	2.91	0.850	
7	31.20	4.10	3.56	1.178	
8	36.40	5.18	4.42	1.833	
9	39.05				Failure Load

Failure Mode: Purlin web bending at support

## TEST RESULTS



## TEST RESULTS

### 3.5 Test #4: 10Z12 with bracing 3 and plate

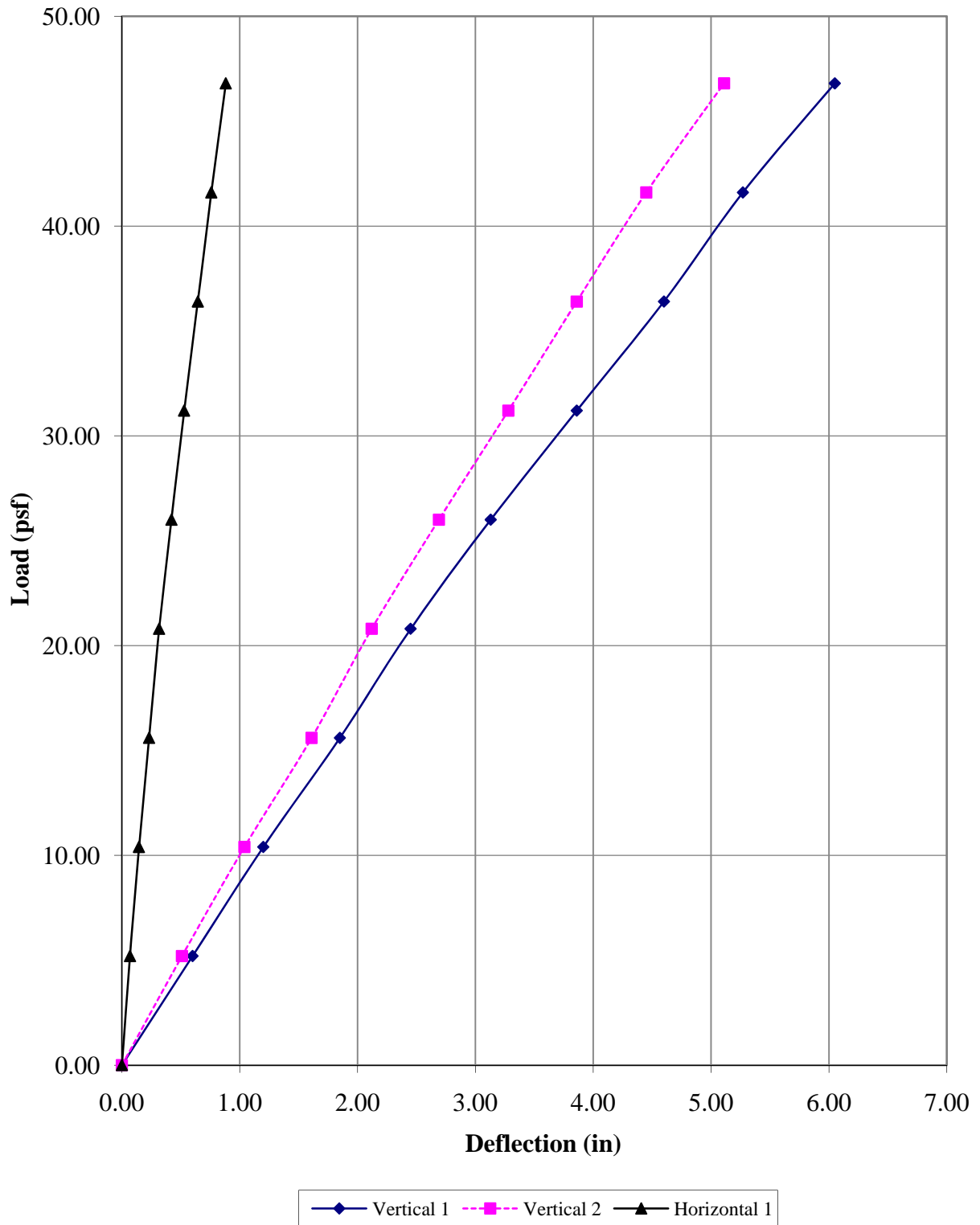
Date: 2.1.10  
 Test Number: 4  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 68.5  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.43  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.60	0.51	0.069	
3	10.40	1.20	1.04	0.145	
4	15.60	1.85	1.61	0.231	
5	20.80	2.45	2.12	0.316	
6	26.00	3.13	2.69	0.421	
7	31.20	3.86	3.28	0.528	
8	36.40	4.60	3.86	0.645	
9	41.60	5.27	4.45	0.759	
10	46.80	6.05	5.11	0.882	
11	48.36				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #4)



## TEST RESULTS

### 3.6 Test #5: 10Z12 with bracing 3 and plate

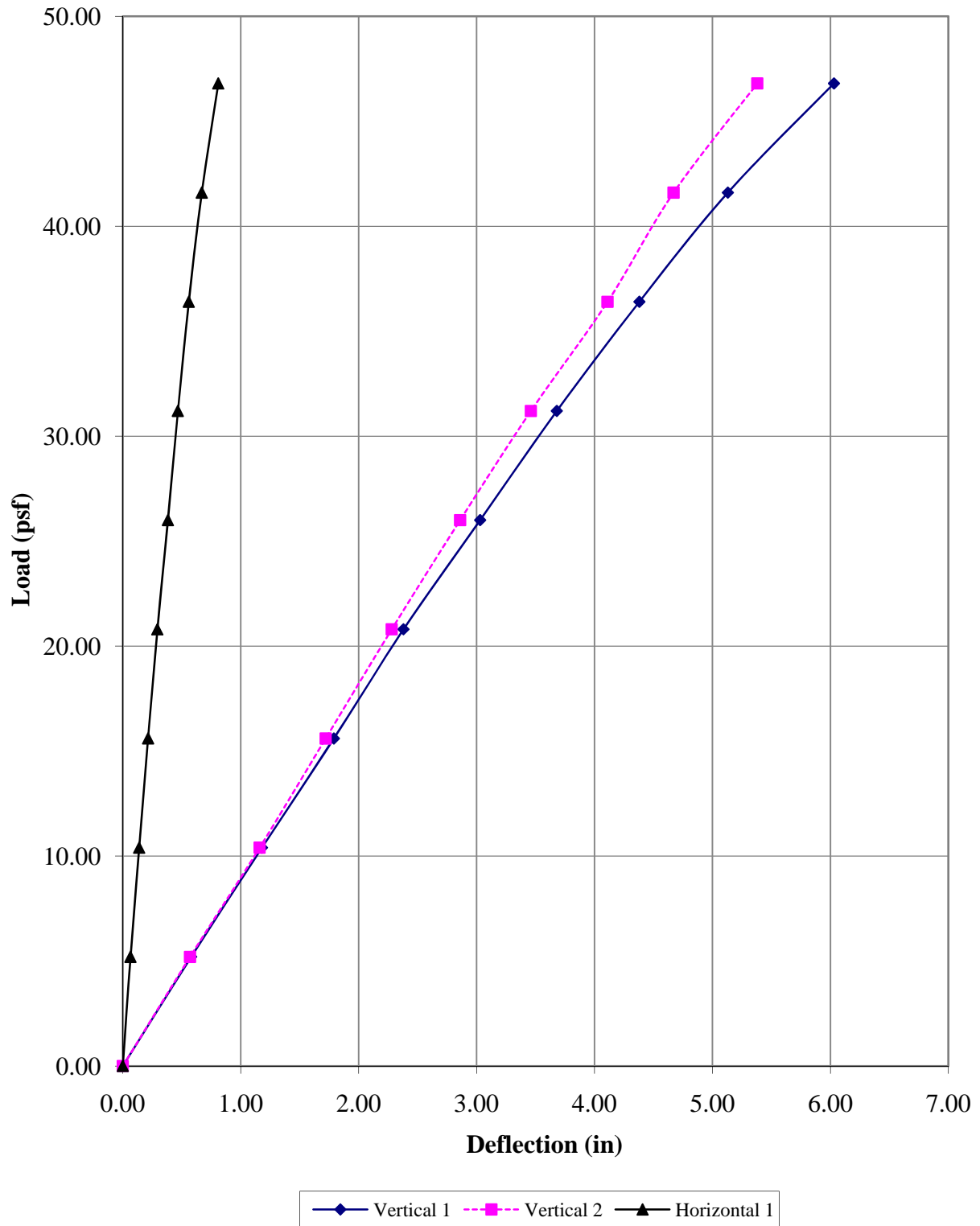
Date: 2.2.10  
 Test Number: 5  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 65.5  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.45  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.58	0.57	0.065	
3	10.40	1.18	1.16	0.139	
4	15.60	1.79	1.72	0.215	
5	20.80	2.38	2.28	0.293	
6	26.00	3.03	2.86	0.383	
7	31.20	3.68	3.46	0.467	
8	36.40	4.38	4.11	0.560	
9	41.60	5.13	4.67	0.670	
10	46.80	6.03	5.38	0.810	
11	49.92				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #5)



## TEST RESULTS

### 3.7 Test #6: 10Z12 with bracing 3 and plate

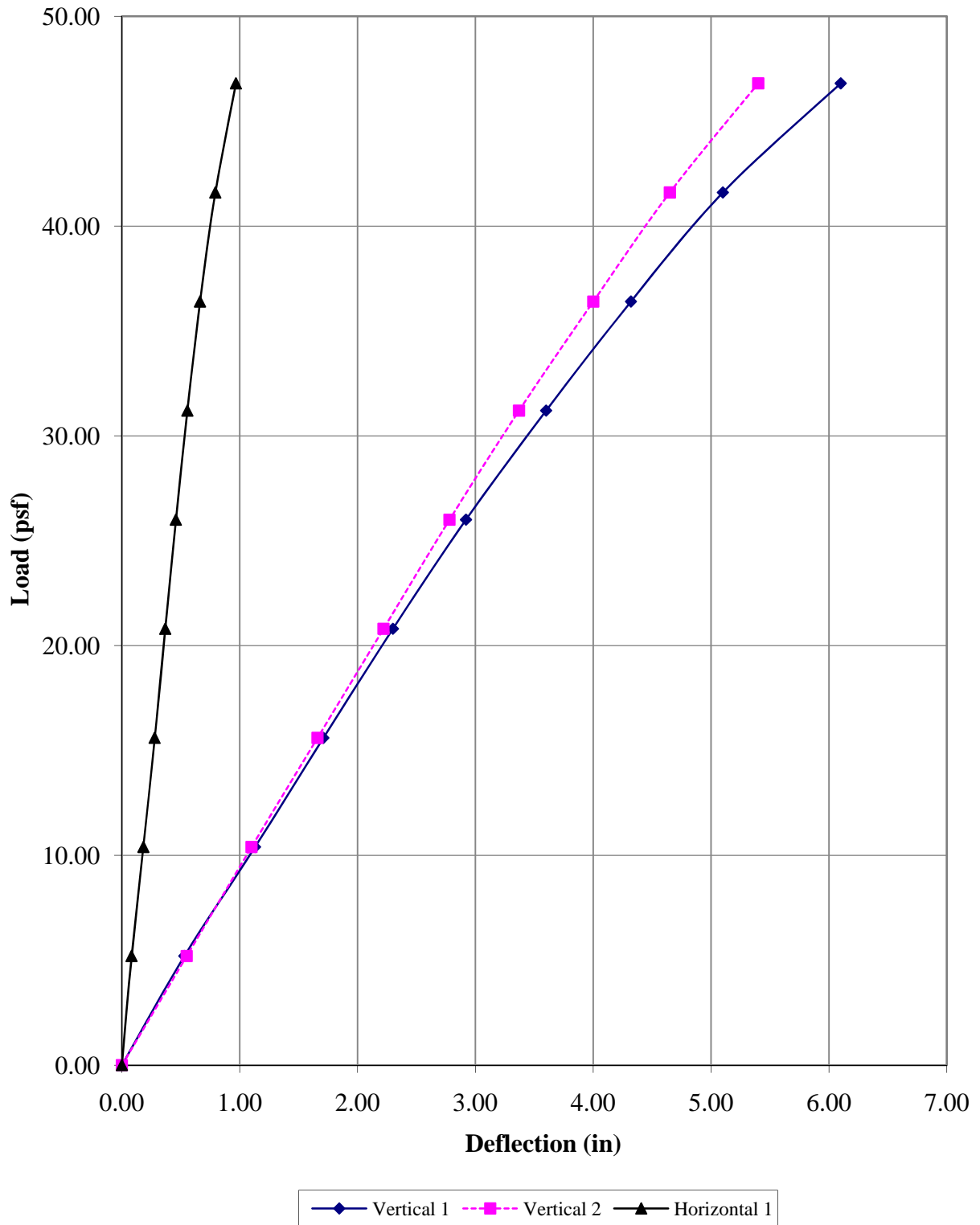
Date: 2.2.10  
 Test Number: 6  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 65  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.52  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.53	0.55	0.082	
3	10.40	1.13	1.10	0.183	
4	15.60	1.71	1.66	0.278	
5	20.80	2.30	2.22	0.368	
6	26.00	2.92	2.78	0.458	
7	31.20	3.60	3.37	0.556	
8	36.40	4.32	4.00	0.663	
9	41.60	5.10	4.65	0.793	
10	46.80	6.10	5.40	0.968	
11	49.19				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #6)





