



## ASTM E1592 TEST RESULTS

### SS1500 PANEL

*Zimmerman Metals, Inc.*  
*Over 60 years of Quality Workmanship and Service*

201 East 58<sup>th</sup> Avenue, Denver CO 80216  
303/294-0180 fax:303/292-5013 800/247-4202

  
**CERNY & IVEY ENGINEERS, INC.**  
**CONSULTING ENGINEERS — TESTING LABORATORY**

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January 22, 1997

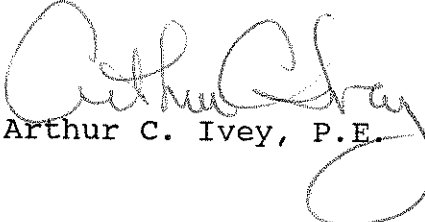
Engineering Report 96505-4


Zimmerman Metals, Inc.,  
SS1500 Standing Seam Panel Uplift Test

**SUMMARY**

Beginning November 20, 1996, testing of Zimmerman Metals, Inc. SS1500 Standing Seam roof panels was performed to determine their loading characteristics under uniform static uplift loads. The panels were 16 inches wide with a nominal 1 1/2 inch mechanically formed Standing Seam rib, 24 gage, steel and were tested with spans of 3 feet, 6 inches and one foot. The panels were tested in accordance with ASTM E 1592, "Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference." The 3-foot, 6-inch span test specimen failed at an uplift load of 72.8 PSF when a seam separated at the clips. The 1 foot span test specimen was tested to the limit of the chamber seal (127.9 PSF) with no failure.

Respectively submitted,

  
Arthur C. Ivey, P.E.

  
Todd Breedlove  
Senior Laboratory Technician



TECHNICAL SOCIETIES

American Concrete Institute  
American Society for Testing & Materials  
American Society of Civil Engineers  
American Society of Mechanical Engineers

Georgia Society of Professional Engineers  
Institute of Electrical & Electronic Engineers  
Microscopy Society of America

National Fire Protection Association  
National Society of Professional Engineers  
Society for Experimental Mechanics  
Society of Automotive Engineers

## INTRODUCTION

On November 20, 1996, testing of SS1500 Standing Seam Panels manufactured by Zimmerman Metals, Inc. was initiated to determine their loading characteristics under uplift loading conditions. The panels were tested in accordance with ASTM E-1592, "Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference." The panels were constructed on the test fixture by Architectural Metal Specialties, Inc. personnel. The panels were tested to failure. The loading characteristics were recorded and photographed. Color photographs of the test specimen and failure modes are included in this report.

## SPECIMEN

The specimen tested was an assembly of 16-inch SS1500 Standing Seam panels supplied by Zimmerman Metals. The panels were installed on a support structure using the appropriate formed sections, clips, and fasteners.

The SS1500 Standing Seam panels covered a nominal 16 inches and had 1 1/2-inch ribs (Figure 1). The material used to form the panels was 24 gage, 56.1 KSI average yield strength for 3-foot, 6-inch support and 62.6 KSI for 1 foot 0-inch support test (determined by Cerny & Ivey, see attached Laboratory

Report 96505) cold formed painted galvanized sheet steel.

The supports used for testing were 16-gage cee and zee sections. The eave end was supported by an 8-inch deep cee section. The remaining supports were 8-inch deep zee sections. The supports were made of cold formed steel and were spaced at 3 feet, 6 inches on centers for the first test and 1 foot on centers for the second test.

Clips supplied by Architectural Metal Specialties (1 1/2 inch 24 ga. steel Standing Seam clips) were used to attach the panels to the formed cee and zee sections (Photographs A through D). Each clip was attached to the support with two 1 inch by No. 8 self drill and tap pancake head screws (Photograph E). The starting edge of the first panel was secured with a 24 gage J-track. The J-track was attached to supports at 1 foot on centers. A formed edge detail lapped over the J-track and panel leg (Photograph F through N). The 24 gage edge detail was attached to the J-track with 1 inch by No. 8 self drill and tap pancake head screws spaced 1 foot on centers.

During installation each panel was lapped over the preceding panel and locked into place by hand crimping one end. A panel was split to finish the leading edge. No additional fasteners were installed on the leading edge.

After installation, the panel seams were double crimped with an electric seamer supplied by AMSI (Photograph I). The final specimen size was 21 feet, 0 inches long (11 feet, 0 inches for 1 foot on centers) by 6 feet, 8 inches (five panels) wide (Photographs J and K).

#### PROCEDURE

The panels were assembled in the test chamber by personnel from Architectural Metal Specialties, Inc. (Figure 2). A plastic film (6 mil thickness) was placed by Cerny & Ivey Engineers, Inc. personnel during panel installation to seal the panel assembly against air leakage. The plastic film was pleated so that it did not affect the test results by causing fillets or distribution of the pressure by bridging across members. The panel edges and plastic sheet were then sealed to the edge of the test chamber.

Deflection gages, accurate to 0.0005 inch, were installed above the ribs on the edge of the third panel at the center of the center span (two gages) and over the adjacent support location (two gages). Two gages were placed on the center of the third panel flat section at these same lines. The chamber pressure was measured at both ends (diagonal corners) of the chamber using water manometers accurate to 0.01 inch of water.

Pressure was applied to the specimen to a reference "zero" load of 1-inch of water (5.2 PSF) and maintained for 60 seconds; the deflection gages were then read. The load was then reduced to zero for a recovery period before increasing to the next load increment, where it was maintained for 60 seconds; deflections were then read. The load was returned to an actual zero load for a recovery period and then returned to the reference "zero" load and maintained for 60 seconds; set deflections were then read. This procedure was repeated until failure of the panel occurred. This procedure was performed in accordance with ASTM E-1592, "Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference."

## RESULTS

Test No. 96505-9 (Photographs L through N)  
Specimen: Zimmerman Metals Standing Seam Panel, 24 gage,  
56.1 KSI Painted galvanized steel, 3 1/2 foot  
supports

Date: November 20, 1996

LOAD (PSF)	<u>RIB DEFLECTION (INCHES)</u>						<u>RIB SET (INCHES)</u>					
	<u>MIDSPAN</u>			<u>SUPPORT</u>			<u>MIDSPAN</u>			<u>SUPPORT</u>		
	<u>4</u>	<u>6</u>	<u>AVG</u>	<u>1</u>	<u>3</u>	<u>AVG</u>	<u>4</u>	<u>6</u>	<u>AVG</u>	<u>1</u>	<u>3</u>	<u>AVG</u>
5.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.4	0.03	0.03	0.03	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
15.6	0.06	0.08	0.07	0.04	0.06	0.05	0.01	0.01	0.01	0.01	0.01	0.01
20.8	0.09	0.13	0.11	0.06	0.10	0.08	0.02	0.02	0.02	0.02	0.02	0.02
26.0	0.13	0.19	0.16	0.10	0.16	0.13	0.04	0.04	0.04	0.03	0.03	0.03
31.2	0.16	0.24	0.20	0.13	0.19	0.16	0.05	0.05	0.05	0.04	0.04	0.04
36.4	0.21	0.28	0.24	0.16	0.24	0.20	0.08	0.06	0.07	0.06	0.06	0.06
41.6	0.27	0.34	0.30	0.21	0.29	0.25	0.10	0.08	0.09	0.07	0.08	0.08
46.8	0.32	0.38	0.35	0.25	0.33	0.29	0.12	0.11	0.12	0.09	0.09	0.09
52.0	0.40	0.45	0.42	0.32	0.39	0.36	0.13	0.12	0.12	0.11	0.11	0.11
57.2	0.46	0.52	0.49	0.37	0.45	0.41	0.15	0.14	0.14	0.12	0.13	0.12
62.4	0.53	0.59	0.56	0.42	0.51	0.46	0.17	0.15	0.16	0.13	0.14	0.14
67.6	0.62	0.71	0.66	0.50	0.58	0.54	0.19	0.16	0.18	0.14	0.15	0.14

LOAD (PSF)	<u>MIDPANEL DEFLECTION (INCHES)</u>		<u>MIDPANEL SET (INCHES)</u>	
	<u>MIDSPAN</u>	<u>SUPPORT</u>	<u>MIDSPAN</u>	<u>SUPPORT</u>
	5	2	5	2
5.2	0.00	0.00	0.00	0.00
15.6	1.05	0.91	0.01	-0.09
20.8	1.53	1.40	0.02	-0.08
26.0	1.94	1.80	0.03	-0.08
31.2	2.15	2.02	0.04	-0.07
36.4	2.38	2.26	0.04	-0.06
41.6	2.66	2.55	0.06	-0.06
46.8	2.90	2.80	0.07	-0.04
52.0	3.21	3.13	0.07	-0.04
57.2	3.42	3.35	0.08	-0.03
62.4	3.60	3.53	0.05	-0.05
67.6	3.85	3.81	0.03	-0.02

#### OBSERVATIONS

10.4 PSF Visible deflection of pans  
5.2 PSF Panels return to initial shape  
15.6 PSF Increased pan deflection,  
visible spreading of panel ribs  
5.2 PSF Panels return to initial shape  
41.6 PSF Increased pan deflection and rib spread  
5.2 PSF Set in leading edge pan  
52.0 PSF Increased pan deflection and rib spread.  
Ribs rotate in clips  
5.2 PSF Set at pan ends  
57.2 PSF Deformation at clip locations  
72.8 PSF Panel ribs unseam at clips

Test No. 96505-6 (Photographs O through Q)  
Specimen: Zimmerman Metals Standing Seam Panel, 24 gage,  
62.6 KSI Painted galvanized steel, 1 foot  
supports  
Date: November 21, 1996

LOAD (PSF)	RIB DEFLECTION (INCHES)						RIB SET (INCHES)					
	MIDSPAN			SUPPORT			MIDSPAN			SUPPORT		
	4	6	AVG	1	3	AVG	4	6	AVG	1	3	AVG
5.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.8	0.02	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
10.4	0.03	0.00	0.02	0.03	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00
13.0	0.02	0.01	0.02	0.03	-0.02	0.00	0.01	0.00	0.00	0.01	0.00	0.00
15.6	0.03	0.02	0.02	0.03	-0.02	0.00	0.02	0.01	0.02	0.02	0.00	0.01
20.8	0.04	0.02	0.03	0.04	0.02	0.03	0.02	0.01	0.02	0.02	0.00	0.01
26.0	0.05	0.03	0.04	0.06	--	0.06	0.02	0.01	0.02	0.03	--	0.03
31.2	0.06	0.03	0.04	0.07	--	0.07	0.02	0.01	0.02	0.03	--	0.03
36.4	0.07	0.04	0.06	0.08	--	0.08	0.03	0.02	0.02	0.03	--	0.03
41.6	0.08	0.05	0.06	0.09	--	0.09	0.03	0.02	0.02	0.04	--	0.04
46.8	0.10	0.05	0.08	0.11	--	0.11	0.04	0.02	0.03	0.04	--	0.04
52.0	0.11	0.06	0.08	0.12	--	0.12	0.04	0.02	0.03	0.04	--	0.04
57.2	0.14	0.09	0.12	0.16	--	0.16	0.07	0.02	0.04	0.07	--	0.07
62.4	0.16	0.10	0.13	0.18	--	0.18	0.06	0.02	0.04	0.06	--	0.06