## TEST RESULTS

### 3.8 Test #7: 10Z12 with Retro-fit bracing and plate

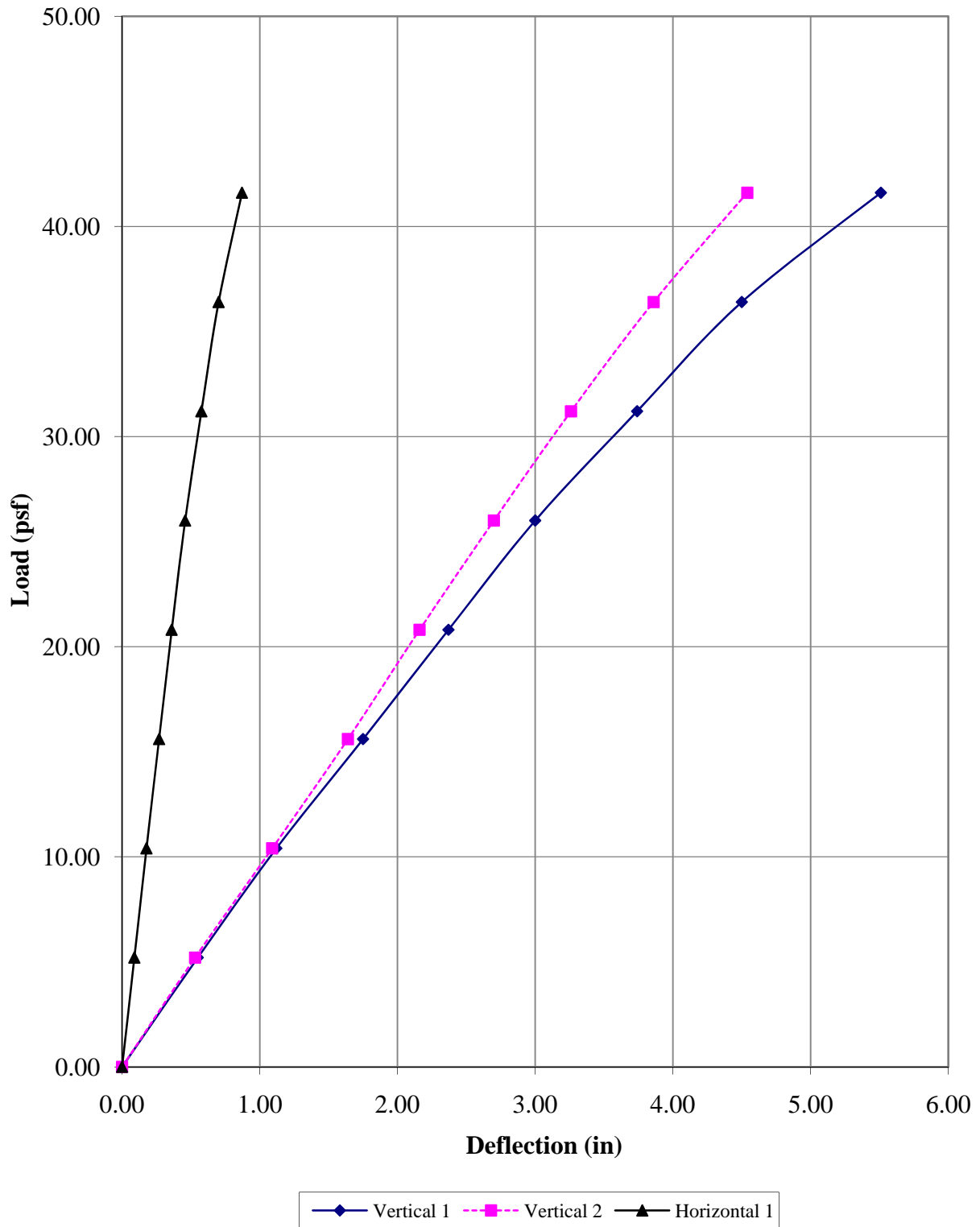
Date: 2.3.10  
 Test Number: 7  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 65.5  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.51  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Retro Fit Bracing at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.55	0.53	0.089	
3	10.40	1.12	1.09	0.177	
4	15.60	1.75	1.64	0.269	
5	20.80	2.37	2.16	0.360	
6	26.00	3.00	2.70	0.458	
7	31.20	3.74	3.26	0.576	
8	36.40	4.50	3.86	0.701	
9	41.60	5.51	4.54	0.871	
10	43.89				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #7)



## TEST RESULTS

### 3.9 Test #8: 8Z14

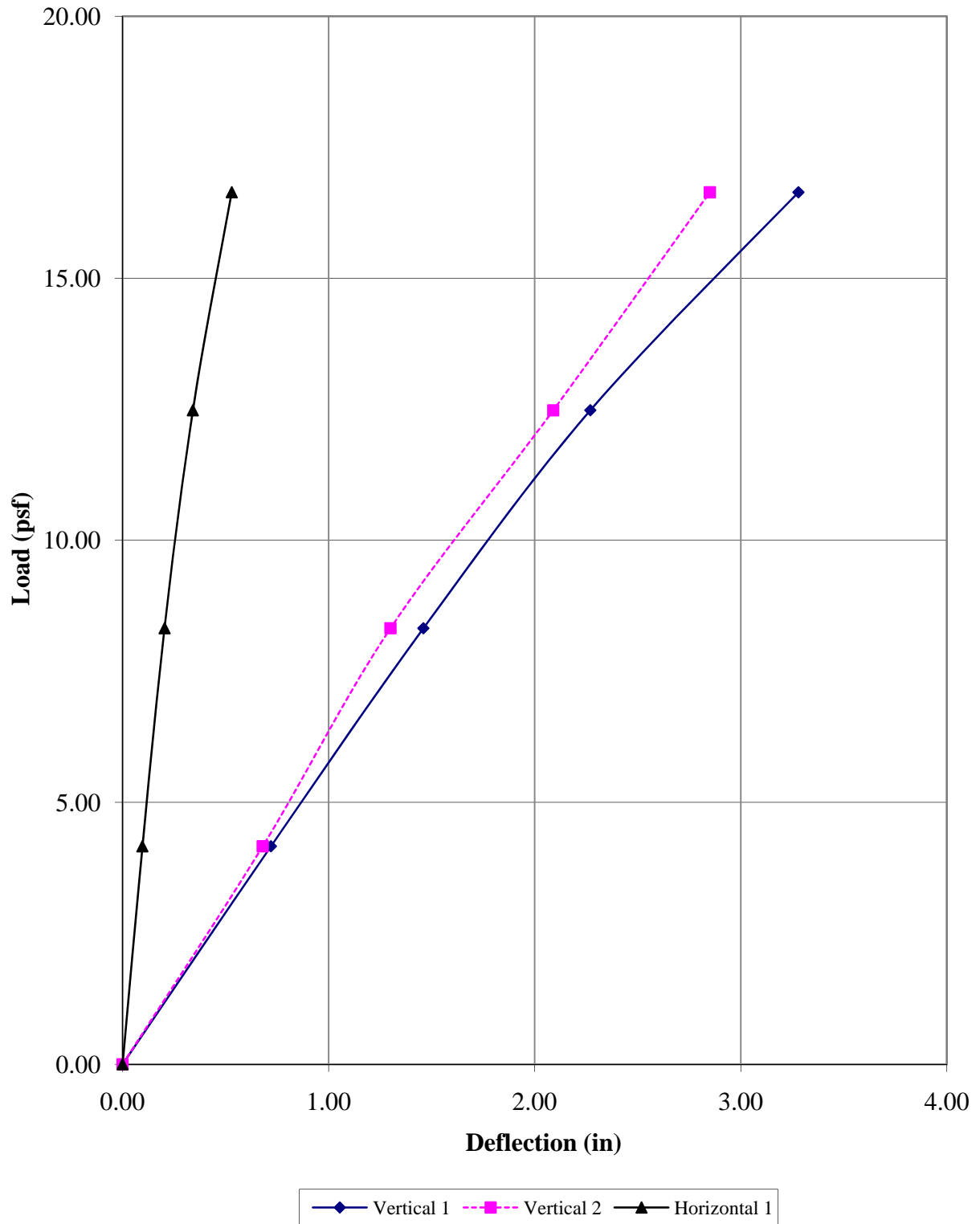
Date: 2.4.10  
 Test Number: 8  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 8" x 2.5"  
 Purlin Thickness: 14 ga.  
 Yield Stress (ksi): 59.5  
 Purlin Span (ft): 27  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 3.23  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: None

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	4.16	0.72	0.68	0.096	
3	8.32	1.46	1.30	0.204	
4	12.48	2.27	2.09	0.341	
5	16.64	3.28	2.85	0.530	
6	20.49				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #8)



## TEST RESULTS

### 3.10 Test #9: 8Z16

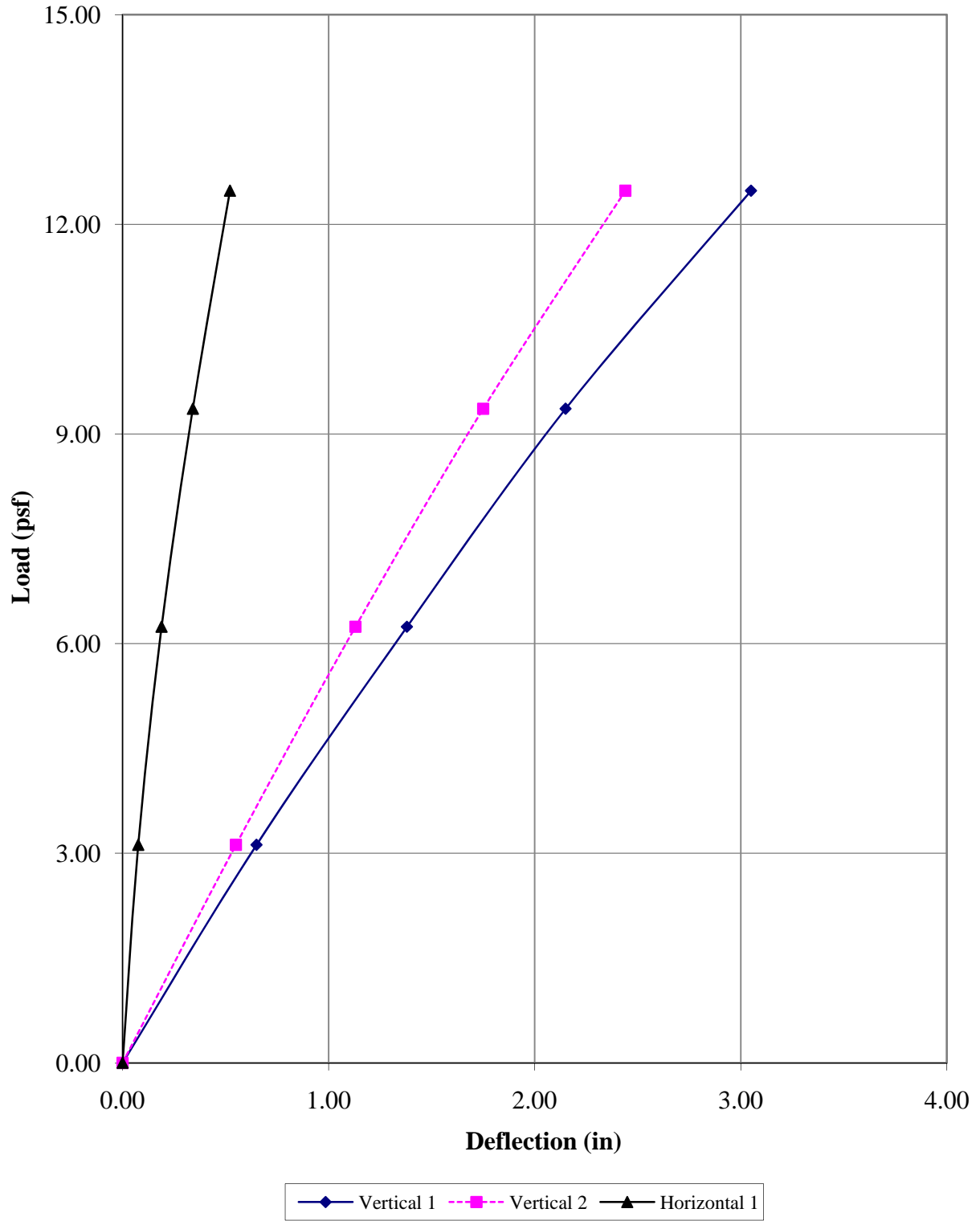
Date: 2.4.10  
Test Number: 9  
Panel Type: CO Buildings PBR Panel  
Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
Panel Span (ft): 5' 0"  
Panel Length (ft): 7' 0"  
Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
Purlin Size: Zee 8" x 2.5"  
Purlin Thickness: 16 ga.  
Yield Stress (ksi): 63  
Purlin Span (ft): 27  
Panel Weight (psf): 0.88  
Purlin Weight (lb/ft): 2.53  
Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
Bracing: None

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	3.12	0.65	0.55	0.076	
3	6.24	1.38	1.13	0.189	
4	9.36	2.15	1.75	0.341	
5	12.48	3.05	2.44	0.521	
6	14.56				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #9)



## TEST RESULTS

### 3.11 Test #10: 10Z12 with bracing 3 and plate (Uplift)

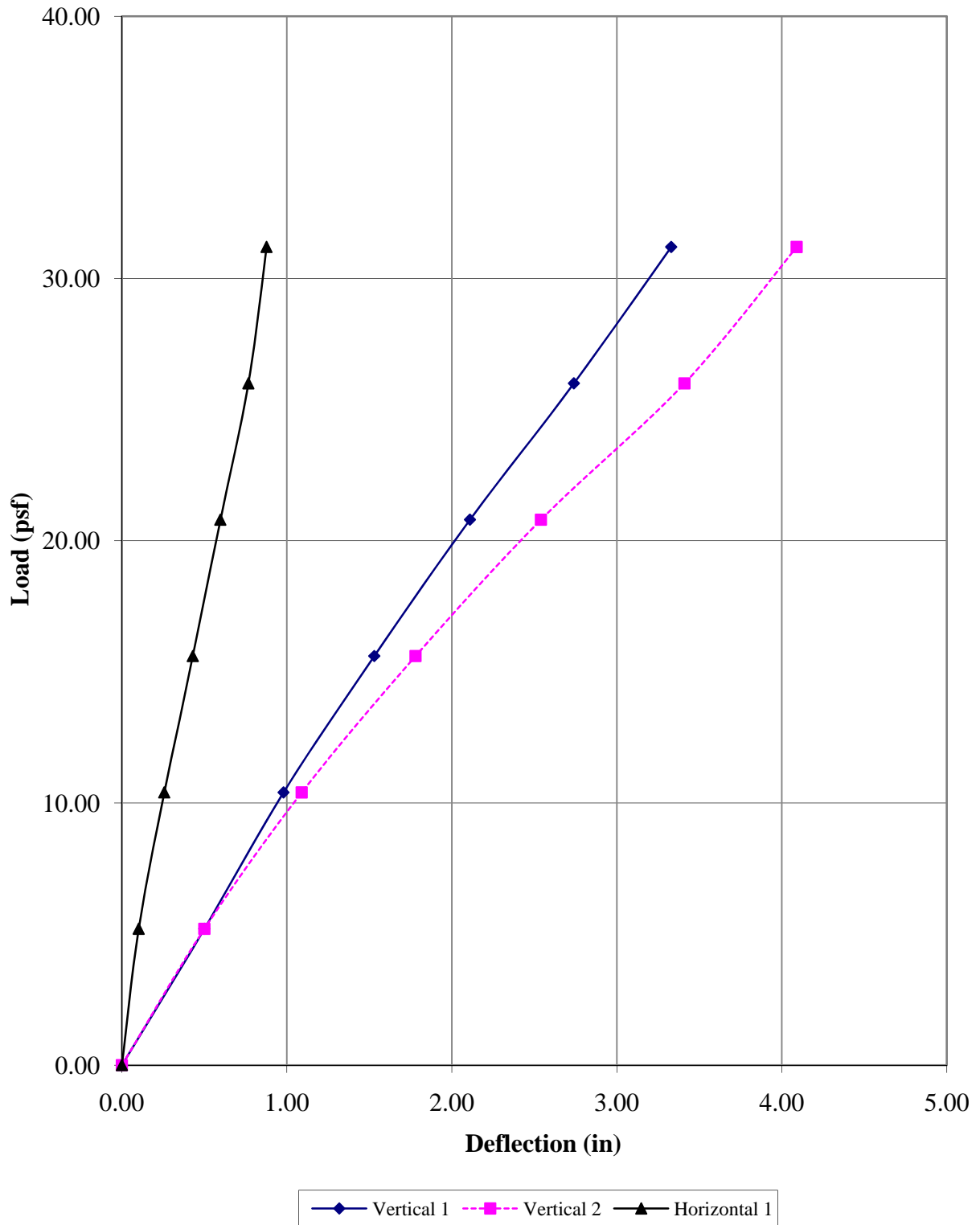
Date: 2.5.10  
 Test Number: 10 Uplift  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 68  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.44  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.50	0.50	0.102	
3	10.40	0.98	1.09	0.257	
4	15.60	1.53	1.78	0.430	
5	20.80	2.11	2.54	0.597	
6	26.00	2.74	3.41	0.767	
7	31.20	3.33	4.09	0.877	
8	36.40				Failure Load

Failure Mode: Bottom flange lip of ridge purlin buckled at 5' left of mid span

## TEST RESULTS

### Load vs Deflection (Test #10)





## TEST RESULTS

### 3.12 Test #11: 10Z12 with bracing 3, plate and without 3" thick insulation

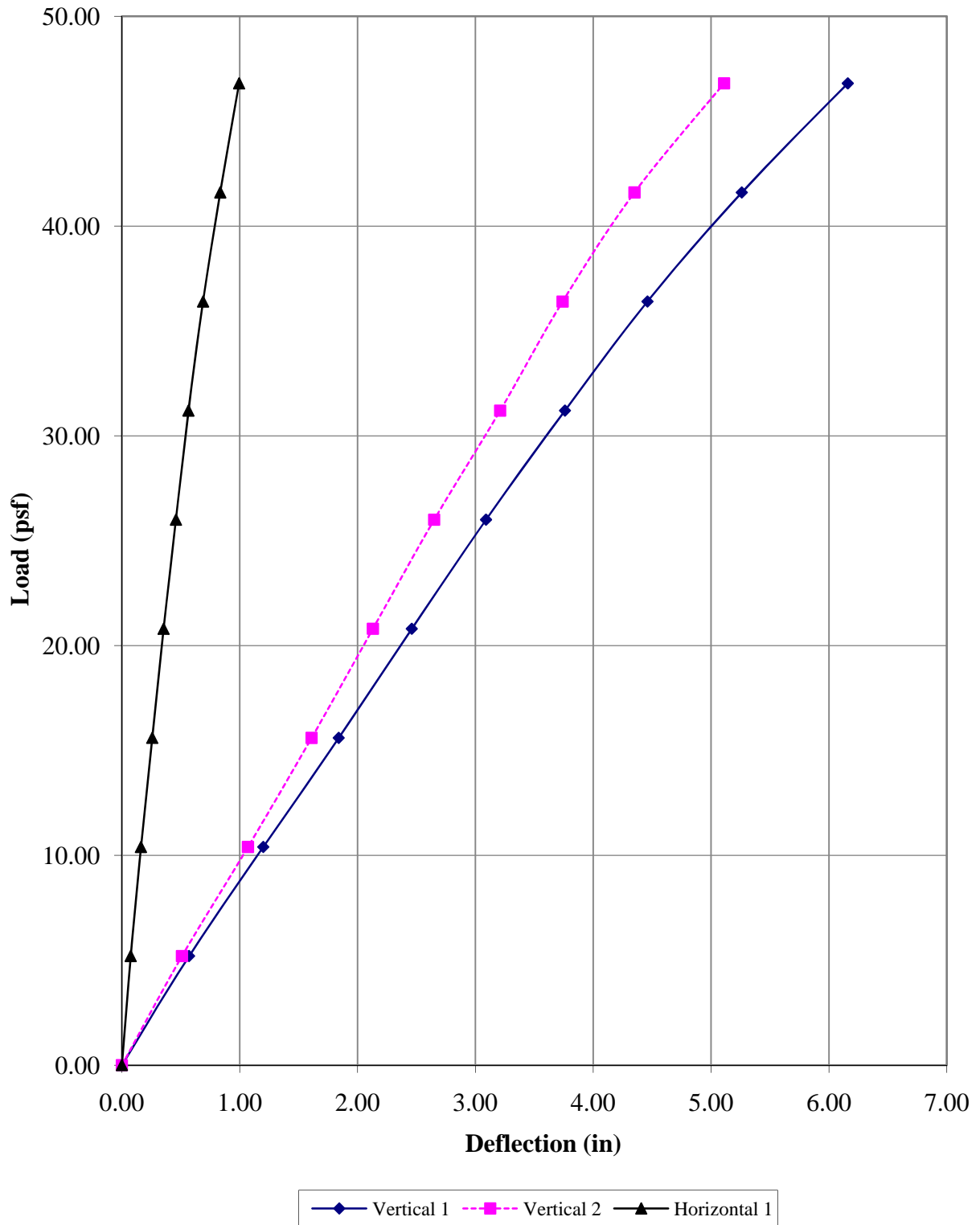
Date: 2.23.10  
 Test Number: 11  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 68  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.42  
 Purlin-Frame Attachment: Welded anti roll clip at eave & ridge  
 Bracing: Brace option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.57	0.51	0.075	
3	10.40	1.20	1.07	0.162	
4	15.60	1.84	1.61	0.258	
5	20.80	2.46	2.13	0.354	
6	26.00	3.09	2.65	0.459	
7	31.20	3.76	3.21	0.565	
8	36.40	4.46	3.74	0.689	
9	41.60	5.26	4.35	0.835	
10	46.80	6.16	5.11	0.995	
11	48.36				Failure Load

Failure Mode: Top flange of eave purlin buckled near mid span

## TEST RESULTS

### Load vs Deflection (Test #11)



## TEST RESULTS

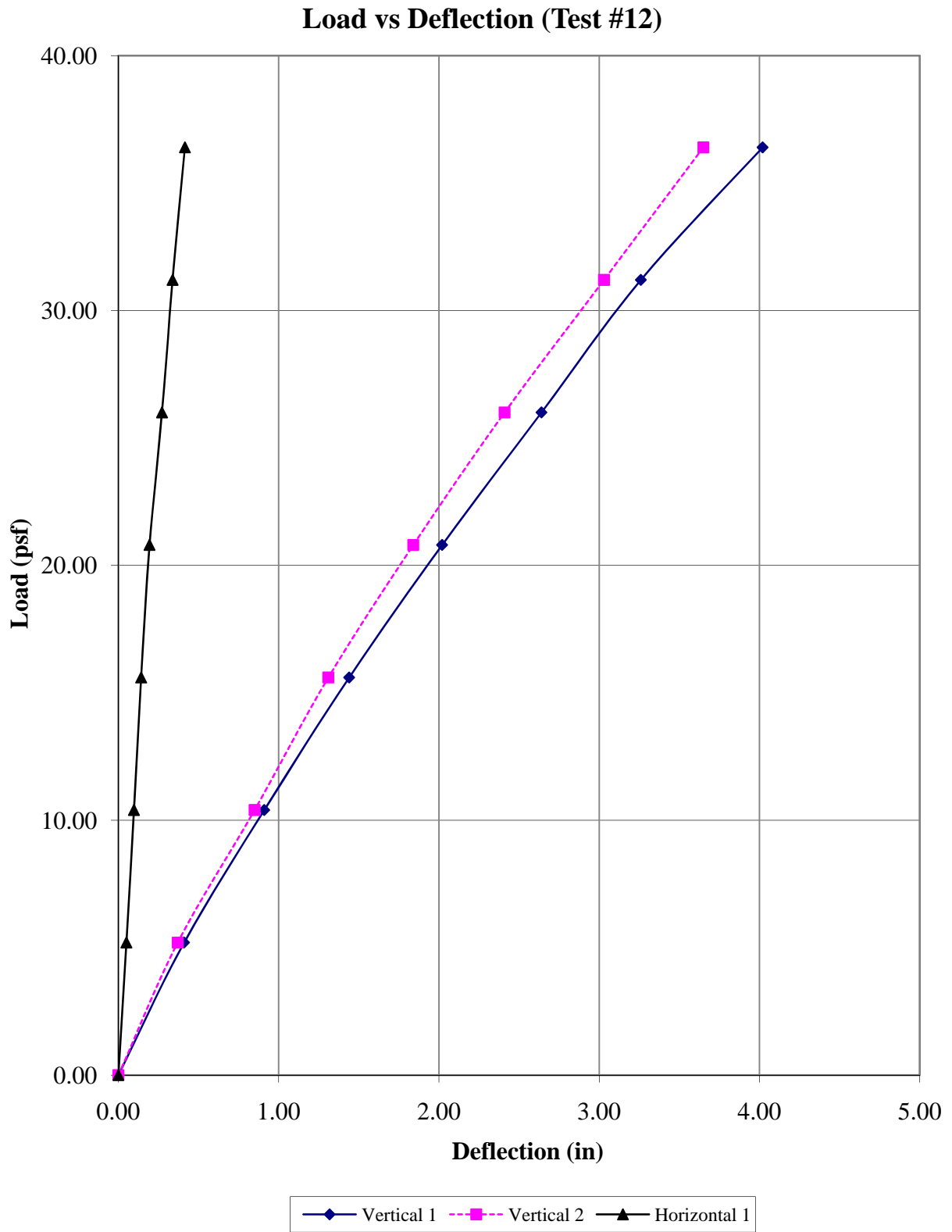
### 3.13 Test #12: 10Z12 with bracing 3, plate and 3 bolts (Uplift)

Date: 2.24.10  
 Test Number: 12 Uplift  
 Panel Type: CO Buildings PBR Panel  
 Panel Fasteners: #12 x 2" long SDS @ 12" o.c.  
 Sidelap Fasteners: 1/4" x 7/8" long SDS @ 12" o.c.  
 Panel Span (ft): 5' 0"  
 Panel Length (ft): 7' 0"  
 Insulation: 4" Insulation, Sealed N Safe, 3" Insulation  
 Purlin Size: Zee 10" x 2.5"  
 Purlin Thickness: 12 ga.  
 Yield Stress (ksi): 68  
 Purlin Span (ft): 30  
 Panel Weight (psf): 0.88  
 Purlin Weight (lb/ft): 5.39  
 Purlin-Frame Attachment: Welded antiroll clip at eave & ridge with 7" high plate with 2 bolts at bottom and 1 bolt at top  
 Bracing: Bracing option 3 at mid span

No	Pressure (psf)	Deflection Reading (in)			Remarks
		Vertical 1	Vertical 2	Horizontal 1	
1	0.00	0.00	0.00	0.000	
2	5.20	0.41	0.37	0.050	
3	10.40	0.91	0.85	0.097	
4	15.60	1.44	1.31	0.142	
5	20.80	2.02	1.84	0.194	
6	26.00	2.64	2.41	0.272	
7	31.20	3.26	3.03	0.338	
8	36.40	4.02	3.65	0.415	
9	41.39				Failure Load

Failure Mode: Bottom flange lip of eave purlin buckled near mid span

## TEST RESULTS



## TEST RESULTS

### 3.7 MODIFICATION FACTOR CALCULATION

#### 3.7.1 MODIFICATION FACTOR FOR TEST #1

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.500
Purlin thickness 't' (in):	0.100
Measured yield stress 'F <sub>yt</sub> ' (ksi):	68.5
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	41.600
Specimen weight 'p <sub>d</sub> ' (psf):	2.415
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.144
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.243
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	4.937
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	7.08
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	166.84
M <sub>ts</sub> (kip.in)	225.24
M <sub>nt</sub> (kip.in)	283.86
Modification Factor 'R <sub>t</sub> ':	0.793

## TEST RESULTS

### 3.7.2 MODIFICATION FACTOR FOR TEST #2

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.500
Purlin thickness 't' (in):	0.101
Measured yield stress 'F <sub>yt</sub> ' (ksi):	67.5
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	40.087
Specimen weight 'p <sub>d</sub> ' (psf):	2.426
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.114
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.392
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	4.935
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	6.82
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	161.14
M <sub>ts</sub> (kip.in)	217.54
M <sub>nt</sub> (kip.in)	277.72
Modification Factor 'R <sub>t</sub> ':	0.783

## TEST RESULTS

### 3.7.3 MODIFICATION FACTOR FOR TEST #3

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.100
Measured yield stress 'F <sub>yt</sub> ' (ksi):	67.0
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	39.052
Specimen weight 'p <sub>d</sub> ' (psf):	2.433
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.119
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.529
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.590
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	7.36
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	157.48
M <sub>ts</sub> (kip.in)	212.60
M <sub>nt</sub> (kip.in)	275.94
Modification Factor 'R <sub>t</sub> ':	0.770

## TEST RESULTS

### 3.7.4 MODIFICATION FACTOR FOR TEST #4

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.101
Measured yield stress 'F <sub>yt</sub> ' (ksi):	68.5
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	48.360
Specimen weight 'p <sub>d</sub> ' (psf):	2.431
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.137
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.439
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.004
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	8.32
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	192.58
M <sub>ts</sub> (kip.in)	259.98
M <sub>nt</sub> (kip.in)	283.36
Modification Factor 'R <sub>t</sub> ':	0.918



## TEST RESULTS

### 3.7.5 MODIFICATION FACTOR FOR TEST #5

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.101
Measured yield stress 'F <sub>yt</sub> ' (ksi):	65.5
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	49.920
Specimen weight 'p <sub>d</sub> ' (psf):	2.438
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.184
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.585
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.488
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	9.16
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	198.71
M <sub>ts</sub> (kip.in)	268.26
M <sub>nt</sub> (kip.in)	274.07
Modification Factor 'R <sub>t</sub> ':	0.979

## TEST RESULTS

### 3.7.6 MODIFICATION FACTOR FOR TEST #6

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.102
Measured yield stress 'F <sub>yt</sub> ' (ksi):	65.0
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	49.192
Specimen weight 'p <sub>d</sub> ' (psf):	2.458
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.256
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.939
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.239
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	8.64
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	195.90
M <sub>ts</sub> (kip.in)	264.46
M <sub>nt</sub> (kip.in)	276.62
Modification Factor 'R <sub>t</sub> ':	0.956

## TEST RESULTS

### 3.7.7 MODIFICATION FACTOR FOR TEST #7

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.102
Measured yield stress 'F <sub>yt</sub> ' (ksi):	65.5
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	43.888
Specimen weight 'p <sub>d</sub> ' (psf):	2.453
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.184
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.821
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.551
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	8.13
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	175.89
M <sub>ts</sub> (kip.in)	237.45
M <sub>nt</sub> (kip.in)	274.02
Modification Factor 'R <sub>t</sub> ':	0.867

## TEST RESULTS

### 3.7.8 MODIFICATION FACTOR FOR TEST #8

Purlin depth 'd' (in):	8.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.068
Measured yield stress 'F <sub>yt</sub> ' (ksi):	59.5
Purlin span 'L' (ft):	27.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	20.488
Specimen weight 'p <sub>d</sub> ' (psf):	1.804
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	1.947
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	9.155
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	2.904
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	5.35
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	84.73
M <sub>ts</sub> (kip.in)	92.65
M <sub>nt</sub> (kip.in)	115.84
Modification Factor 'R <sub>t</sub> ':	0.800