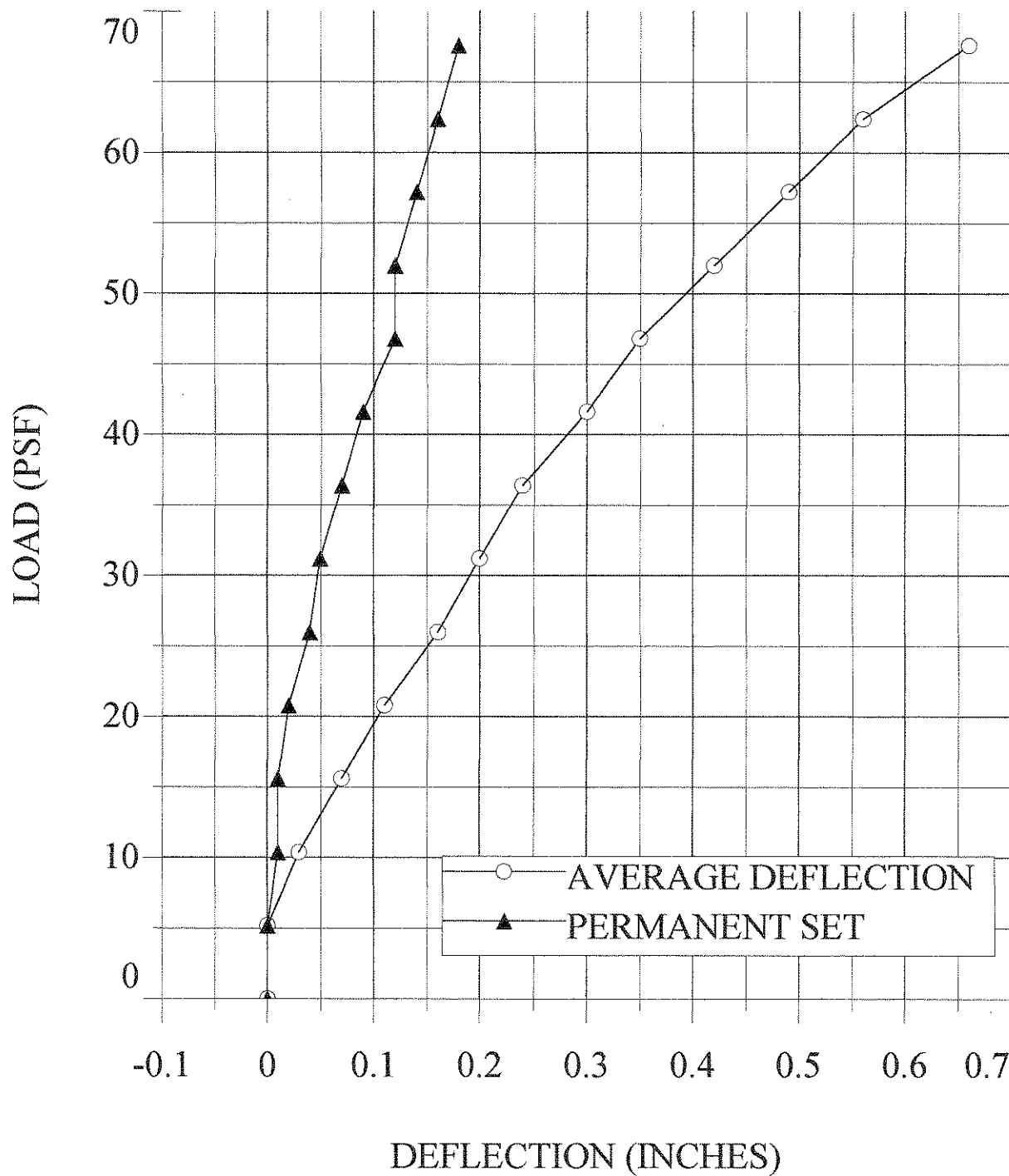
LOAD (PSF)	<u>MIDPANEL DEFLECTION (INCHES)</u>		<u>MIDPANEL SET (INCHES)</u>	
	<u>MIDSPAN</u>	<u>SUPPORT</u>	<u>MIDSPAN</u>	<u>SUPPORT</u>
	5	2	5	2
5.2	0.00	0.00	0.00	0.00
7.8	0.37	0.38	0.01	0.00
10.4	-0.01	0.11	0.01	0.00
13.0	1.16	1.12	0.02	0.00
15.6	1.34	1.31	0.01	0.00
20.8	1.68	1.65	0.01	0.00
26.0	1.92	1.88	-0.02	-0.01
31.2	2.12	2.10	0.02	-0.01
36.4	2.26	2.22	0.01	-0.01
41.6	2.41	2.39	0.00	-0.01
46.8	2.57	2.58	-0.01	-0.03
52.0	2.82	2.80	-0.01	-0.02
57.2	3.02	2.99	-0.06	-0.05
62.4	3.07	3.05	-0.06	-0.05

#### OBSERVATIONS

7.8 PSF Visible deflection of pans  
5.2 PSF Panels return to initial shape  
10.4 PSF Increased pan deflection.  
Visible spreading of panel ribs  
5.2 PSF Panels return to initial shape  
52.0 PSF Increased pan deflection and rib spread  
5.2 PSF Pan 5 does not return to flat  
57.2 PSF Increased pan deflection and rib spread  
5.2 PSF Pan 2 and 5 don't return to flat  
127.9 PSF Maximum pressure available due to leakage

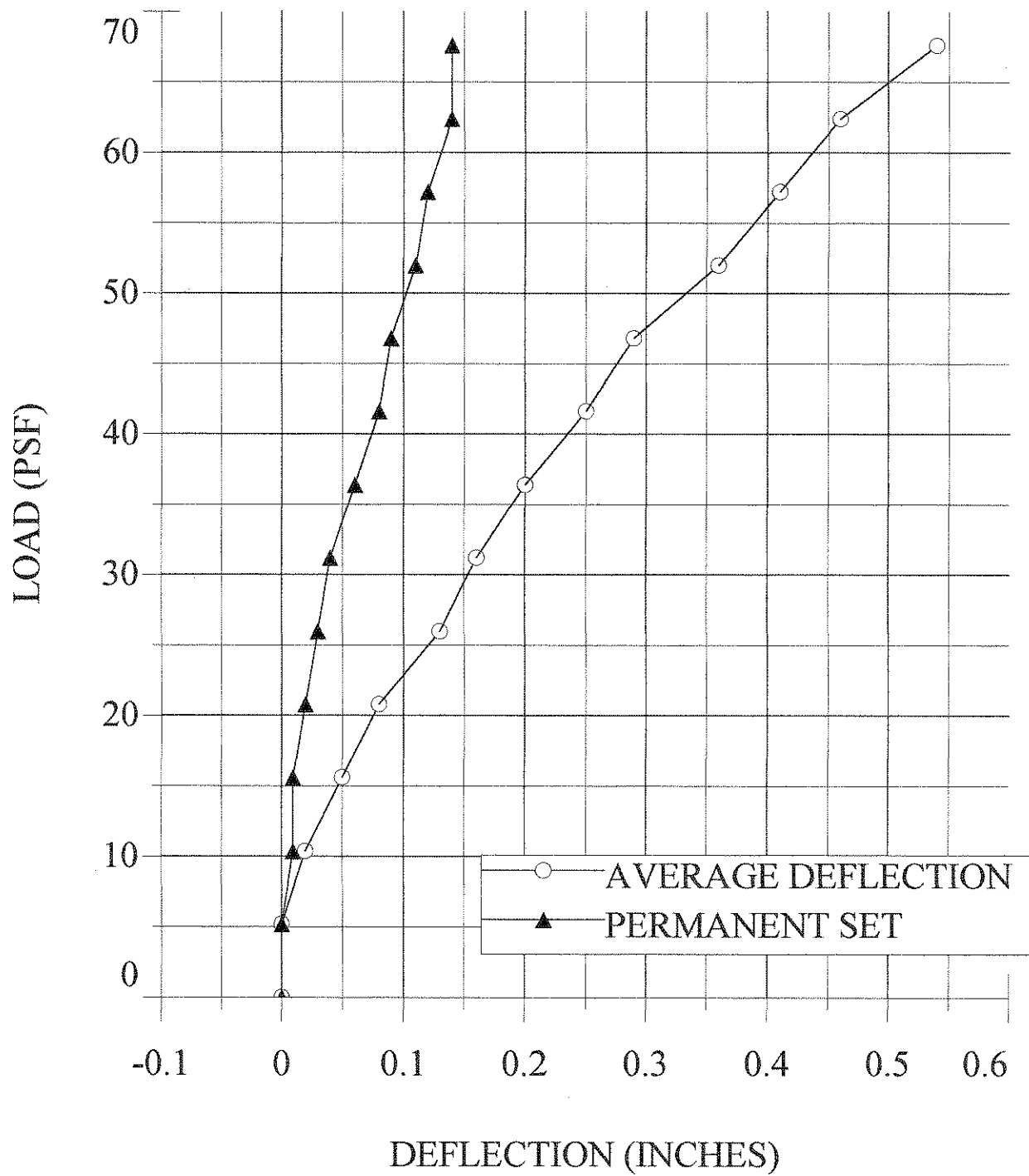
The deflection of the panels during testing is  
represented graphically in the pages that follow:

## PANEL TEST 96505-9



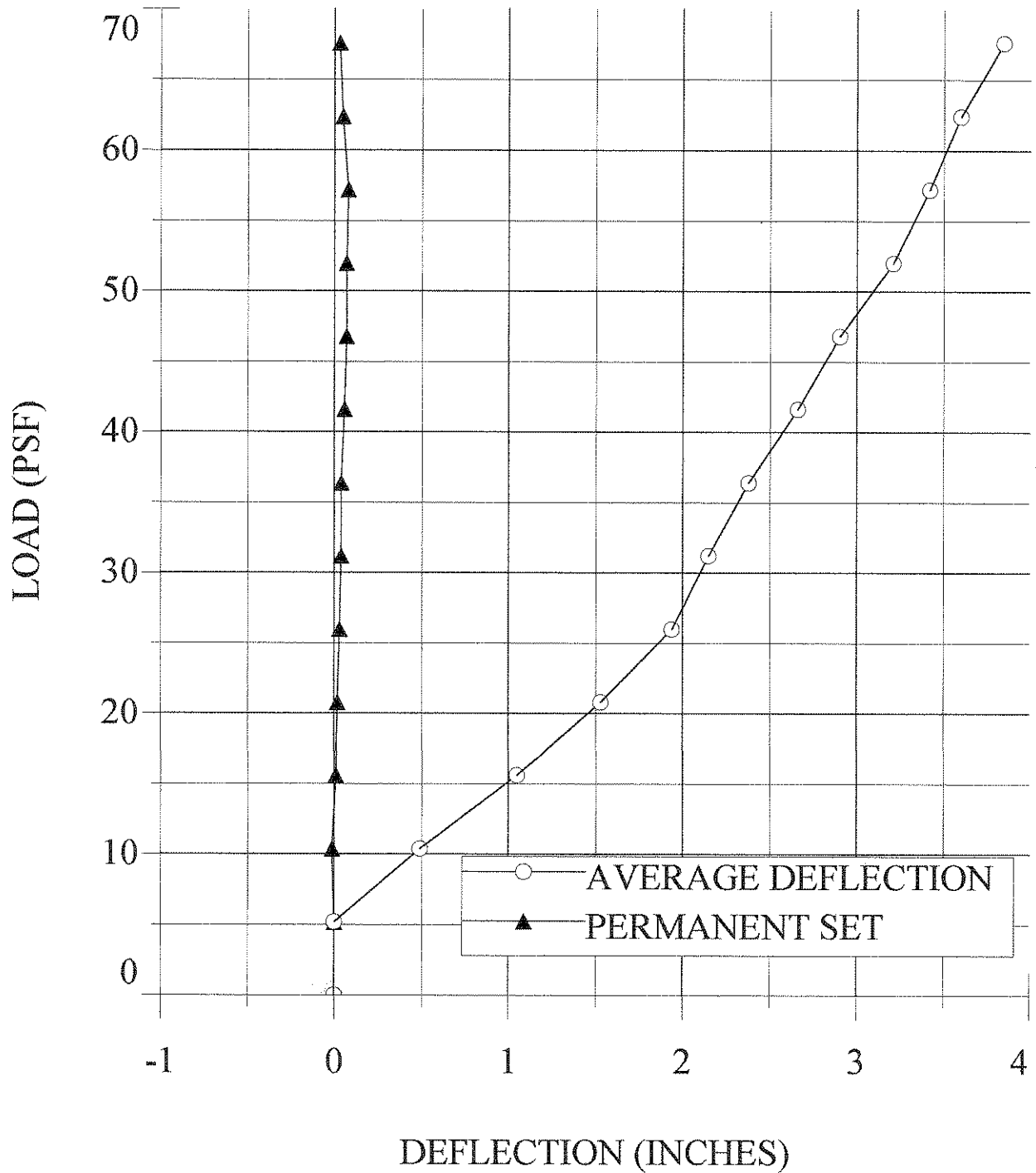
**RIB MIDSPAN**

## PANEL TEST 96505-9



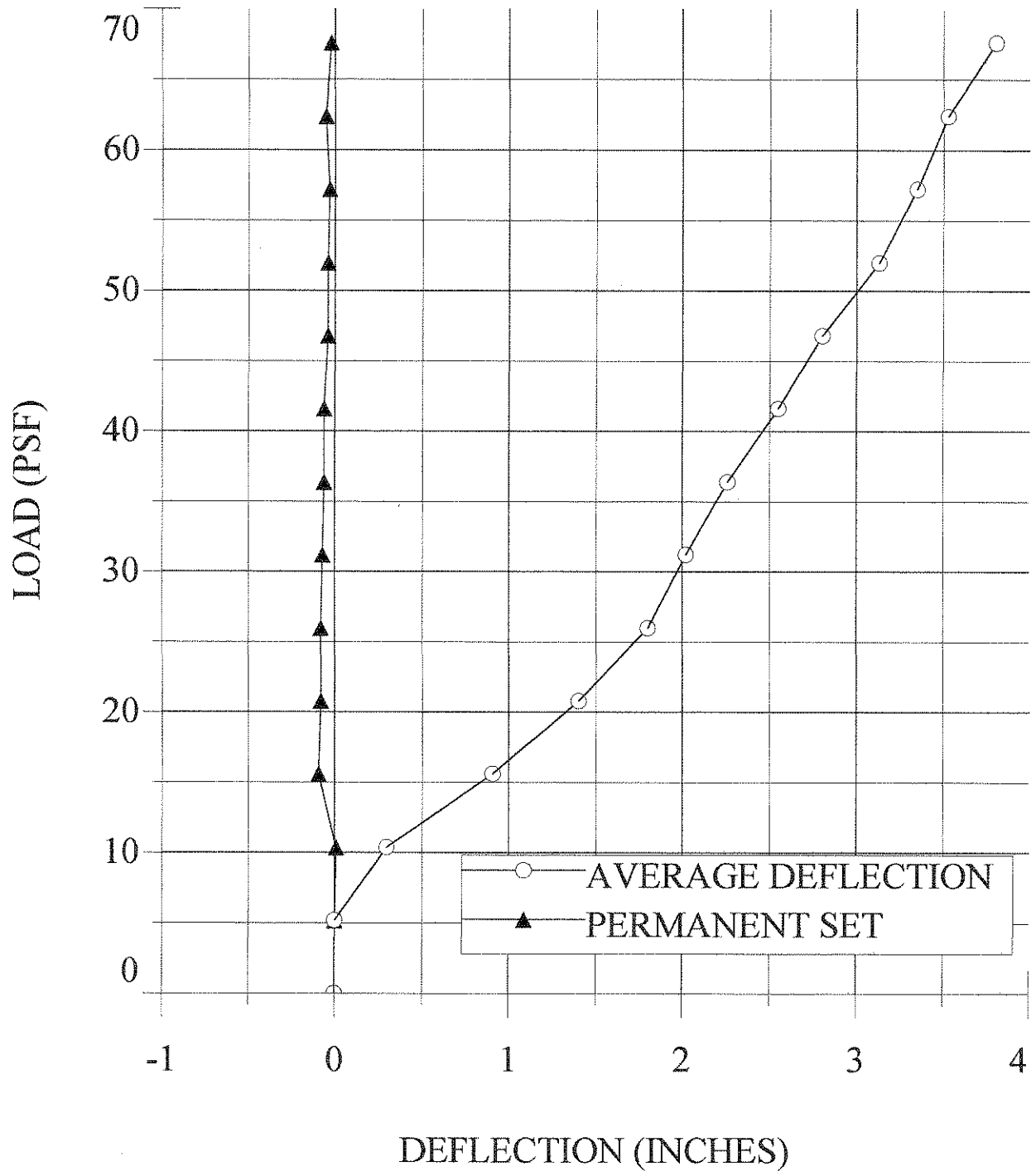
RIB SUPPORT

## PANEL TEST 96505-9



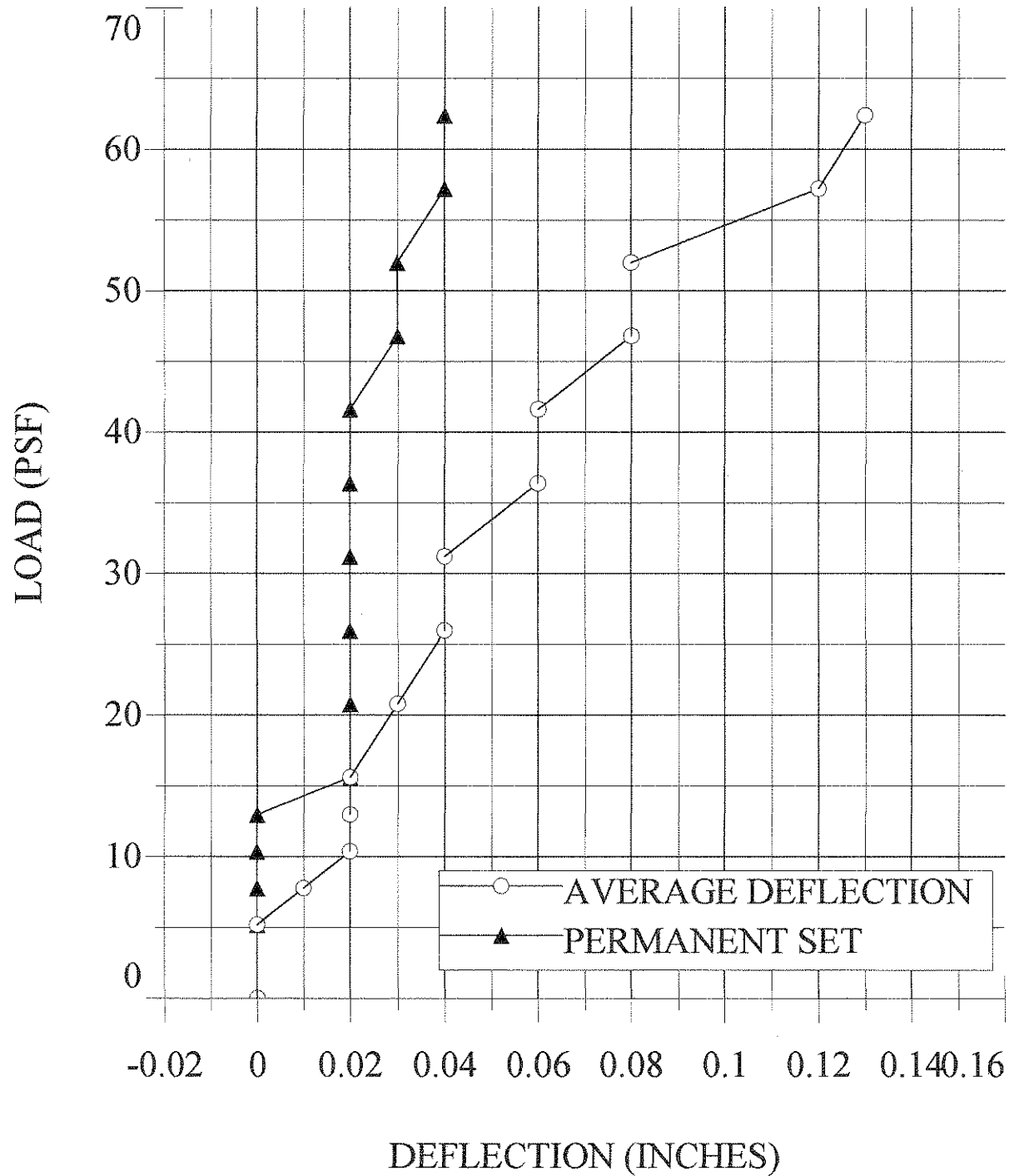
**MID PANEL MIDSPAN**

## PANEL TEST 96505-9



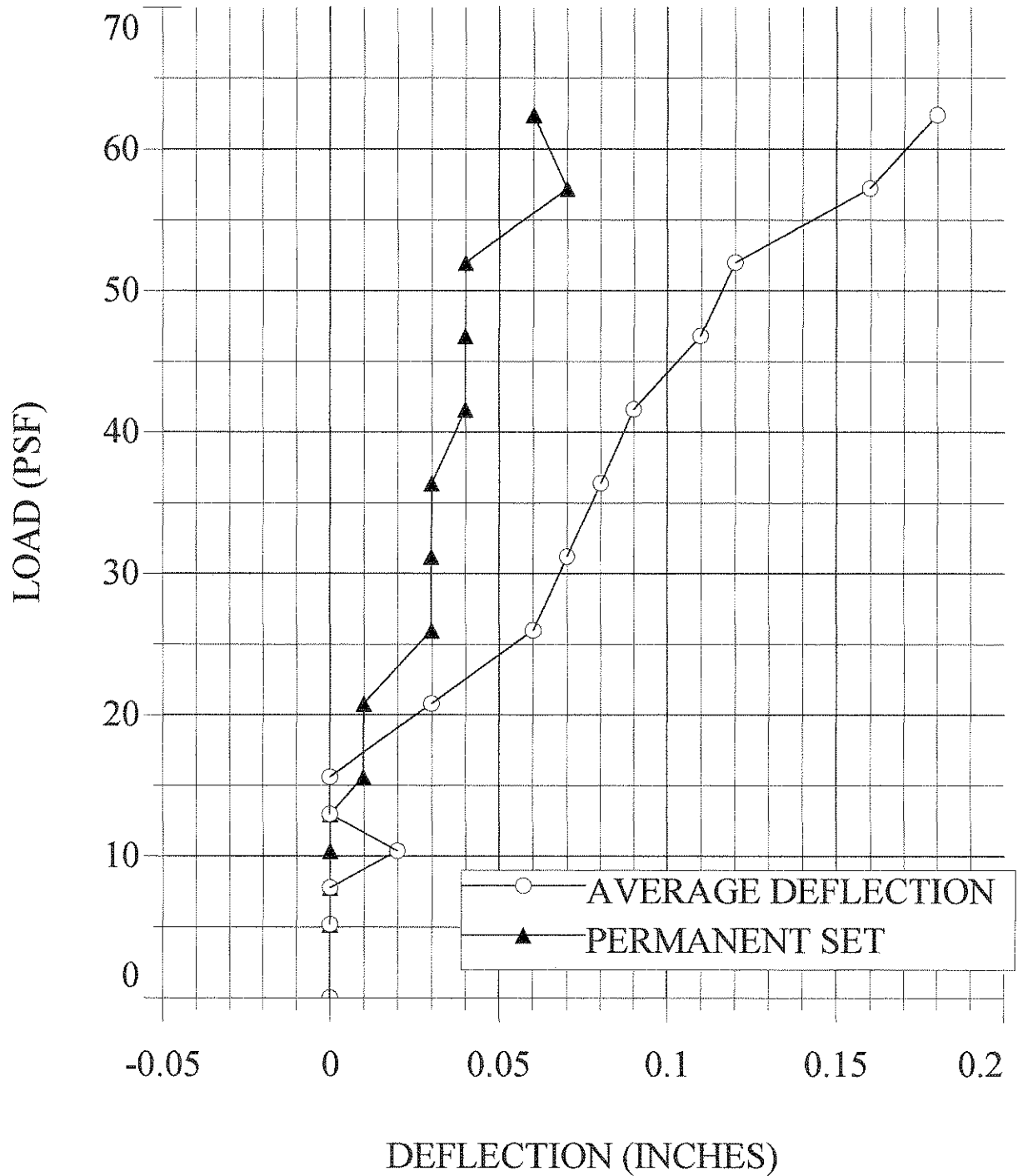
### MID PANEL SUPPORT

## PANEL TEST 96505-6



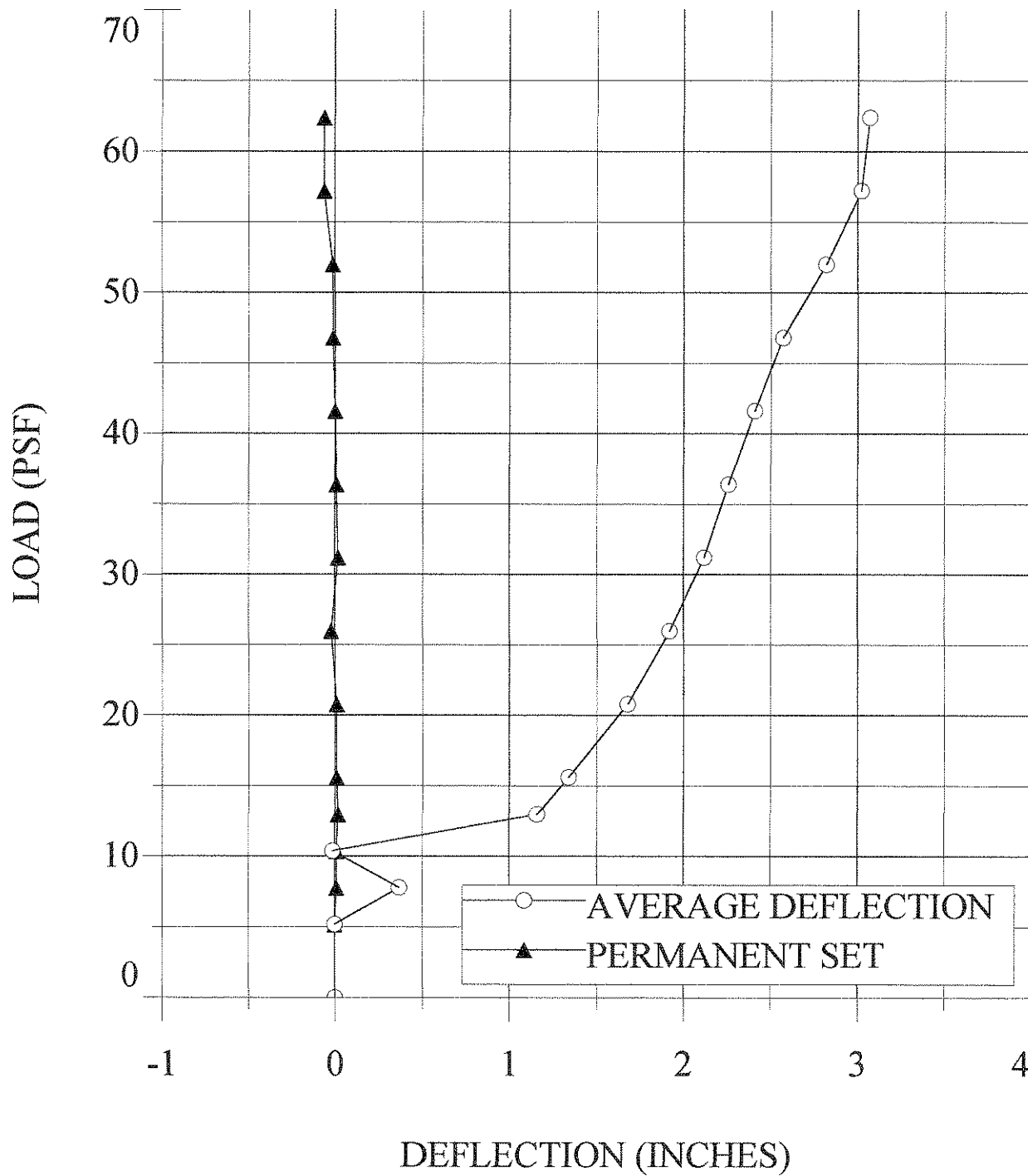
**RIB MIDSPAN**

## PANEL TEST 96505-6



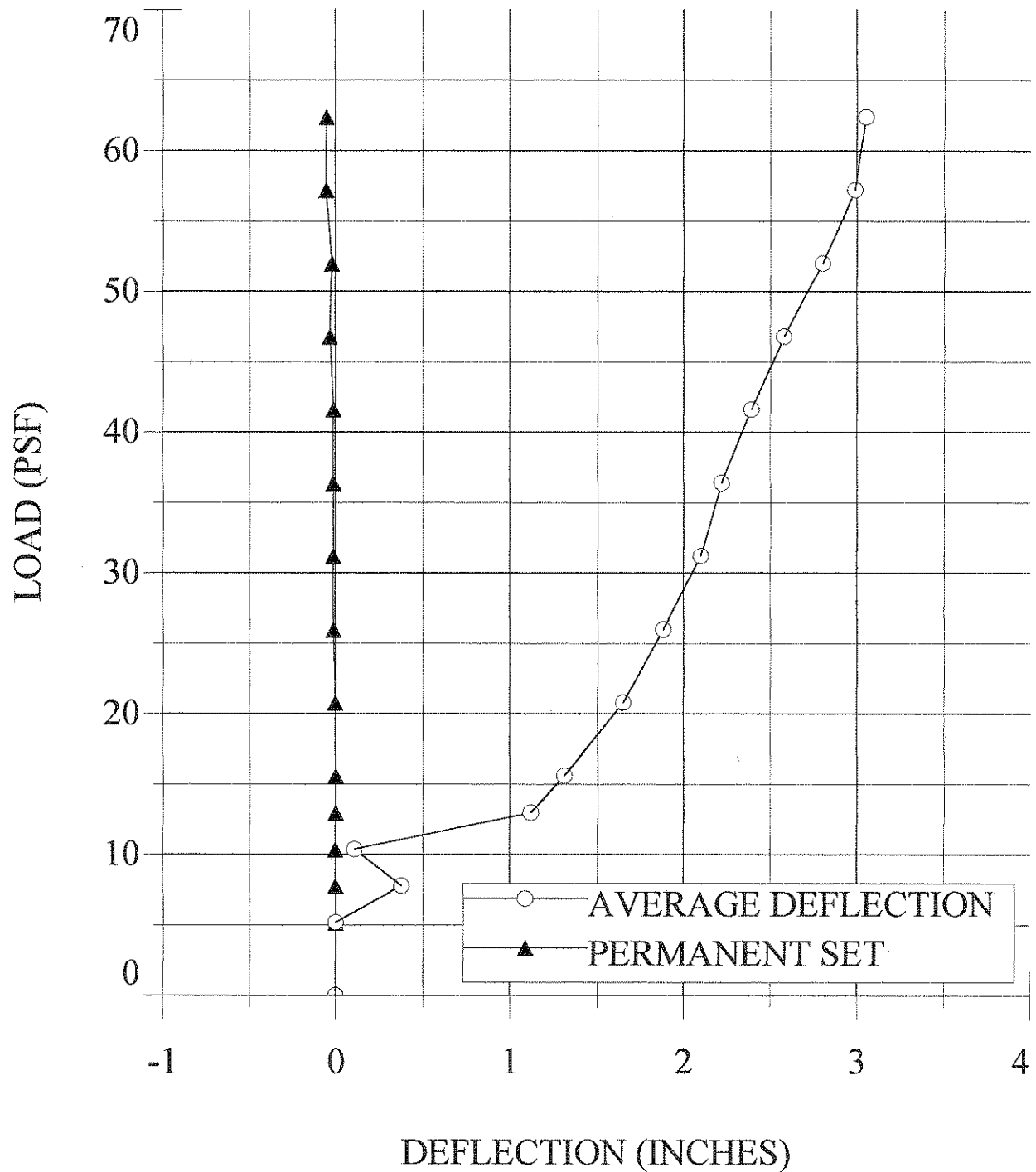
## RIB SUPPORT

## PANEL TEST 96505-6



**MID PANEL MIDSPAN**

## PANEL TEST 96505-6



### MID PANEL SUPPORT

### CONCLUSIONS

A table of negative wind pressure versus allowable panel span was created using the test results. Allowable panel loads at the tested spans were calculated using the provisions of the "Cold Formed Steel Design Manual" - 1986 edition with 1989 addendum by the American Iron and Steel Institute. The allowable panel spans were calculated for given panel loads between the maximum and minimum allowable panel pressures based on the tested spans. Linear interpolation was used between the tested spans.