## TEST RESULTS

### 3.7.9 MODIFICATION FACTOR FOR TEST #9

Purlin depth 'd' (in):	8.000
Purlin flange width 'b' (in):	2.560
Purlin thickness 't' (in):	0.053
Measured yield stress 'F <sub>yt</sub> ' (ksi):	63.0
Purlin span 'L' (ft):	27.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	14.560
Specimen weight 'p <sub>d</sub> ' (psf):	1.603
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	1.287
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	7.032
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	2.736
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	4.43
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	61.58
M <sub>ts</sub> (kip.in)	67.34
M <sub>nt</sub> (kip.in)	81.05
Modification Factor 'R <sub>t</sub> ':	0.831

## TEST RESULTS

### 3.7.10 MODIFICATION FACTOR FOR TEST #10

Purlin depth 'd' (in):	10.000
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.100
Measured yield stress 'F <sub>yt</sub> ' (ksi):	68.0
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	36.400
Specimen weight 'p <sub>d</sub> ' (psf):	2.453
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.132
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.650
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.235
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} - p_d) s$	5.70
$w_{ts} \text{ (lb/ft)} = (p_{ts} - p_d) s$	126.86
M <sub>ts</sub> (kip.in)	171.26
M <sub>nt</sub> (kip.in)	281.00
Modification Factor 'R <sub>t</sub> ':	0.609

## TEST RESULTS

### 3.7.11 MODIFICATION FACTOR FOR TEST #11

Purlin depth 'd' (in):	10.030
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.100
Measured yield stress 'F <sub>yt</sub> ' (ksi):	68.5
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.737
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	48.360
Specimen weight 'p <sub>d</sub> ' (psf):	2.429
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.137
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.798
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.153
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} + p_d) s$	8.36
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	192.59
M <sub>ts</sub> (kip.in)	260.00
M <sub>nt</sub> (kip.in)	283.41
Modification Factor 'R <sub>t</sub> ':	0.917

## TEST RESULTS

### 3.7.12 MODIFICATION FACTOR FOR TEST #12

Purlin depth 'd' (in):	10.030
Purlin flange width 'b' (in):	2.625
Purlin thickness 't' (in):	0.100
Measured yield stress 'F <sub>yt</sub> ' (ksi):	68.0
Purlin span 'L' (ft):	30.000
Maximum anticipated purlin spacing 'B' (ft):	5.000
Tributary width of purlin tested 's' (ft):	3.789
Failure load of single span system tested 'p <sub>ts</sub> ' (psf):	41.392
Specimen weight 'p <sub>d</sub> ' (psf):	2.419
Effective section modulus 'S <sub>et</sub> ' (in <sup>3</sup> ):	4.058
Moment of inertia of full unreduced section I <sub>x</sub> (in <sup>4</sup> ):	22.498
Product moment of inertia of full unreduced section I <sub>xy</sub> (in <sup>4</sup> ):	5.003
C2 from Specification Table D6.3.1-1	8.2
C3 from Specification Table D6.3.1-1	33.0
$P_L \text{ (lb/ft)} = 0.5 \left( \frac{C2}{1000} \frac{I_{xy} L}{I_x d} + C3 \frac{0.25bt}{d^2} \right) (p_{ts} - p_d) s$	6.42
$w_{ts} \text{ (lb/ft)} = (p_{ts} + p_d) s + 2P_L (d/B)$	149.81
M <sub>ts</sub> (kip.in)	202.25
M <sub>nt</sub> (kip.in)	275.94
Modification Factor 'R <sub>t</sub> ':	0.733



## PHOTOGRAPHS



**PHOTO 1** View of the purlin-frame attachment for Test #1, 2, 3, 8 & 9.  
(DSC00001)



**PHOTO 2** View of the panel attachment.  
(DSC00003)

## PHOTOGRAPHS



**PHOTO 3** View of the test setup prior to failure.  
(DSC00108)



**PHOTO 4** View of the test setup at failure.  
(DSC00110)



## PHOTOGRAPHS



**PHOTO 5** View of the web bending failure of 12 ga. 10" deep Zee purlin (Test #1). (DSC00081)



**PHOTO 6** View of the web bending failure of 12 ga. 10" deep Zee purlin (Test #2). (DSC00091)



## PHOTOGRAPHS



**PHOTO 7** View of the web bending failure of 12 ga. 10" deep Zee purlin (Test #3).  
(DSC00091)



**PHOTO 8** View of the purlin-frame attachment for Test #4, 5, 6, 7, 10 & 11.  
(DSC00102)



## PHOTOGRAPHS



**PHOTO 9** View of attachment of bracing option 3 at midspan.  
(DSC00146)



**PHOTO 10** View of the flange buckling failure of 12 ga. 10" deep Zee purlin (Test #4).  
(DSC00112)



## PHOTOGRAPHS



**PHOTO 11** View of the flange buckling failure of 12 ga. 10" deep Zee purlin (Test #5). (DSC00034)



**PHOTO 12** View of the flange buckling failure of 12 ga. 10" deep Zee purlin (Test #6). (DSC00037)



## PHOTOGRAPHS



**PHOTO 13** View of attachment of retrofit bracing at midspan.  
(DSC00128)



**PHOTO 14** View of the flange buckling failure of 12 ga. 10" deep Zee purlin (Test #7).  
(DSC00132)



## PHOTOGRAPHS



**PHOTO 15** View of the flange buckling failure of 14 ga. 8" deep Zee purlin (Test #8). (DSC00137)



**PHOTO 16** View of the flange buckling failure of 14 ga. 8" deep Zee purlin (Test #9). (DSC00141)



## PHOTOGRAPHS



**PHOTO 17** View of Test #10 under uplift load.  
(DSC00150)



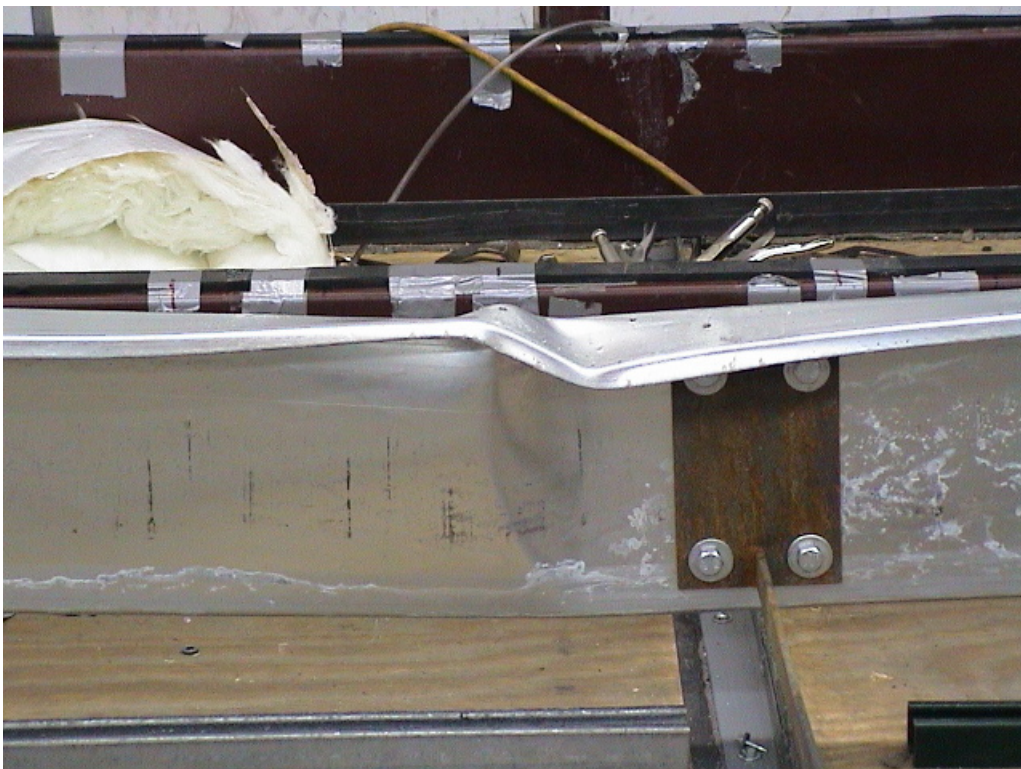
**PHOTO 18** View of the bottom lip buckling failure of 12 ga. 10" deep Zee purlin (Test #10).  
(DSC00152)



## PHOTOGRAPHS



**PHOTO 19** View of the Sealed 'N' Safe™ thermal block attachment to purlin without 3" thick insulation. (DSC00025)



**PHOTO 20** View of the flange buckling failure of 12 ga. 10" deep Zee purlin (Test #11). (DSC00031)



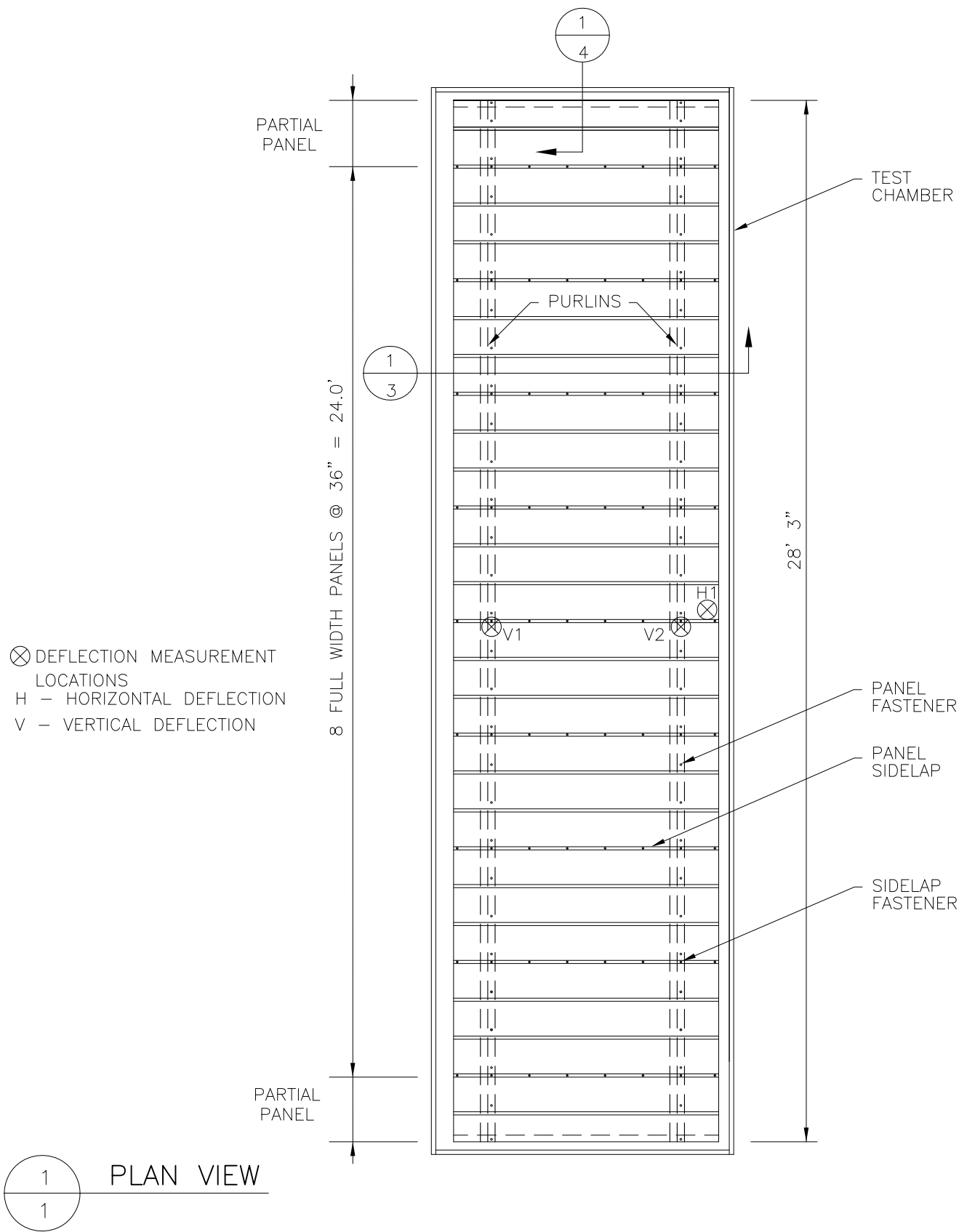
## PHOTOGRAPHS



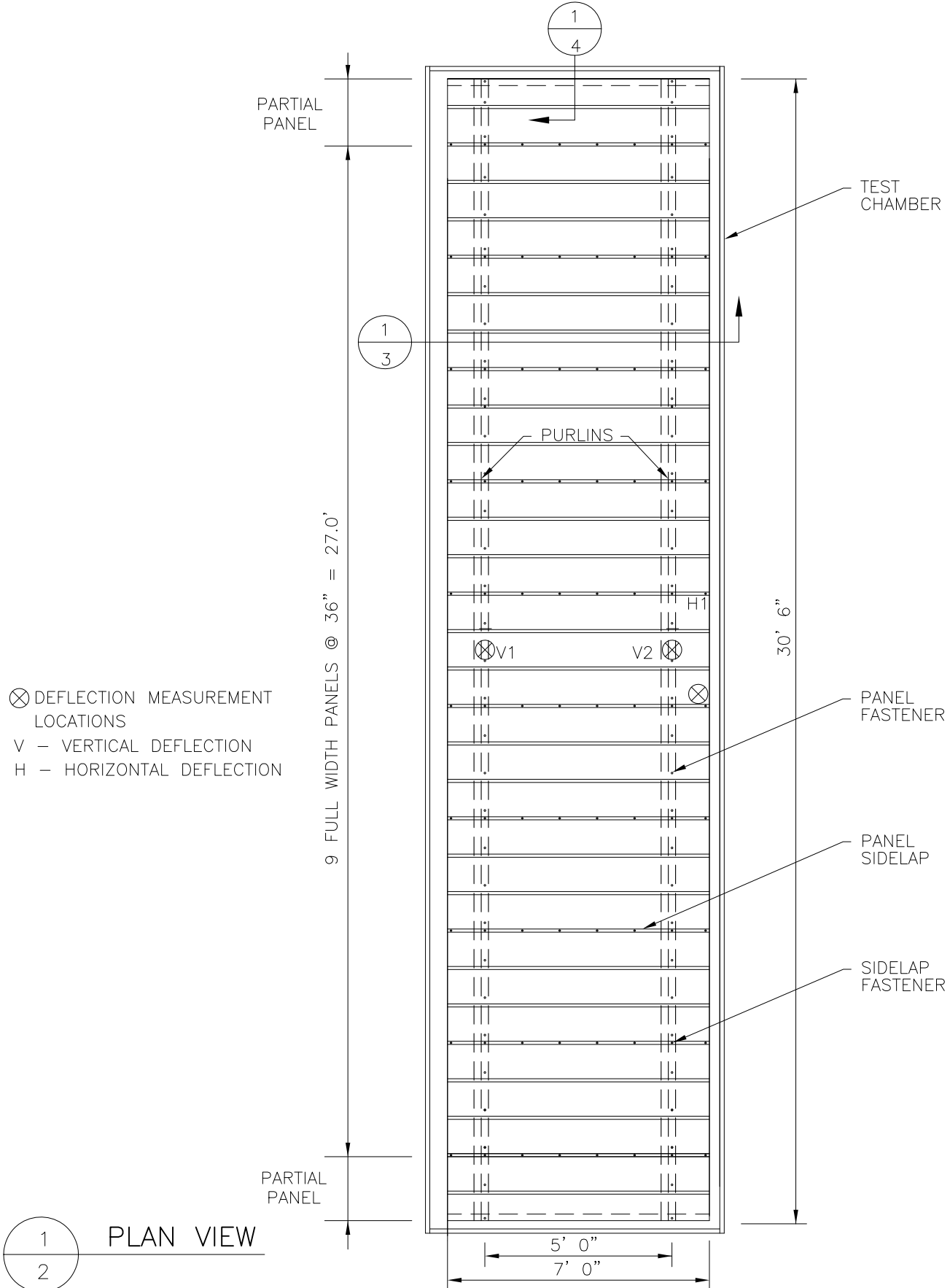
**PHOTO 21** View of the purlin-frame attachment for Test #12.  
(DSC00036)