The allowable panel loads were determined using the ultimate test loads and factors of safety prescribed by section F1 of the Cold Formed Steel Design Manual. The calculations were based on the following equations:

(Eq. F1-1)  $R \geq (1.5(D) + 2(W)) / 1.333$  for panel failure

(Eq. F1-4)  $R \geq (2.5(D) + 2.5(W)) / 1.333$  for connection failure

Where R = required panel strength based on tests  
D = dead load (included in test data)  
W = wind load

The required panel or connection strength was divided by  $1 \frac{1}{3}$  for wind loading. Panel seam separations were considered as a connection failure.

The generated span table is as follows:

Engineering Report 96505-4  
 January 22, Allowable Panel Span for Uplift Wind Pressure  
Zimmerman Metals, Inc.  
SS 1500 Standing Seam Panel  
16" wide / 24 Gage Steel

Page 20

Three Span Continuous Panel

Negative Pressure (psf)	Allowable Span (ft.)	Negative Pressure (psf)	Allowable Span (ft.)
38.8	3.50	63	2.20
39	3.49	64	2.14
40	3.44	65	2.09
41	3.38	66	2.04
42	3.33	67	1.98
43	3.28	68	1.93
44	3.22	69	1.88
45	3.17	70	1.82
46	3.11	71	1.77
47	3.06	72	1.71
48	3.01	73	1.66
49	2.95	74	1.61
50	2.90	75	1.55
51	2.84	76	1.50
52	2.79	77	1.45
53	2.74	78	1.39
54	2.68	79	1.34
55	2.63	80	1.28
56	2.58	81	1.23
57	2.52	82	1.18
58	2.47	83	1.12
59	2.41	84	1.07
60	2.36	85	1.01
61	2.31	85.3	1.00
62	2.25		

<u>Test Data :</u>	<u>Test Span</u> (ft.)	<u>Ultimate</u> <u>Pressure</u> (psf)	<u>Allowable</u> <u>Pressure</u> (psf)
	3.5	72.8	38.8
	1.0	127.9	85.3
	* * * * *	* * * * *	

TOTAL P.05

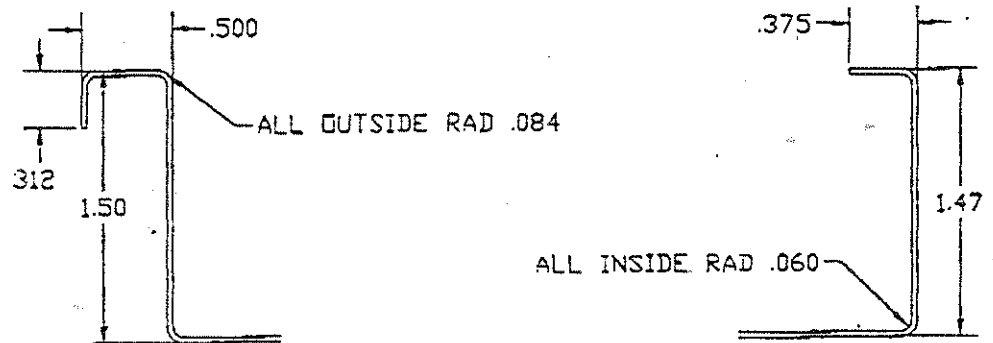


ZIMMERMAN METALS INC.  
201 E. 58TH AVE.  
DENVER, CO. 80216  
U.S.A.

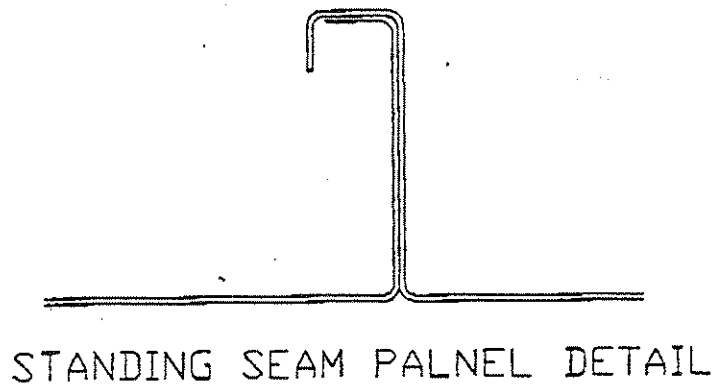
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MANUFACTURERS OF PORTABLE  
ROLL-FORMING MACHINES

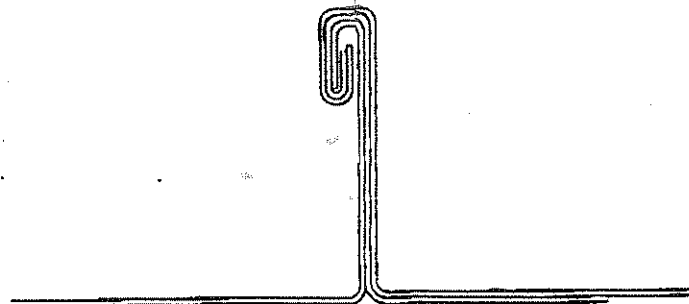
SS1500



1 1/2" STANDING SEAM



STANDING SEAM PALNEL DETAIL

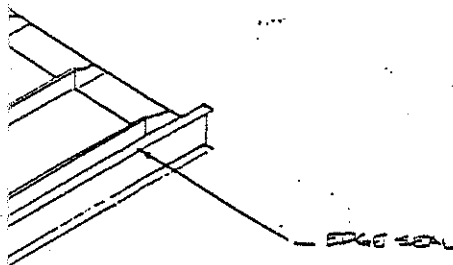


SEAMED CLIP DETAIL

Figure 1

## 2 GENERAL SPECIMEN LAYOUT

FOR MANOMETER



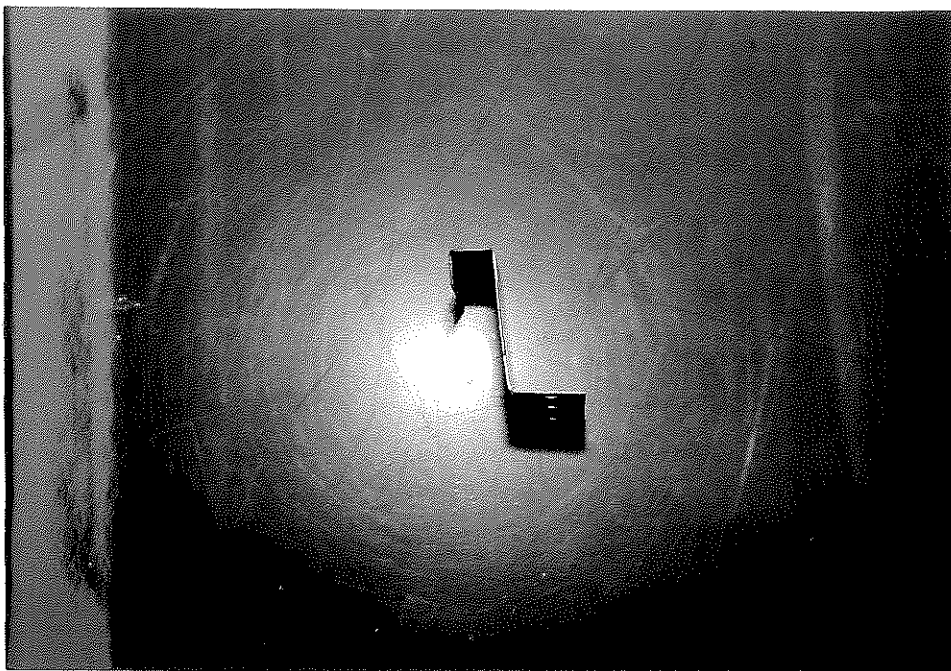
TEST SPECIMEN

IT FOLLOWS UNDER PANELS IN RIBS

TO

IS IN ACCORDANCE WITH ASTM E-1592,  
METHOD FOR STRUCTURAL PERFORMANCE OF  
AND SIDING SYSTEMS BY UNIFORM STATIC  
PRESSURE" AS OUTLINED IN THE U.S. ARMY  
GUIDE SPECIFICATION FOR MILITARY  
-07416 (SSSMR SYSTEMS)..

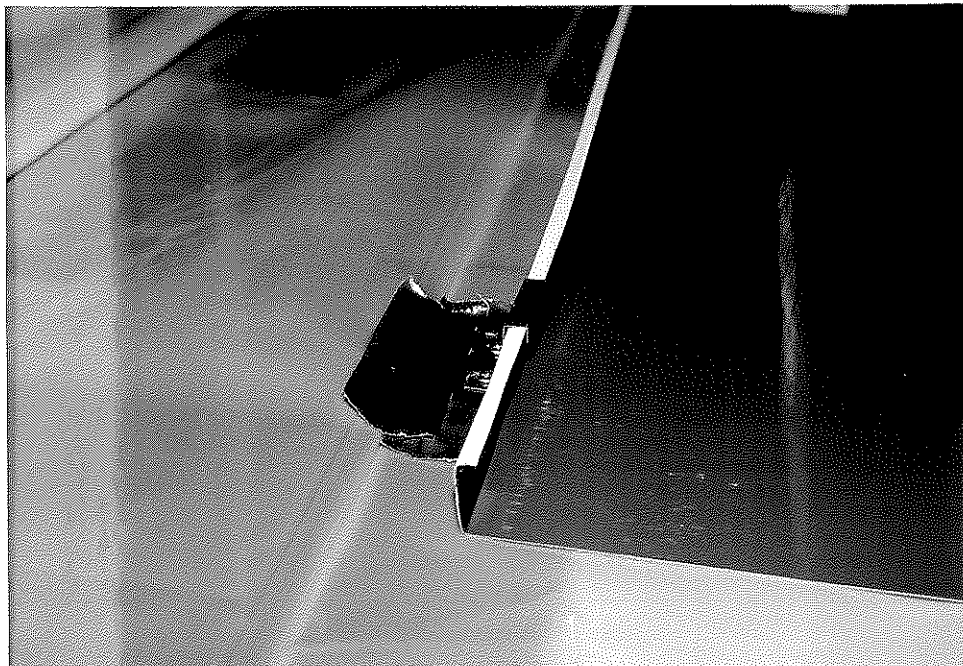
CERNY & IVEY ENGINEERS, INC. ATLANTA, GEORGIA			
SSSMR TEST CHAMBER			
U.S. ARMY CORP OF ENGINEERS STANDARD TEST 2.			
DATE 7-2-92	SCALE AS NOTED	DESIGNED ACI	INITIALS



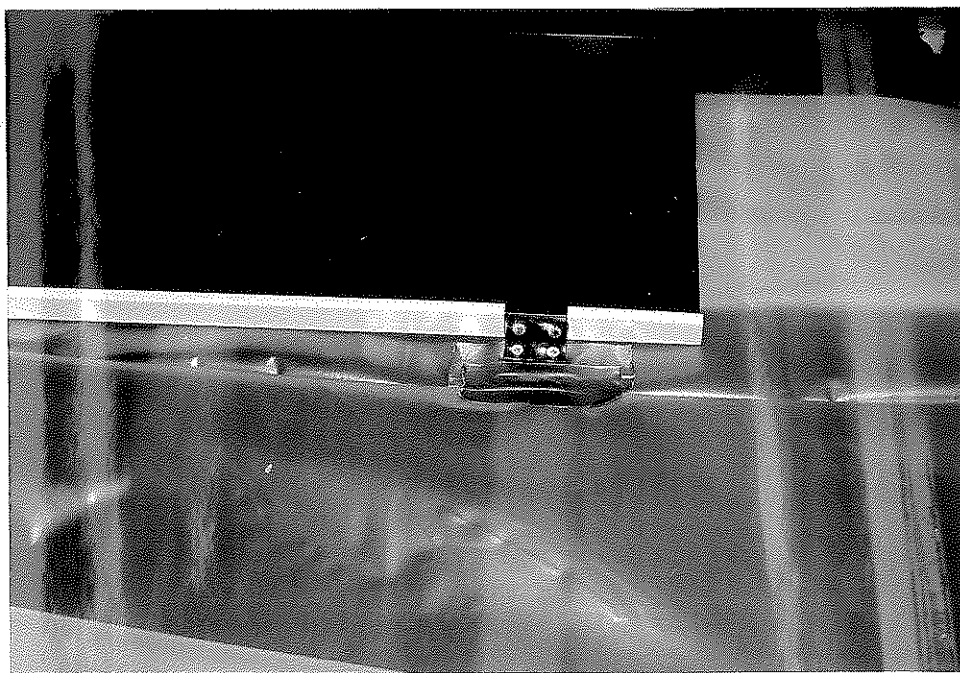
PHOTOGRAPH A  
STANDING SEAM CLIP



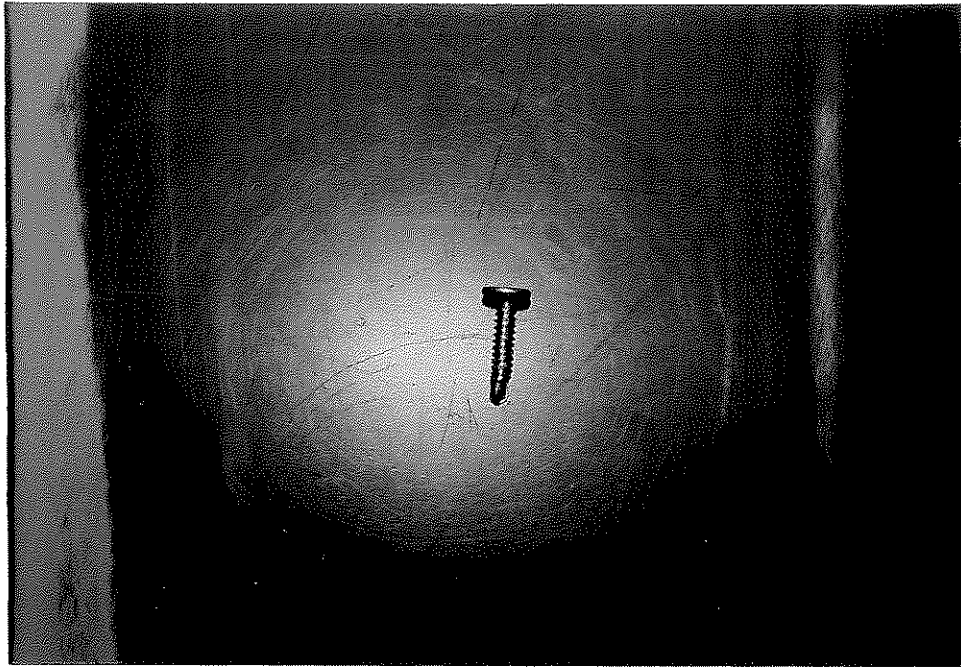
PHOTOGRAPH B  
STANDING SEAM CLIP



PHOTOGRAPH C  
INSTALLATION OF CLIP



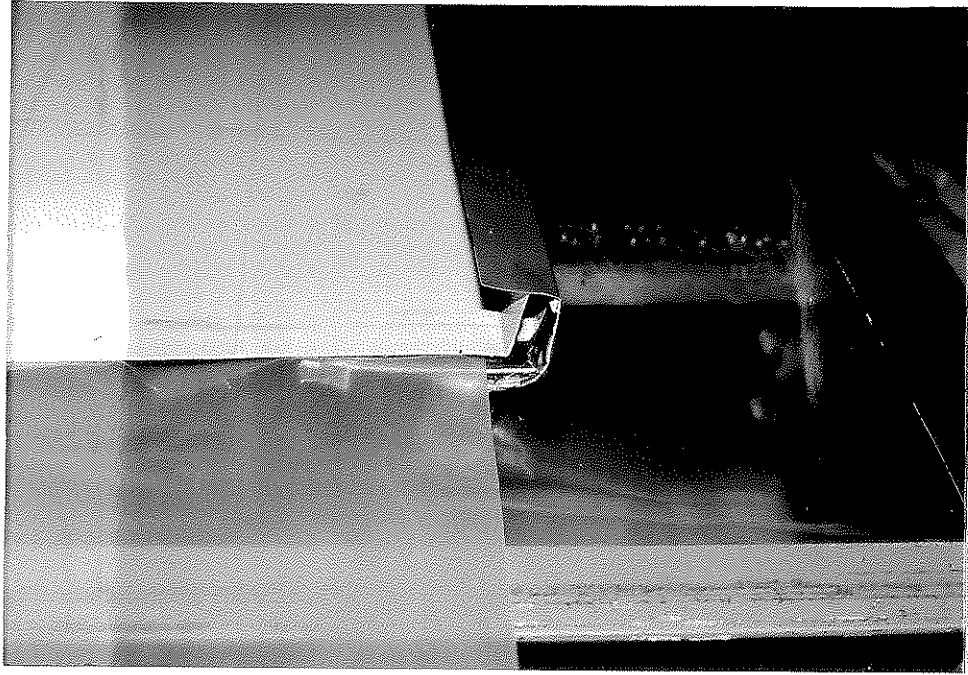
PHOTOGRAPH D  
CLIP INSTALLATION



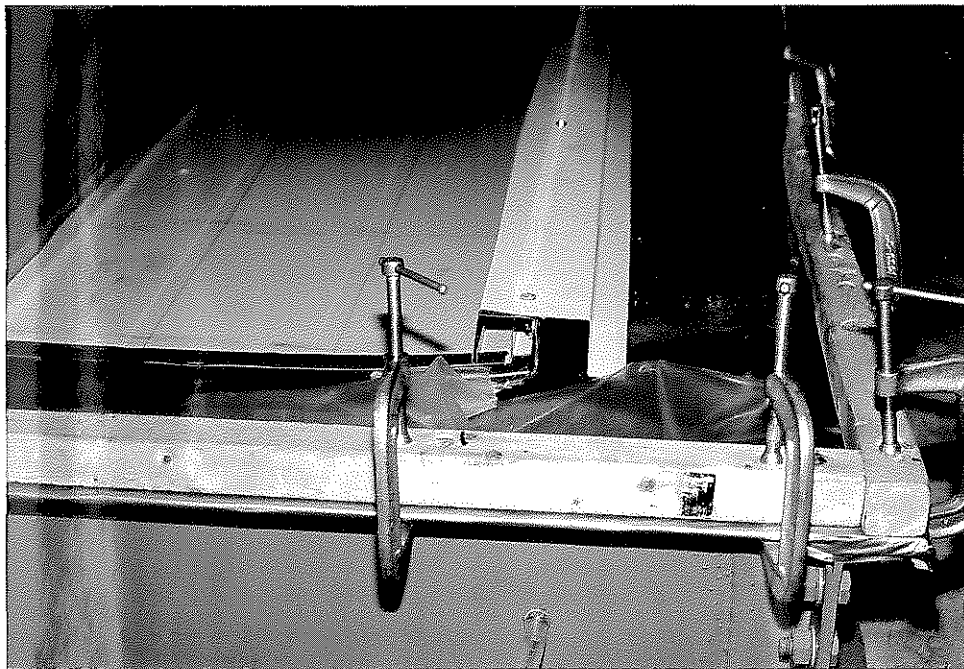
PHOTOGRAPH E  
TYPICAL PANCAKE HEAD FASTENER