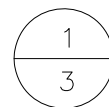
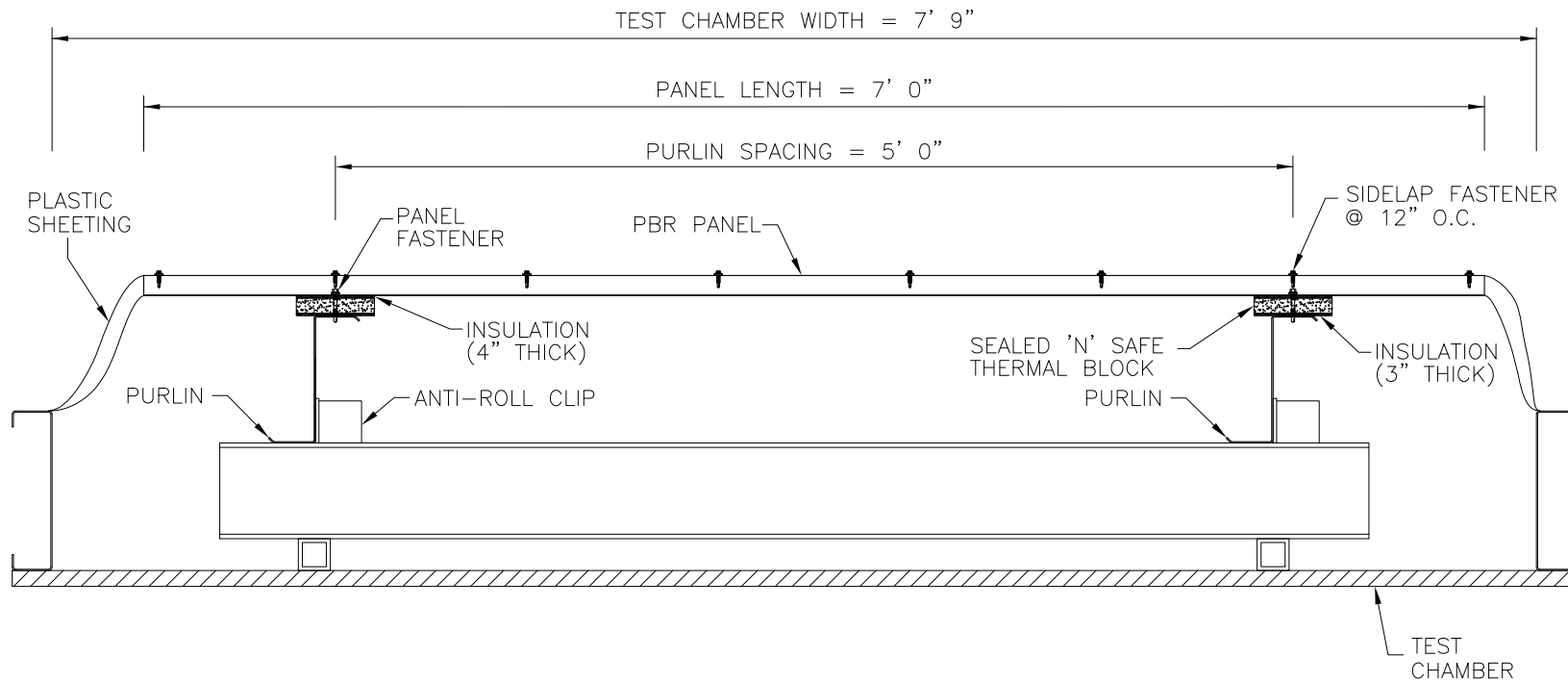


**PHOTO 22** View of the bottom lip buckling failure of 12 ga. 10" deep Zee purlin (Test #12).  
(DSC00038)



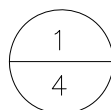
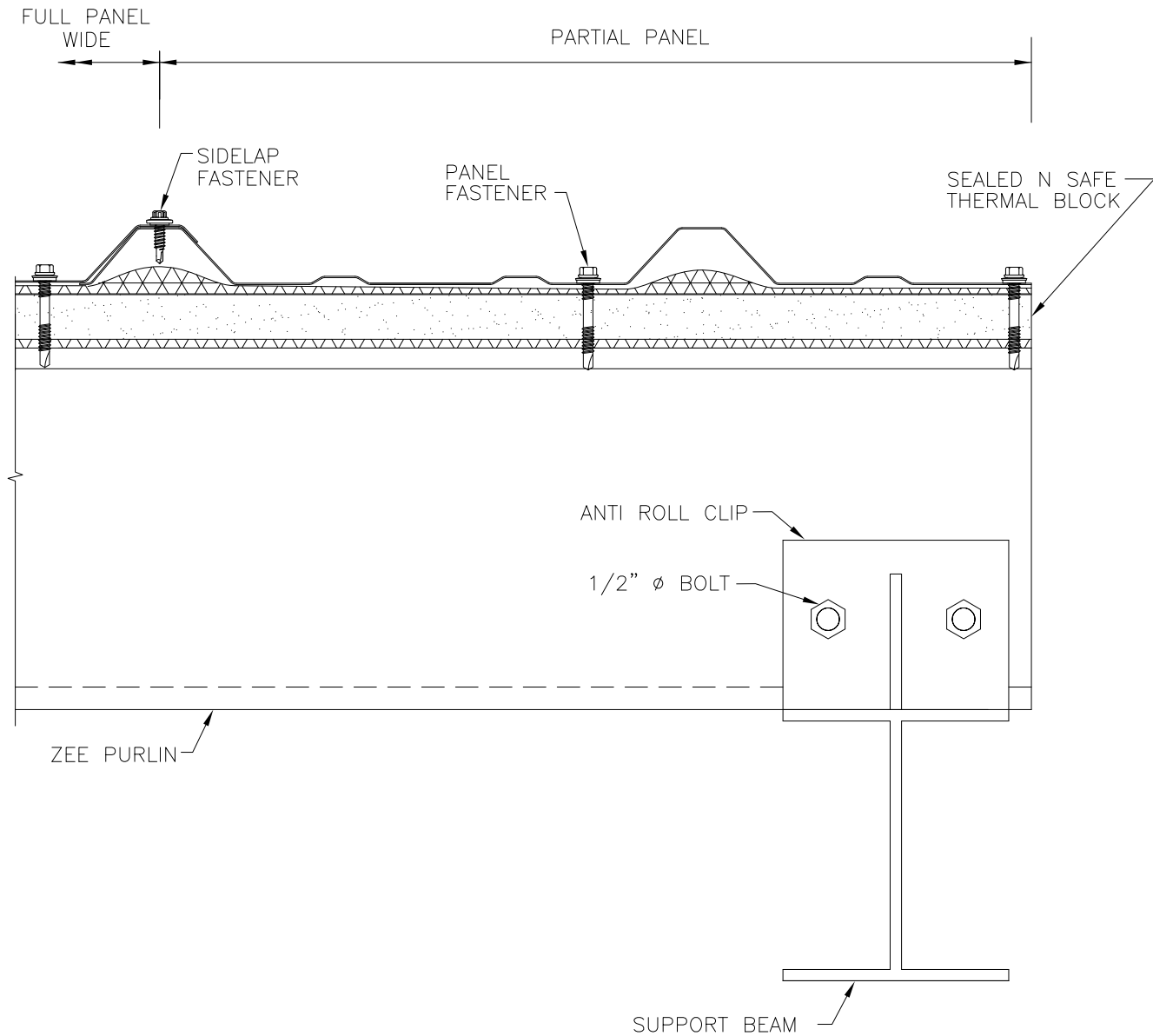
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SECTION VIEW

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DETAIL OF "PURLIN SUPPORTS"



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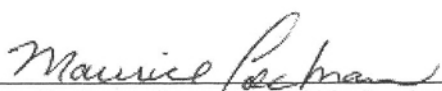
Report No.: 10020090-001-v1  
Date Received: 2/2/2010  
Date Reported: 2/5/2010  
P.O. No.: Credit Card

Sample Description: (1) Test Sample No.: 1A, CO Building 10Z - Test #1

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.100
Width, inch	0.507
Tensile Strength, psi	89,000
Yield Strength, psi at 0.2% offset	68,500
Elongation in 2 inches, %	22

Approved by:

  
Maurice Cochran, Supervisor of Mechanical Testing  
Sherry Laboratories

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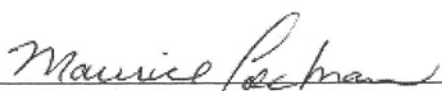
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Sample Description: (1) Test Sample No.: 2A, CO Building 10Z - Test #2

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.101
Width, inch	0.505
Tensile Strength, psi	87,500
Yield Strength, psi at 0.2% offset	67,500
Elongation in 2 inches, %	22

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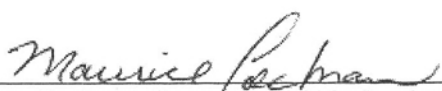
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Sample Description: (1) Test Sample No.: 3A, CO Building 10Z - Test #3

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.100
Width, inch	0.506
Tensile Strength, psi	87,000
Yield Strength, psi at 0.2% offset	67,000
Elongation in 2 inches, %	21

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Sample Description: (1) Test Sample No.: 4A, CO Building 10Z - Test #4

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.101
Width, inch	0.504
Tensile Strength, psi	88,000
Yield Strength, psi at 0.2% offset	68,500
Elongation in 2 inches, %	22

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Maurice Cochran, Supervisor of Mechanical Testing  
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Sample Description: (1) Test Sample No.: 5A, CO Building 10Z - Test #5

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.101
Width, inch	0.502
Tensile Strength, psi	86,000
Yield Strength, psi at 0.2% offset	65,500
Elongation in 2 inches, %	22

Approved by: \_\_\_\_\_

*Maurice Cochran*  
Maurice Cochran, Supervisor of Mechanical Testing  
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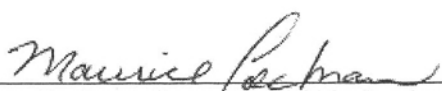
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Sample Description: (1) Test Sample No.: 6A, CO Building 10Z - Test #6

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.102
Width, inch	0.503
Tensile Strength, psi	85,500
Yield Strength, psi at 0.2% offset	65,000
Elongation in 2 inches, %	22

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Sample Description: (1) Test Sample No.: 7A, CO Building 10Z - Test #7

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.102
Width, inch	0.502
Tensile Strength, psi	85,500
Yield Strength, psi at 0.2% offset	65,500
Elongation in 2 inches, %	22

Approved by: Maurice Cochran  
Maurice Cochran, Supervisor of Mechanical Testing  
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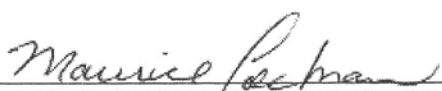
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Date Reported: 2/10/2010  
P.O. No.: Verbal

Sample Description: (1) Test Sample No.: 8A, CO Building 8Z - Test #8

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.068
Width, inch	0.502
Tensile Strength, psi	69,000
Yield Strength, psi at 0.2% offset	59,500
Elongation in 2 inches, %	29

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Maurice Cochran, Supervisor of Mechanical Testing  
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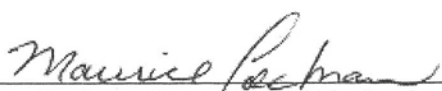
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P.O. No.: Verbal

Sample Description: (1) Test Sample No.: 9A, CO Building 8Z - Test #9

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.053
Width, inch	0.503
Tensile Strength, psi	72,000
Yield Strength, psi at 0.2% offset	63,000
Elongation in 2 inches, %	27

Approved by:

  
Maurice Cochran, Supervisor of Mechanical Testing  
Sherry Laboratories

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TESTING TODAY, PROTECTING TOMORROW

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Sherry Laboratories  
3100 North Hemlock Circle  
Broken Arrow, OK 74012-1115

Tel: 918-258-6066  
800-982-8378  
Fax: 918-258-1154

### LABORATORY REPORT

Attn: Bala Sockalingam  
ENCON Technology, Inc.  
1216 N. Lansing Ave., Suite C  
Tulsa, OK 74106

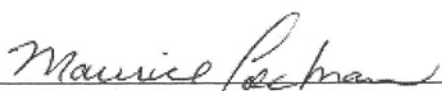
Report No.: 10020323-006-v1  
Date Received: 2/5/2010  
Date Reported: 2/10/2010  
P.O. No.: Verbal

Sample Description: (1) Test Sample No.: 10A, CO Building 10Z - Test #1

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.100
Width, inch	0.502
Tensile Strength, psi	86,500
Yield Strength, psi at 0.2% offset	66,500
Elongation in 2 inches, %	20

Approved by:

  
Maurice Cochran, Supervisor of Mechanical Testing  
Sherry Laboratories

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Fax: 918-258-1154

### LABORATORY REPORT

Attn: Bala Sockalingam  
ENCON Technology, Inc.  
1216 N. Lansing Ave., Suite C  
Tulsa, OK 74106

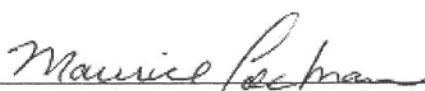
Report No.: 10021136-005-v1  
Date Received: 2/25/2010  
Date Reported: 3/2/2010  
P.O. No.: Verbal

Sample Description: (1) Test Sample, CO Building 10Z - Test #11, Sample No.: 11A

#### Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.100
Width, inch	0.500
Tensile Strength, psi	89,500
Yield Strength, psi at 0.2% offset	68,500
Elongation in 2 inches, %	23

Approved by:

  
Maurice Cochran, Supervisor of Mechanical Testing  
Sherry Laboratories

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Sherry Laboratories  
3100 North Hemlock Circle  
Broken Arrow, OK 74012-1115

Tel: 918-258-6066  
800-982-8378  
Fax: 918-258-1154

### LABORATORY REPORT

Attn: Bala Sockalingam  
ENCON Technology, Inc.  
1216 N. Lansing Ave., Suite C  
Tulsa, OK 74106

Report No.: 10021136-006-v1  
Date Received: 2/25/2010  
Date Reported: 3/2/2010  
P.O. No.: Verbal

Sample Description: (1) Test Sample, CO Building 10Z - Test #12, Sample No.: 12A

#### Tensile Test (Rectangular) per ASTM E8-08

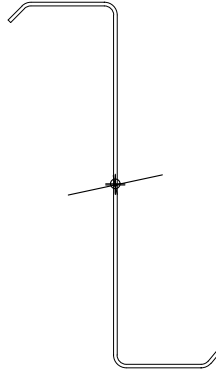
Parameter	Result
Orientation	Parallel to Length of the Specimen
Thickness, inch	0.100
Width, inch	0.500
Tensile Strength, psi	89,000
Yield Strength, psi at 0.2% offset	68,000
Elongation in 2 inches, %	20

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

Test results relate only to the items tested. This document shall not be reproduced, except in full, without the written approval of Sherry Laboratories. The recording of false, fictitious, or fraudulent statements or entries on this document may be a punishable offense under federal and state law. A2LA Accredited Laboratory Certificate No. 1089-01 (Mechanical) & 1089-02 (Chemical).

Section: Test#1.sct  
 Zee 12 ga Test #1  
 PBR 10Z Gravity  
 Rev. Date: 2/6/2010 3:34:51 PM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com



### Section Inputs

---

Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E            29500000 psi  
 Yield Strength, Fy                68500 psi  
 Tensile Strength, Fu              89000 psi  
 Warping Constant Override, Cw        0 in^6  
 Torsion Constant Override, J        0 in^4

Stiffened Zee, Thickness 0.1 in

Placement of Part from Origin:

X to center of gravity                0 in

Y to center of gravity                0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6875	45.000	0.25000	None	0.000	0.0000	0.3438
2	2.5000	0.000	0.25000	Single	0.000	0.0000	1.2500
3	10.0000	-90.000	0.25000	Single	0.000	0.0000	5.0000
4	2.5630	0.000	0.25000	Single	0.000	0.0000	1.2815
5	0.6250	50.000	0.25000	None	0.000	0.0000	0.3125

Section: Test#1.sct  
 Zee 12 ga Test #1  
 PBR 10Z Gravity  
 Rev. Date: 2/6/2010 3:34:51 PM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com

### Full Section Properties

Area	1.5799 in <sup>2</sup>	Wt.	5.3717 lb/ft	Width	15.799 in
Ix	22.243 in <sup>4</sup>	rx	3.7522 in	Ixy	-4.559 in <sup>4</sup>
Sx(t)	4.4504 in <sup>3</sup>	y(t)	4.9981 in	$\alpha$	12.061 deg
Sx(b)	4.4470 in <sup>3</sup>	y(b)	5.0019 in		
		Height	10.0000 in		
Iy	1.883 in <sup>4</sup>	ry	1.0916 in	Xo	-0.0026 in
Sy(l)	0.6416 in <sup>3</sup>	x(l)	2.9344 in	Yo	0.0307 in
Sy(r)	0.6455 in <sup>3</sup>	x(r)	2.9165 in	jx	0.0083 in
		Width	5.8509 in	jy	-0.0335 in
I1	23.217 in <sup>4</sup>	r1	3.8335 in		
I2	0.909 in <sup>4</sup>	r2	0.7584 in		
Ic	24.126 in <sup>4</sup>	rc	3.9078 in	Cw	33.848 in <sup>6</sup>
Io	24.128 in <sup>4</sup>	ro	3.9079 in	J	0.005266 in <sup>4</sup>

### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=68500 psi

Compression		Positive Moment		Positive Moment	
Pao	34724 lb	Maxo	169979 lb-in	Mayo	22207 lb-in
Ae	0.91245 in <sup>2</sup>	Ixe	21.265 in <sup>4</sup>	Iye	1.612 in <sup>4</sup>
		Sxe(t)	4.1440 in <sup>3</sup>	Sye(l)	0.5613 in <sup>3</sup>
Tension		Sxe(b)	4.3678 in <sup>3</sup>	Sye(r)	0.5414 in <sup>3</sup>
Ta	64804 lb	Negative Moment		Negative Moment	
		Maxo	168246 lb-in	Mayo	22453 lb-in
Shear		Ixe	21.131 in <sup>4</sup>	Iye	1.637 in <sup>4</sup>
Vay	9568 lb	Sxe(t)	4.3583 in <sup>3</sup>	Sye(l)	0.5474 in <sup>3</sup>
Vax	10416 lb	Sxe(b)	4.1018 in <sup>3</sup>	Sye(r)	0.5722 in <sup>3</sup>

Section: Test#2.sct

Zee 12 ga Test #2

PBR 10Z Gravity

Rev. Date: 2/7/2010 11:36:13 AM

By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E

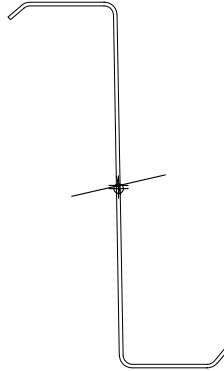
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

---

Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 67500 psi

Tensile Strength, Fu 87500 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.101 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6250	40.000	0.25000	None	0.000	0.0000	0.3125
2	2.5000	0.000	0.25000	Single	0.000	0.0000	1.2500
3	10.0000	-89.000	0.25000	Single	0.000	0.0000	5.0000
4	2.5630	0.000	0.25000	Single	0.000	0.0000	1.2815
5	0.6250	50.000	0.25000	None	0.000	0.0000	0.3125

Section: Test#2.sct  
 Zee 12 ga Test #2  
 PBR 10Z Gravity  
 Rev. Date: 2/7/2010 11:36:13 AM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com

### Full Section Properties

Area	1.5914 in <sup>2</sup>	Wt.	5.4106 lb/ft	Width	15.756 in
Ix	22.392 in <sup>4</sup>	rx	3.7511 in	Ixy	-4.935 in <sup>4</sup>
Sx(t)	4.4673 in <sup>3</sup>	y(t)	5.0125 in	$\alpha$	12.931 deg
Sx(b)	4.4894 in <sup>3</sup>	y(b)	4.9878 in		
		Height	10.0002 in		
Iy	2.030 in <sup>4</sup>	ry	1.1294 in	Xo	0.0036 in
Sy(l)	0.6714 in <sup>3</sup>	x(l)	3.0232 in	Yo	-0.0843 in
Sy(r)	0.6780 in <sup>3</sup>	x(r)	2.9939 in	jx	-0.0054 in
		Width	6.0171 in	jy	0.0930 in
I1	23.525 in <sup>4</sup>	r1	3.8449 in		
I2	0.897 in <sup>4</sup>	r2	0.7507 in		
Ic	24.422 in <sup>4</sup>	rc	3.9175 in	Cw	33.442 in <sup>6</sup>
Io	24.433 in <sup>4</sup>	ro	3.9184 in	J	0.005411 in <sup>4</sup>

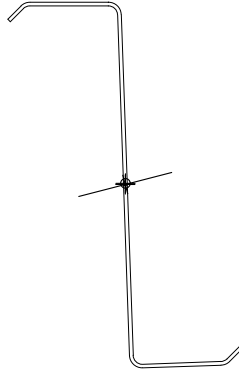
### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=67500 psi

Compression		Positive Moment		Positive Moment	
Pao	34497 lb	Maxo	166296 lb-in	Mayo	23078 lb-in
Ae	0.91991 in <sup>2</sup>	Ixe	21.247 in <sup>4</sup>	Iye	1.745 in <sup>4</sup>
		Sxe(t)	4.1143 in <sup>3</sup>	Sye(l)	0.5895 in <sup>3</sup>
Tension		Sxe(b)	4.3934 in <sup>3</sup>	Sye(r)	0.5710 in <sup>3</sup>
Ta	64321 lb	Negative Moment		Negative Moment	
		Maxo	168211 lb-in	Mayo	22534 lb-in
Shear		Ixe	21.344 in <sup>4</sup>	Iye	1.723 in <sup>4</sup>
Vay	9846 lb	Sxe(t)	4.3812 in <sup>3</sup>	Sye(l)	0.5575 in <sup>3</sup>
Vax	10442 lb	Sxe(b)	4.1617 in <sup>3</sup>	Sye(r)	0.5888 in <sup>3</sup>

Section: Test#3.sct  
 Zee 12 ga Test #3  
 PBR 10Z Gravity  
 Rev. Date: 2/7/2010 11:45:34 AM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com



### Section Inputs

---

Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E           29500000 psi  
 Yield Strength, Fy               67000 psi  
 Tensile Strength, Fu           87000 psi  
 Warping Constant Override, Cw       0 in<sup>6</sup>  
 Torsion Constant Override, J       0 in<sup>4</sup>

Stiffened Zee, Thickness 0.1 in

Placement of Part from Origin:

X to center of gravity           0 in

Y to center of gravity           0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6560	45.000	0.25000	None	0.000	0.0000	0.3280
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	10.0000	-88.000	0.25000	Single	0.000	0.0000	5.0000
4	2.6250	2.000	0.25000	Single	0.000	0.0000	1.3125
5	0.6250	45.000	0.25000	None	0.000	0.0000	0.3125



Section: Test#3.sct

Zee 12 ga Test #3

PBR 10Z Gravity

Rev. Date: 2/7/2010 11:45:34 AM

By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E

ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com

## Full Section Properties

Area	1.5982 in <sup>2</sup>	Wt.	5.4339 lb/ft	Width	15.982 in
Ix	22.529 in <sup>4</sup>	rx	3.7546 in	Ixy	-5.590 in <sup>4</sup>
Sx(t)	4.5275 in <sup>3</sup>	y(t)	4.9761 in	$\alpha$	14.538 deg
Sx(b)	4.4975 in <sup>3</sup>	y(b)	5.0093 in		
		Height	9.9854 in		
Iy	2.425 in <sup>4</sup>	ry	1.2317 in	Xo	0.0051 in
Sy(l)	0.7559 in <sup>3</sup>	x(l)	3.2073 in	Yo	0.0318 in
Sy(r)	0.7586 in <sup>3</sup>	x(r)	3.1960 in	jx	-0.0523 in
		Width	6.4033 in	jy	-0.0273 in
I1	23.979 in <sup>4</sup>	r1	3.8735 in		
I2	0.975 in <sup>4</sup>	r2	0.7811 in		
Ic	24.954 in <sup>4</sup>	rc	3.9514 in	Cw	36.657 in <sup>6</sup>
Io	24.956 in <sup>4</sup>	ro	3.9515 in	J	0.005327 in <sup>4</sup>

## Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=67000 psi

Compression

Positive Moment

Positive Moment

Pao 33876 lb

Maxo 165233 lb-in

Mayo 25213 lb-in

Ae 0.91011 in<sup>2</sup>Ixe 21.214 in<sup>4</sup>Iye 2.056 in<sup>4</sup>Sxe(t) 4.1185 in<sup>3</sup>Sye(l) 0.6568 in<sup>3</sup>Sxe(b) 4.3882 in<sup>3</sup>Sye(r) 0.6284 in<sup>3</sup>

Tension

Ta 64120 lb

Negative Moment

Negative Moment

Maxo 163884 lb-in

Mayo 25151 lb-in

Ixe 21.192 in<sup>4</sup>Iye 2.058 in<sup>4</sup>Sxe(t) 4.4173 in<sup>3</sup>Sye(l) 0.6269 in<sup>3</sup>Sxe(b) 4.0849 in<sup>3</sup>Sye(r) 0.6595 in<sup>3</sup>

Shear

Vay 9553 lb

Vax 10773 lb

Section: Test#4.sct

Zee 12 ga Test #4

PBR 10Z Gravity

Rev. Date: 2/6/2010 6:03:28 PM

By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E

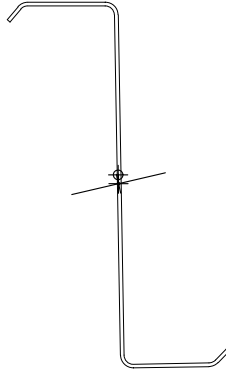
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

---

Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 68500 psi

Tensile Strength, Fu 88000 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.101 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6250	50.000	0.25000	None	0.000	0.0000	0.3125
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	10.0000	-89.000	0.25000	Single	0.000	0.0000	5.0000
4	2.5630	1.000	0.25000	Single	0.000	0.0000	1.2815
5	0.5630	46.000	0.25000	None	0.000	0.0000	0.2815

Section: Test#4.sct  
 Zee 12 ga Test #4  
 PBR 10Z Gravity  
 Rev. Date: 2/6/2010 6:03:28 PM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com

### Full Section Properties

Area	1.5961 in <sup>2</sup>	Wt.	5.4268 lb/ft	Width	15.803 in
Ix	22.439 in <sup>4</sup>	rx	3.7495 in	Ixy	-5.004 in <sup>4</sup>
Sx(t)	4.5246 in <sup>3</sup>	y(t)	4.9594 in	$\alpha$	13.091 deg
Sx(b)	4.4569 in <sup>3</sup>	y(b)	5.0347 in		
		Height	9.9942 in		
Iy	2.083 in <sup>4</sup>	ry	1.1423 in	Xo	-0.0097 in
Sy(l)	0.6848 in <sup>3</sup>	x(l)	3.0415 in	Yo	0.2436 in
Sy(r)	0.6914 in <sup>3</sup>	x(r)	3.0125 in	jx	-0.0385 in
		Width	6.0540 in	jy	-0.2590 in
I1	23.603 in <sup>4</sup>	r1	3.8455 in		
I2	0.919 in <sup>4</sup>	r2	0.7589 in		
Ic	24.522 in <sup>4</sup>	rc	3.9197 in	Cw	34.127 in <sup>6</sup>
Io	24.617 in <sup>4</sup>	ro	3.9272 in	J	0.005427 in <sup>4</sup>

### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=68500 psi

Compression		Positive Moment		Positive Moment	
Pao	34664 lb	Maxo	169677 lb-in	Mayo	23786 lb-in
Ae	0.91087 in <sup>2</sup>	Ixe	21.201 in <sup>4</sup>	Iye	1.785 in <sup>4</sup>
		Sxe(t)	4.1366 in <sup>3</sup>	Sye(l)	0.5997 in <sup>3</sup>
Tension		Sxe(b)	4.3541 in <sup>3</sup>	Sye(r)	0.5799 in <sup>3</sup>
Ta	65469 lb	Negative Moment		Negative Moment	
		Maxo	167106 lb-in	Mayo	23337 lb-in
Shear		Ixe	21.184 in <sup>4</sup>	Iye	1.769 in <sup>4</sup>
Vay	9853 lb	Sxe(t)	4.4183 in <sup>3</sup>	Sye(l)	0.5689 in <sup>3</sup>
Vax	10858 lb	Sxe(b)	4.0740 in <sup>3</sup>	Sye(r)	0.6009 in <sup>3</sup>