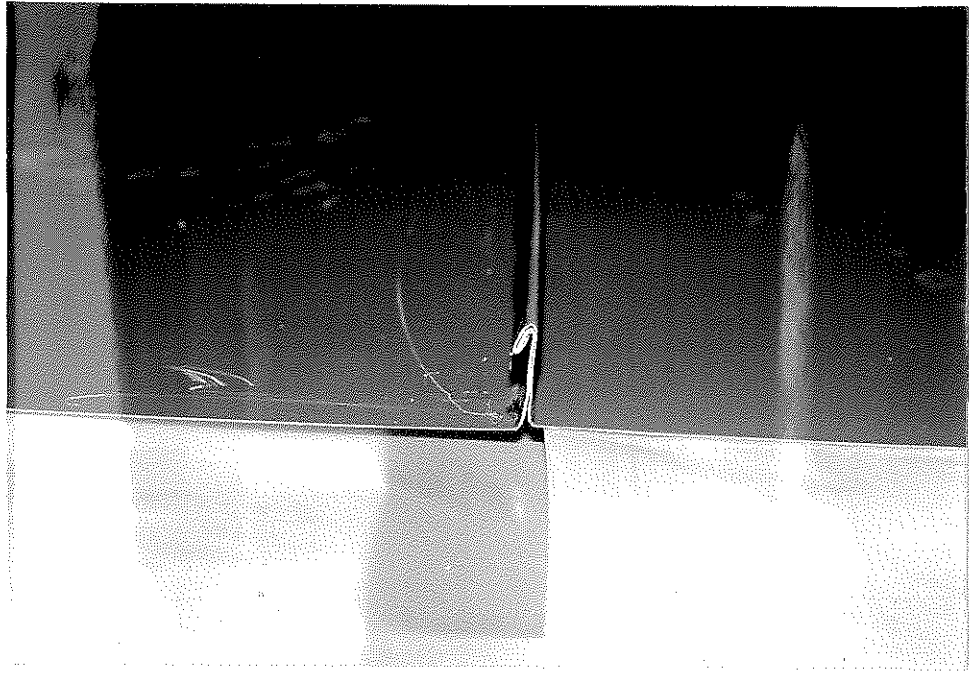
PHOTOGRAPH F  
J-TRACK INSTALLED ON SUPPORTS



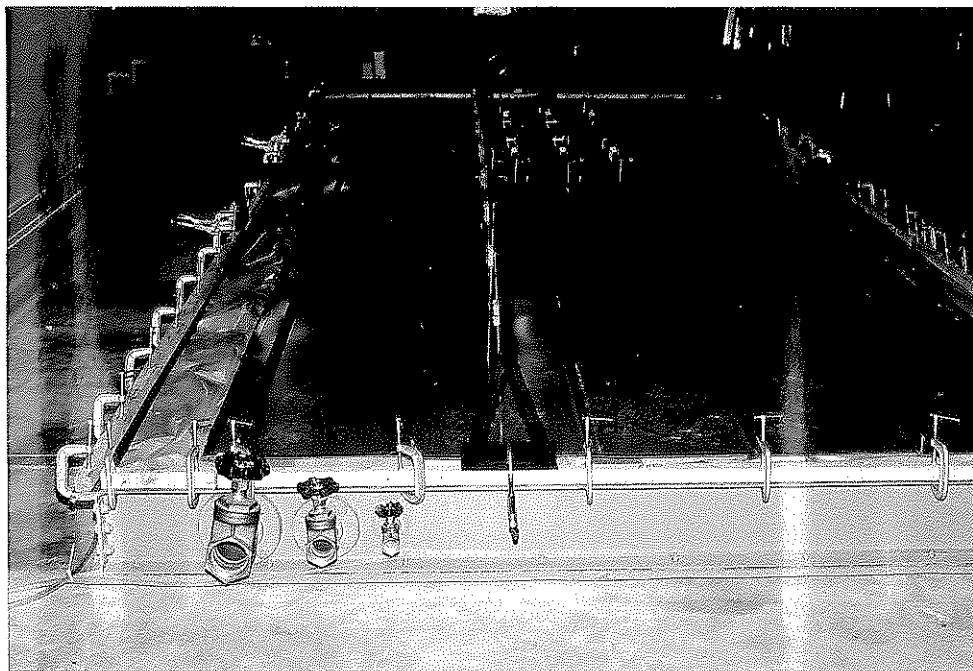
PHOTOGRAPH G  
J-TRACK AND PANEL



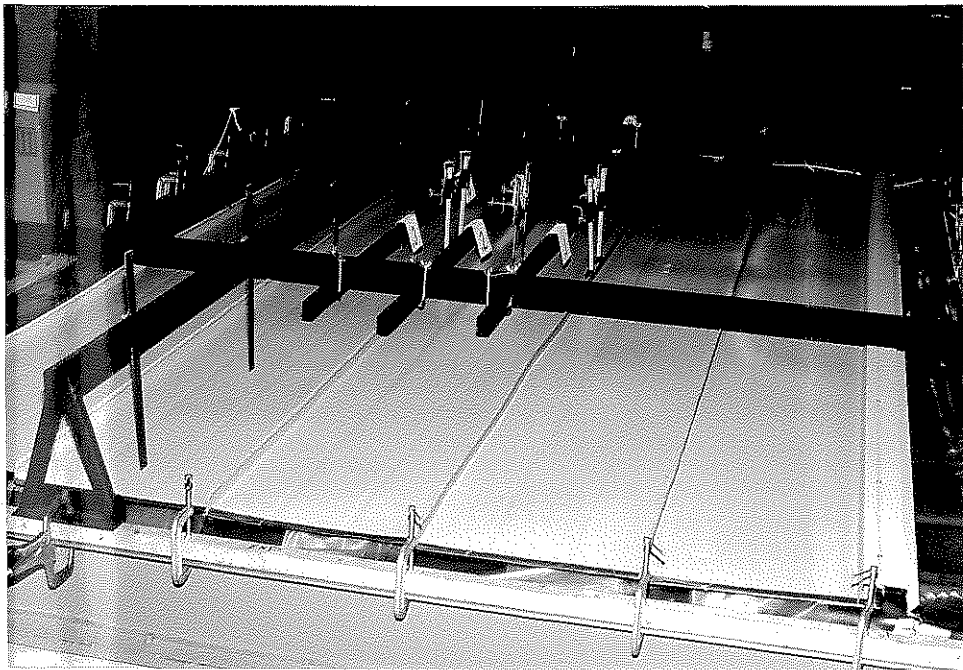
PHOTOGRAPH H  
EDGE DETAIL



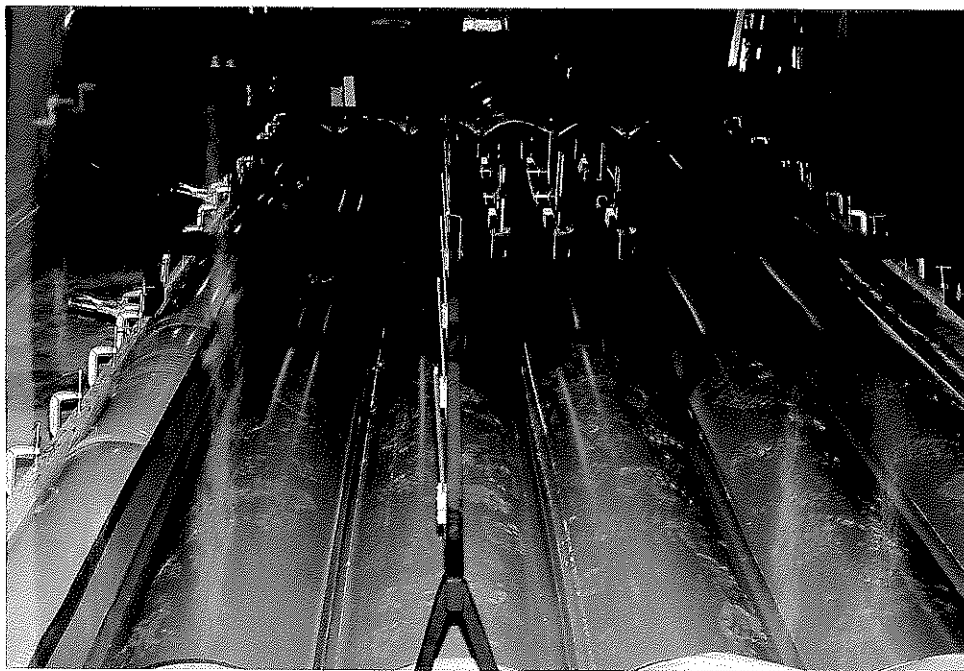
PHOTOGRAPH I  
PROFILE OF CRIMPED PANEL SEAM



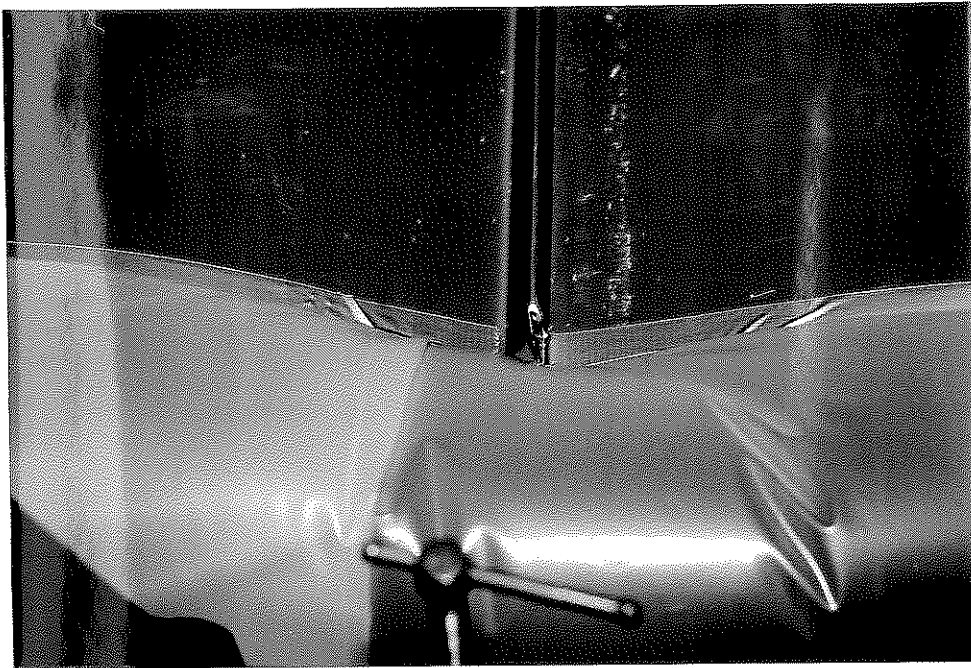
PHOTOGRAPH J  
ASSEMBLED PANEL WITH 3-FOOT, 6-INCH SUPPORTS