Section: Test#5.sct

Zee 12 ga Test #5

PBR 10Z Gravity

Rev. Date: 2/10/2010 3:18:50 PM

By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E

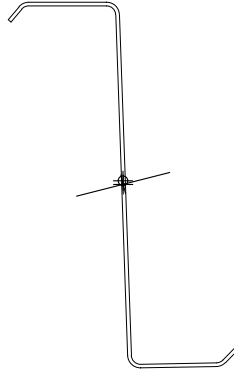
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

---

Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 65500 psi

Tensile Strength, Fu 86000 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.101 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6250	50.000	0.25000	None	0.000	0.0000	0.3125
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	10.0000	-88.000	0.25000	Single	0.000	0.0000	5.0000
4	2.5630	1.000	0.25000	Single	0.000	0.0000	1.2815
5	0.6250	46.000	0.25000	None	0.000	0.0000	0.3125

Section: Test#5.sct  
 Zee 12 ga Test #5  
 PBR 10Z Gravity  
 Rev. Date: 2/10/2010 3:18:50 PM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com

### Full Section Properties

Area	1.6037 in <sup>2</sup>	Wt.	5.4527 lb/ft	Width	15.879 in
Ix	22.585 in <sup>4</sup>	rx	3.7527 in	Ixy	-5.488 in <sup>4</sup>
Sx(t)	4.5390 in <sup>3</sup>	y(t)	4.9758 in	$\alpha$	14.226 deg
Sx(b)	4.5030 in <sup>3</sup>	y(b)	5.0156 in		
		Height	9.9915 in		
Iy	2.329 in <sup>4</sup>	ry	1.2050 in	Xo	-0.0026 in
Sy(l)	0.7416 in <sup>3</sup>	x(l)	3.1402 in	Yo	0.0972 in
Sy(r)	0.7437 in <sup>3</sup>	x(r)	3.1314 in	jx	-0.0329 in
		Width	6.2716 in	jy	-0.1010 in
I1	23.977 in <sup>4</sup>	r1	3.8666 in		
I2	0.938 in <sup>4</sup>	r2	0.7646 in		
Ic	24.914 in <sup>4</sup>	rc	3.9415 in	Cw	35.249 in <sup>6</sup>
Io	24.929 in <sup>4</sup>	ro	3.9427 in	J	0.005453 in <sup>4</sup>

### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=65500 psi

Compression		Positive Moment		Positive Moment	
Pao	34023 lb	Maxo	164109 lb-in	Mayo	24577 lb-in
Ae	0.93498 in <sup>2</sup>	Ixe	21.451 in <sup>4</sup>	Iye	2.005 in <sup>4</sup>
		Sxe(t)	4.1842 in <sup>3</sup>	Sye(l)	0.6525 in <sup>3</sup>
Tension		Sxe(b)	4.4097 in <sup>3</sup>	Sye(r)	0.6266 in <sup>3</sup>
Ta	62901 lb	Negative Moment		Negative Moment	
		Maxo	163597 lb-in	Mayo	24465 lb-in
Shear		Ixe	21.515 in <sup>4</sup>	Iye	2.001 in <sup>4</sup>
Vay	9836 lb	Sxe(t)	4.4515 in <sup>3</sup>	Sye(l)	0.6238 in <sup>3</sup>
Vax	10434 lb	Sxe(b)	4.1711 in <sup>3</sup>	Sye(r)	0.6534 in <sup>3</sup>

Section: Test#6.sct

Zee 12 ga Test #6

PBR 10Z Gravity

Rev. Date: 2/10/2010 3:21:06 PM

By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E

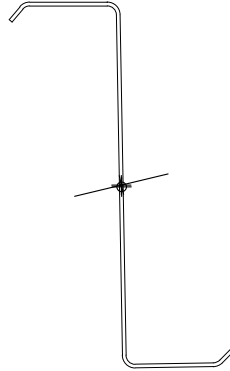
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 65000 psi

Tensile Strength, Fu 85500 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.102 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6250	50.000	0.25000	None	0.000	0.0000	0.3125
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	10.0000	-89.000	0.25000	Single	0.000	0.0000	5.0000
4	2.6250	1.000	0.25000	Single	0.000	0.0000	1.3125
5	0.6250	45.000	0.25000	None	0.000	0.0000	0.3125

Section: Test#6.sct  
 Zee 12 ga Test #6  
 PBR 10Z Gravity  
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 bala@encontech.com

### Full Section Properties

Area	1.6244 in <sup>2</sup>	Wt.	5.5230 lb/ft	Width	15.926 in
Ix	22.939 in <sup>4</sup>	rx	3.7578 in	Ixy	-5.239 in <sup>4</sup>
Sx(t)	4.5905 in <sup>3</sup>	y(t)	4.9970 in	$\alpha$	13.416 deg
Sx(b)	4.5904 in <sup>3</sup>	y(b)	4.9971 in		
		Height	9.9942 in		
Iy	2.225 in <sup>4</sup>	ry	1.1705 in	Xo	0.0071 in
Sy(l)	0.7259 in <sup>3</sup>	x(l)	3.0657 in	Yo	-0.0522 in
Sy(r)	0.7179 in <sup>3</sup>	x(r)	3.1001 in	jx	-0.0156 in
		Width	6.1658 in	jy	0.0578 in
I1	24.189 in <sup>4</sup>	r1	3.8588 in		
I2	0.976 in <sup>4</sup>	r2	0.7750 in		
Ic	25.164 in <sup>4</sup>	rc	3.9359 in	Cw	36.507 in <sup>6</sup>
Io	25.169 in <sup>4</sup>	ro	3.9363 in	J	0.005633 in <sup>4</sup>

### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=65000 psi

Compression		Positive Moment		Positive Moment	
Pao	34448 lb	Maxo	165639 lb-in	Mayo	23236 lb-in
Ae	0.95396 in <sup>2</sup>	Ixe	21.865 in <sup>4</sup>	Iye	1.892 in <sup>4</sup>
		Sxe(t)	4.2557 in <sup>3</sup>	Sye(l)	0.6317 in <sup>3</sup>
Tension		Sxe(b)	4.5026 in <sup>3</sup>	Sye(r)	0.5970 in <sup>3</sup>
Ta	63226 lb	Negative Moment		Negative Moment	
		Maxo	164383 lb-in	Mayo	23860 lb-in
Shear		Ixe	21.760 in <sup>4</sup>	Iye	1.919 in <sup>4</sup>
Vay	10151 lb	Sxe(t)	4.4939 in <sup>3</sup>	Sye(l)	0.6130 in <sup>3</sup>
Vax	10561 lb	Sxe(b)	4.2234 in <sup>3</sup>	Sye(r)	0.6322 in <sup>3</sup>

Section: Test#7.sct

Zee 12 ga Test #7

PBR 10Z Gravity

Rev. Date: 2/10/2010 3:24:09 PM

By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E

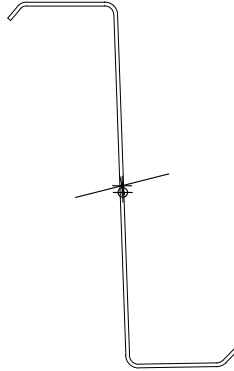
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 65500 psi

Tensile Strength, Fu 85500 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.102 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.5630	50.000	0.25000	None	0.000	0.0000	0.2815
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	10.0000	-88.000	0.25000	Single	0.000	0.0000	5.0000
4	2.6250	1.000	0.25000	Single	0.000	0.0000	1.3125
5	0.6250	46.000	0.25000	None	0.000	0.0000	0.3125



Section: Test#7.sct

Zee 12 ga Test #7

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Tulsa, OK 74106

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bala@encontech.com

## Full Section Properties

Area	1.6193 in <sup>2</sup>	Wt.	5.5056 lb/ft	Width	15.875 in
Ix	22.821 in <sup>4</sup>	rx	3.7541 in	Ixy	-5.551 in <sup>4</sup>
Sx(t)	4.5529 in <sup>3</sup>	y(t)	5.0126 in	$\alpha$	14.241 deg
Sx(b)	4.5836 in <sup>3</sup>	y(b)	4.9789 in		
		Height	9.9915 in		
Iy	2.357 in <sup>4</sup>	ry	1.2065 in	Xo	0.0185 in
Sy(l)	0.7543 in <sup>3</sup>	x(l)	3.1248 in	Yo	-0.1889 in
Sy(r)	0.7440 in <sup>3</sup>	x(r)	3.1680 in	jx	-0.0237 in
		Width	6.2927 in	jy	0.2061 in
I1	24.230 in <sup>4</sup>	r1	3.8683 in		
I2	0.948 in <sup>4</sup>	r2	0.7651 in		
Ic	25.178 in <sup>4</sup>	rc	3.9432 in	Cw	35.523 in <sup>6</sup>
Io	25.237 in <sup>4</sup>	ro	3.9478 in	J	0.005616 in <sup>4</sup>

## Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=65500 psi

Compression

Positive Moment

Positive Moment

Pao 34284 lb

Maxo 164084 lb-in

Mayo 24294 lb-in

Ae 0.94215 in<sup>2</sup>Ixe 21.621 in<sup>4</sup>Iye 2.007 in<sup>4</sup>Sxe(t) 4.1835 in<sup>3</sup>Sye(l) 0.6574 in<sup>3</sup>Sxe(b) 4.4825 in<sup>3</sup>Sye(r) 0.6194 in<sup>3</sup>

Tension

Ta 63511 lb

Negative Moment

Negative Moment

Maxo 165258 lb-in

Mayo 25127 lb-in

Ixe 21.638 in<sup>4</sup>Iye 2.043 in<sup>4</sup>Sxe(t) 4.4561 in<sup>3</sup>Sye(l) 0.6406 in<sup>3</sup>Sxe(b) 4.2135 in<sup>3</sup>Sye(r) 0.6586 in<sup>3</sup>

Shear

Vay 10133 lb

Vax 10685 lb

Section: Test#8.sct

Zee 14 ga Test #8

PBR 8Z Gravity

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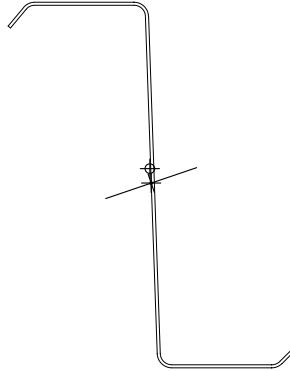
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 59500 psi

Tensile Strength, Fu 69000 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.068 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6800	50.000	0.25000	None	0.000	0.0000	0.3400
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	8.0000	-88.000	0.25000	Single	0.000	0.0000	4.0000
4	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
5	0.5000	45.000	0.25000	None	0.000	0.0000	0.2500

Section: Test#8.sct

Zee 14 ga Test #8

PBR 8Z Gravity

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Tulsa, OK 74106

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bala@encontech.com

## Full Section Properties

Area	0.95097 in <sup>2</sup>	Wt.	3.2333 lb/ft	Width	13.985 in
Ix	9.155 in <sup>4</sup>	rx	3.1027 in	Ixy	-2.904 in <sup>4</sup>
Sx(t)	2.3141 in <sup>3</sup>	y(t)	3.9562 in	$\alpha$	18.699 deg
Sx(b)	2.2654 in <sup>3</sup>	y(b)	4.0413 in		
		Height	7.9975 in		
Iy	1.559 in <sup>4</sup>	ry	1.2803 in	Xo	-0.0320 in
Sy(l)	0.4980 in <sup>3</sup>	x(l)	3.1303 in	Yo	0.3165 in
Sy(r)	0.4994 in <sup>3</sup>	x(r)	3.1216 in	jx	0.0342 in
		Width	6.2519 in	jy	-0.3489 in
I1	10.138 in <sup>4</sup>	r1	3.2650 in		
I2	0.576 in <sup>4</sup>	r2	0.7783 in		
Ic	10.714 in <sup>4</sup>	rc	3.3565 in	Cw	14.800 in <sup>6</sup>
Io	10.810 in <sup>4</sup>	ro	3.3715 in	J	0.001466 in <sup>4</sup>

## Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=59500 psi

Compression

Positive Moment

Positive Moment

Pao 16444 lb

Maxo 69365 lb-in

Mayo 12143 lb-in

Ae 0.49746 in<sup>2</sup>Ixe 8.2138 in<sup>4</sup>Iye 1.1235 in<sup>4</sup>Sxe(t) 1.9469 in<sup>3</sup>Sye(l) 0.3801 in<sup>3</sup>Sxe(b) 2.1738 in<sup>3</sup>Sye(r) 0.3408 in<sup>3</sup>

Tension

Ta 32809 lb

Negative Moment

Negative Moment

Maxo 65946 lb-in

Mayo 12667 lb-in

Ixe 8.0346 in<sup>4</sup>Iye 1.1676 in<sup>4</sup>Sxe(t) 2.1972 in<sup>3</sup>Sye(l) 0.3555 in<sup>3</sup>Sxe(b) 1.8509 in<sup>3</sup>Sye(r) 0.3934 in<sup>3</sup>

Shear

Vay 3786 lb

Vax 6623 lb

Section: Test#9.sct

Zee 16 ga Test #9

PBR 8Z Gravity

Rev. Date: 2/10/2010 3:29:10 PM

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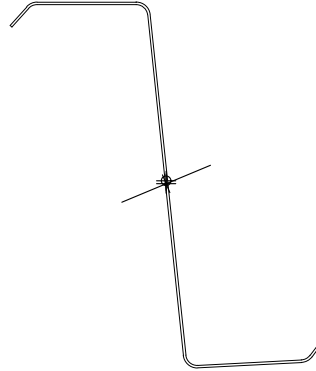
ENCON Technology Inc.

1216 N Lansing Ave, Suite C

Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E 29500000 psi

Yield Strength, Fy 63000 psi

Tensile Strength, Fu 72000 psi

Warping Constant Override, Cw 0 in<sup>6</sup>Torsion Constant Override, J 0 in<sup>4</sup>

Stiffened Zee, Thickness 0.053 in

Placement of Part from Origin:

X to center of gravity 0 in

Y to center of gravity 0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6800	48.000	0.25000	None	0.000	0.0000	0.3400
2	2.5600	0.000	0.25000	Single	0.000	0.0000	1.2800
3	8.0000	-84.000	0.25000	Single	0.000	0.0000	4.0000
4	2.6800	3.000	0.25000	Single	0.000	0.0000	1.3400
5	0.5000	53.000	0.25000	None	0.000	0.0000	0.2500

Section: Test#9.sct

Zee 16 ga Test #9

PBR 8Z Gravity

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Tulsa, OK 74106

Ph: 918 492 5992, Fax: 866 366 1543

bala@encontech.com

## Full Section Properties

Area	0.74439 in <sup>2</sup>	Wt.	2.5309 lb/ft	Width	14.045 in
Ix	7.0321 in <sup>4</sup>	rx	3.0736 in	Ixy	-2.7357 in <sup>4</sup>
Sx(t)	1.7821 in <sup>3</sup>	y(t)	3.9460 in	$\alpha$	22.545 deg
Sx(b)	1.7575 in <sup>3</sup>	y(b)	4.0011 in		
		Height	7.9471 in		
Iy	1.5780 in <sup>4</sup>	ry	1.4560 in	Xo	0.0004 in
Sy(l)	0.4653 in <sup>3</sup>	x(l)	3.3913 in	Yo	0.0651 in
Sy(r)	0.4662 in <sup>3</sup>	x(r)	3.3845 in	jx	-0.0271 in
		Width	6.7758 in	jy	-0.0645 in
I1	8.1678 in <sup>4</sup>	r1	3.3125 in		
I2	0.4423 in <sup>4</sup>	r2	0.7708 in		
Ic	8.6101 in <sup>4</sup>	rc	3.4010 in	Cw	11.721 in <sup>6</sup>
Io	8.6132 in <sup>4</sup>	ro	3.4016 in	J	0.000697 in <sup>4</sup>

## Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=63000 psi

Compression

Positive Moment

Positive Moment

Pao 11616 lb

Maxo 48533 lb-in

Mayo 11143 lb-in

Ae 0.33190 in<sup>2</sup>Ixe 5.7656 in<sup>4</sup>Iye 1.0741 in<sup>4</sup>Sxe(t) 1.2865 in<sup>3</sup>Sye(l) 0.3421 in<sup>3</sup>Sxe(b) 1.6637 in<sup>3</sup>Sye(r) 0.2954 in<sup>3</sup>

Tension

Ta 26798 lb

Negative Moment

Negative Moment

Maxo 44735 lb-in

Mayo 12329 lb-in

Ixe 5.5144 in<sup>4</sup>Iye 1.1741 in<sup>4</sup>Sxe(t) 1.6726 in<sup>3</sup>Sye(l) 0.3268 in<sup>3</sup>Sxe(b) 1.1858 in<sup>3</sup>Sye(r) 0.3688 in<sup>3</sup>

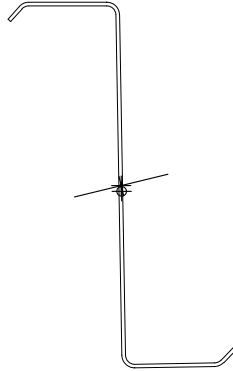
Shear

Vay 1772 lb

Vax 5608 lb

Section: Test#10.sct  
 Zee 12 ga Test #10  
 PBR 10Z Uplift  
 Rev. Date: 2/10/2010 3:31:24 PM  
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Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E           29500000 psi  
 Yield Strength, Fy                 66500 psi  
 Tensile Strength, Fu               86500 psi  
 Warping Constant Override, Cw       0 in<sup>6</sup>  
 Torsion Constant Override, J        0 in<sup>4</sup>

Stiffened Zee, Thickness 0.1 in

Placement of Part from Origin:

X to center of gravity               0 in  
 Y to center of gravity               0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.6250	48.000	0.25000	None	0.000	0.0000	0.3125
2	2.6250	0.000	0.25000	Single	0.000	0.0000	1.3125
3	10.0000	-89.000	0.25000	Single	0.000	0.0000	5.0000
4	2.6800	1.000	0.25000	Single	0.000	0.0000	1.3400
5	0.6250	46.000	0.25000	None	0.000	0.0000	0.3125

Section: Test#10.sct  
 Zee 12 ga Test #10  
 PBR 10Z Uplift  
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Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com

### Full Section Properties

Area	1.5990 in <sup>2</sup>	Wt.	5.4365 lb/ft	Width	15.990 in
Ix	22.650 in <sup>4</sup>	rx	3.7637 in	Ixy	-5.235 in <sup>4</sup>
Sx(t)	4.5196 in <sup>3</sup>	y(t)	5.0115 in	$\alpha$	13.583 deg
Sx(b)	4.5458 in <sup>3</sup>	y(b)	4.9826 in		
		Height	9.9942 in		
Iy	2.247 in <sup>4</sup>	ry	1.1854 in	Xo	0.0126 in
Sy(l)	0.7264 in <sup>3</sup>	x(l)	3.0928 in	Yo	-0.1575 in
Sy(r)	0.7158 in <sup>3</sup>	x(r)	3.1387 in	jx	-0.0067 in
		Width	6.2315 in	jy	0.1709 in
I1	23.915 in <sup>4</sup>	r1	3.8674 in		
I2	0.982 in <sup>4</sup>	r2	0.7836 in		
Ic	24.897 in <sup>4</sup>	rc	3.9459 in	Cw	36.778 in <sup>6</sup>
Io	24.937 in <sup>4</sup>	ro	3.9491 in	J	0.005330 in <sup>4</sup>

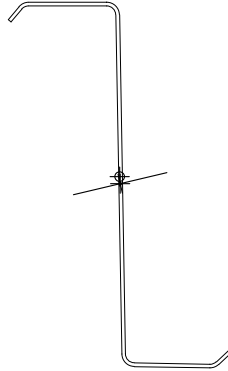
### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=66500 psi

Compression		Positive Moment		Positive Moment	
Pao	33738 lb	Maxo	164555 lb-in	Mayo	23417 lb-in
Ae	0.91320 in <sup>2</sup>	Ixe	21.394 in <sup>4</sup>	Iye	1.890 in <sup>4</sup>
		Sxe(t)	4.1324 in <sup>3</sup>	Sye(l)	0.6263 in <sup>3</sup>
Tension		Sxe(b)	4.4414 in <sup>3</sup>	Sye(r)	0.5881 in <sup>3</sup>
Ta	63672 lb	Negative Moment		Negative Moment	
		Maxo	163536 lb-in	Mayo	24216 lb-in
Shear		Ixe	21.235 in <sup>4</sup>	Iye	1.923 in <sup>4</sup>
Vay	9561 lb	Sxe(t)	4.4025 in <sup>3</sup>	Sye(l)	0.6081 in <sup>3</sup>
Vax	10754 lb	Sxe(b)	4.1069 in <sup>3</sup>	Sye(r)	0.6264 in <sup>3</sup>

Section: Test#11.sct  
 Zee 12 ga Test #11  
 PBR 10Z Gravity  
 Rev. Date: 3/4/2010 2:11:38 PM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E            29500000 psi  
 Yield Strength, Fy                    68500 psi  
 Tensile Strength, Fu                 89000 psi  
 Warping Constant Override, Cw        0 in<sup>6</sup>  
 Torsion Constant Override, J          0 in<sup>4</sup>

Stiffened Zee, Thickness 0.1 in

Placement of Part from Origin:

X to center of gravity                0 in

Y to center of gravity                0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.625	50.000	0.25000	None	0.000	0.000	0.313
2	2.656	0.000	0.25000	Single	0.000	0.000	1.328
3	10.030	-89.000	0.25000	Single	0.000	0.000	5.015
4	2.563	-1.000	0.25000	Single	0.000	0.000	1.281
5	0.625	43.000	0.25000	None	0.000	0.000	0.313



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 Tulsa, OK 74106  
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### Full Section Properties

Area	1.5944 in <sup>2</sup>	Wt.	5.4211 lb/ft	Width	15.944 in
Ix	22.798 in <sup>4</sup>	rx	3.7813 in	Ixy	-5.153 in <sup>4</sup>
Sx(t)	4.5615 in <sup>3</sup>	y(t)	4.9980 in	$\alpha$	13.268 deg
Sx(b)	4.4926 in <sup>3</sup>	y(b)	5.0746 in		
		Height	10.0725 in		
Iy	2.159 in <sup>4</sup>	ry	1.1636 in	Xo	-0.0134 in
Sy(l)	0.7010 in <sup>3</sup>	x(l)	3.0798 in	Yo	0.1915 in
Sy(r)	0.7027 in <sup>3</sup>	x(r)	3.0722 in	jx	0.0148 in
		Width	6.1520 in	jy	-0.2098 in
I1	24.013 in <sup>4</sup>	r1	3.8808 in		
I2	0.944 in <sup>4</sup>	r2	0.7693 in		
Ic	24.957 in <sup>4</sup>	rc	3.9563 in	Cw	35.672 in <sup>6</sup>
Io	25.016 in <sup>4</sup>	ro	3.9610 in	J	0.005315 in <sup>4</sup>

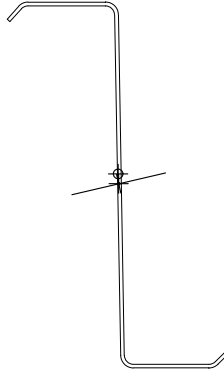
### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=68500 psi

Compression		Positive Moment		Positive Moment	
Pao	34310 lb	Maxo	169706 lb-in	Mayo	23941 lb-in
Ae	0.90157 in <sup>2</sup>	Ixe	21.428 in <sup>4</sup>	Iye	1.834 in <sup>4</sup>
		Sxe(t)	4.1374 in <sup>3</sup>	Sye(l)	0.6094 in <sup>3</sup>
Tension		Sxe(b)	4.3790 in <sup>3</sup>	Sye(r)	0.5837 in <sup>3</sup>
Ta	65400 lb	Negative Moment		Negative Moment	
		Maxo	167844 lb-in	Mayo	23840 lb-in
Shear		Ixe	21.471 in <sup>4</sup>	Iye	1.831 in <sup>4</sup>
Vay	9518 lb	Sxe(t)	4.4496 in <sup>3</sup>	Sye(l)	0.5812 in <sup>3</sup>
Vax	10877 lb	Sxe(b)	4.0920 in <sup>3</sup>	Sye(r)	0.6099 in <sup>3</sup>

Section: Test#12.sct  
 Zee 12 ga Test #12  
 PBR 10Z Uplift  
 Rev. Date: 3/4/2010 2:15:49 PM  
 By: Bala Sockalingam, Ph.D., P.E

Bala Sockalingam, Ph.D., P.E  
 ENCON Technology Inc.  
 1216 N Lansing Ave, Suite C  
 Tulsa, OK 74106  
 Ph: 918 492 5992, Fax: 866 366 1543  
 bala@encontech.com



### Section Inputs

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Material: [N/A]

No strength increase from cold work of forming.

Modulus of Elasticity, E            29500000 psi  
 Yield Strength, Fy                 68000 psi  
 Tensile Strength, Fu               89500 psi  
 Warping Constant Override, Cw       0 in<sup>6</sup>  
 Torsion Constant Override, J         0 in<sup>4</sup>

Stiffened Zee, Thickness 0.1 in

Placement of Part from Origin:

X to center of gravity               0 in

Y to center of gravity               0 in

Outside dimensions, Open shape

	Length (in)	Angle (deg)	Radius (in)	Web	k Coef.	Hole Size (in)	Distance (in)
1	0.625	48.000	0.25000	None	0.000	0.000	0.313
2	2.625	0.000	0.25000	Single	0.000	0.000	1.313
3	10.030	-89.000	0.25000	Single	0.000	0.000	5.015
4	2.563	0.000	0.25000	Single	0.000	0.000	1.281
5	0.563	45.000	0.25000	None	0.000	0.000	0.281

Section: Test#12.sct  
 Zee 12 ga Test #12  
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 Tulsa, OK 74106  
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 bala@encontech.com

### Full Section Properties

Area	1.5847 in <sup>2</sup>	Wt.	5.3878 lb/ft	Width	15.847 in
Ix	22.498 in <sup>4</sup>	rx	3.7679 in	Ixy	-5.003 in <sup>4</sup>
Sx(t)	4.5178 in <sup>3</sup>	y(t)	4.9798 in	$\alpha$	13.049 deg
Sx(b)	4.4546 in <sup>3</sup>	y(b)	5.0504 in		
		Height	10.0302 in		
Iy	2.072 in <sup>4</sup>	ry	1.1435 in	Xo	-0.0150 in
Sy(l)	0.6777 in <sup>3</sup>	x(l)	3.0579 in	Yo	0.2729 in
Sy(r)	0.6860 in <sup>3</sup>	x(r)	3.0206 in	jx	-0.0146 in
		Width	6.0785 in	jy	-0.2935 in
I1	23.657 in <sup>4</sup>	r1	3.8638 in		
I2	0.913 in <sup>4</sup>	r2	0.7589 in		
Ic	24.570 in <sup>4</sup>	rc	3.9376 in	Cw	34.158 in <sup>6</sup>
Io	24.688 in <sup>4</sup>	ro	3.9471 in	J	0.005282 in <sup>4</sup>

### Fully Braced Strength - 2007 North American Specification - US (ASD)

Material Type: [N/A], Fy=68000 psi

Compression		Positive Moment		Positive Moment	
Pao	33877 lb	Maxo	167450 lb-in	Mayo	23415 lb-in
Ae	0.89675 in <sup>2</sup>	Ixe	21.195 in <sup>4</sup>	Iye	1.775 in <sup>4</sup>
		Sxe(t)	4.1124 in <sup>3</sup>	Sye(l)	0.5931 in <sup>3</sup>
Tension		Sxe(b)	4.3466 in <sup>3</sup>	Sye(r)	0.5750 in <sup>3</sup>
Ta	64525 lb	Negative Moment		Negative Moment	
		Maxo	165234 lb-in	Mayo	22802 lb-in
Shear		Ixe	21.188 in <sup>4</sup>	Iye	1.752 in <sup>4</sup>
Vay	9524 lb	Sxe(t)	4.4062 in <sup>3</sup>	Sye(l)	0.5600 in <sup>3</sup>
Vax	10714 lb	Sxe(b)	4.0579 in <sup>3</sup>	Sye(r)	0.5936 in <sup>3</sup>

## **APPENDIX**

### **5.4 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.

The information and test results presented by ENCON in this test report are offered in good faith based on information ENCON believes to be reliable. This information is offered as a guide to assist CUSTOMER in CUSTOMER's endeavors and does not contain any warranties as to fitness by ENCON. No REPRESENTATION OF WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THOSE OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE are made by ENCON, and more specifically, ENCON hereby expressly disclaim such. In no event shall ENCON be liable for ANY CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES, including, without limitation, labor, transportation, loss of use, loss of profits, harm, personnel injury and damage to property.

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**

Information and material provided by CUSTOMER to ENCON was reviewed by an ENCON executive. However, ENCON does not accept the responsibility for accuracy or verification of CUSTOMER's information or the suitability of CUSTOMER materials. Materials supplied by CUSTOMER were tested as received and were not evaluated for code or insurance compliance. CUSTOMER is expected to review the ENCON drawings, tables, test results and other information provided by ENCON to CUSTOMER critically so as to assure CUSTOMER that these presentations, formulas, drawings and other information are accurate and meaningful for the purpose intended.

No other warranties or guarantees shall be issued, implied, delivered or otherwise construed to be issued, implied or delivered.

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