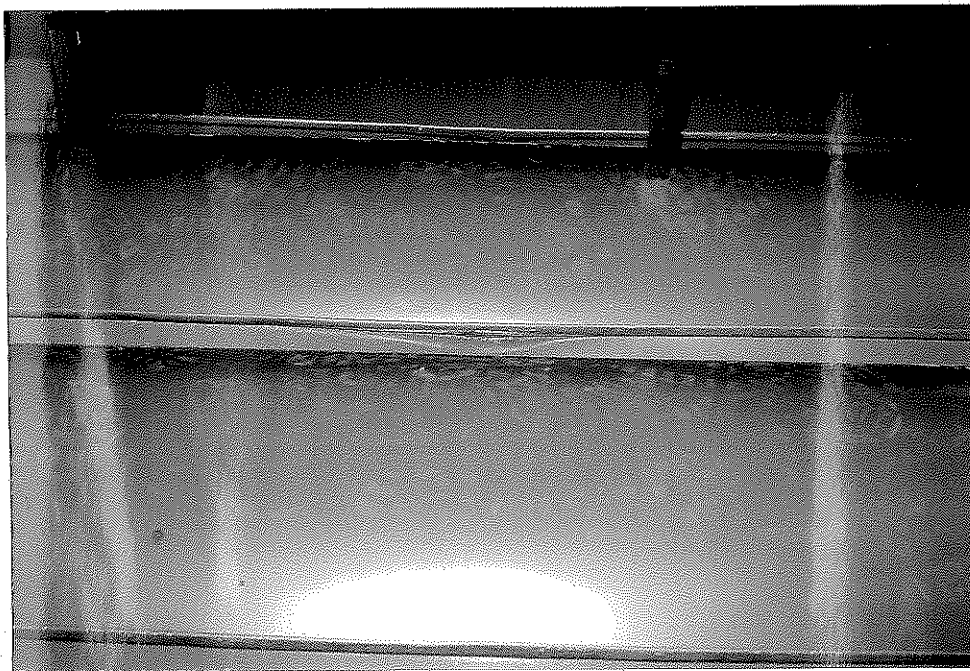
PHOTOGRAPH K  
ASSEMBLED PANEL WITH 1 FOOT 0 INCH SUPPORTS



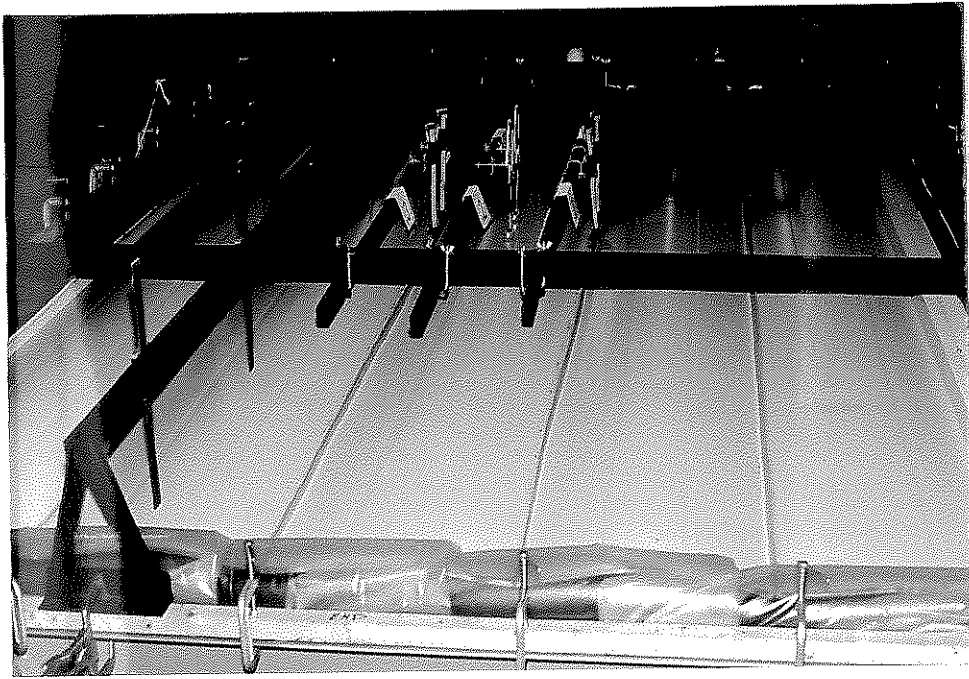
PHOTOGRAPH L  
TEST PANEL 96505-9 WITH LOAD APPLIED



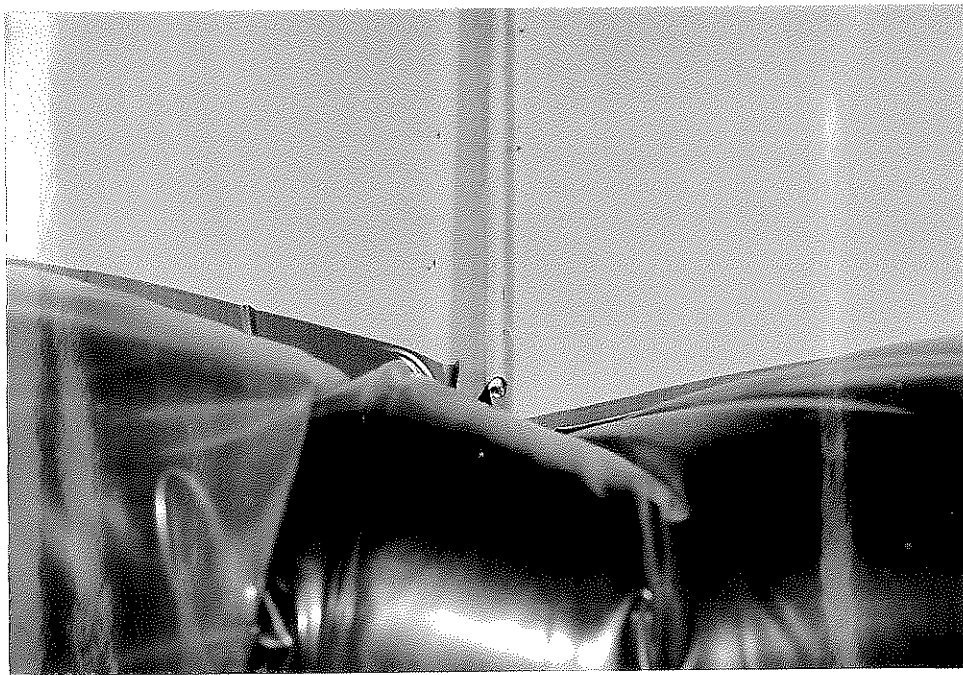
PHOTOGRAPH M  
SPREADING OF PANEL RIB



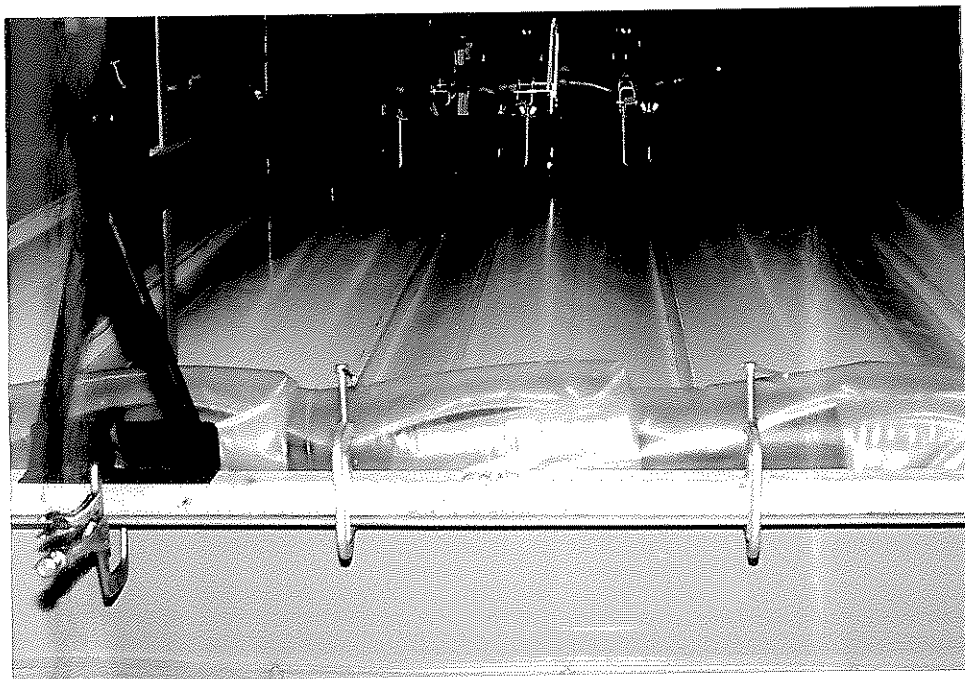
PHOTOGRAPH N  
FAILURE OF SEAM AT CLIP



PHOTOGRAPH Q  
TEST PANEL 96505-6 WITH LOAD APPLIED



PHOTOGRAPH P  
SPREADING OF PANEL RIB



PHOTOGRAPH Q  
DEFLECTION OF PANEL WITH INCREASED LOAD

# LABORATORY REPORT

NUMBER: 96505 January 22, 1997

**CERNY & IVEY ENGINEERS, INC.**  
CONSULTING ENGINEERS — TESTING LABORATORY



5650 PEACHTREE PARKWAY (404)449-6936 NORCROSS (ATL) GA 30092

## REFERENCE

## TEST DESCRIPTION

Tensile Test

## SAMPLE(S) RECEIVED IN LABORATORY

DATE: 11/19/96 BY: CTB VIA: AMSI

## SAMPLE DESCRIPTION

Mr. Eric Paulsen  
Zimmerman Metals, Inc.  
201 East 58th Avenue  
Denver, CO 80216

Steel sheet samples from tested  
Panels: 1 1/2 Snap Lock SL1500  
1 inch Snap Lock SL1000  
Nail-Leg NS1000  
Standing Seam SS1500

## INTRODUCTION

To determine the strength of the materials used to fabricate the panels used in uplift testing, samples were randomly removed for tensile testing. The selected samples were machined in accordance with ASTM A370 and tested per ASTM E8. The material yield strength and ultimate strength were calculated from the test results.

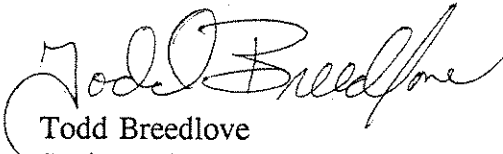
## RESULTS

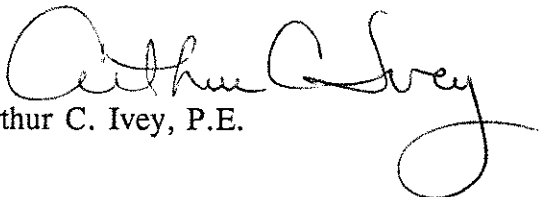
Sample	Base Metal Thickness (in)	% Elongation	Yield Strength (KSI)	Ultimate Strength (KSI)
SL1500A	0.025	20.00	55.3	60.3
SL1500B	0.025	20.45	56.9	58.4
SL1500C	0.025	21.80	57.7	59.4
AVERAGE		20.75	56.6	59.4
SL1000A	0.025	20.70	62.7	63.7
SL1000B	0.025	20.05	62.4	63.6
SL1000C	0.025	18.75	62.7	63.9
AVERAGE		19.83	62.6	63.7
NS 1000A	0.024	21.60	62.5	65.3
NS 1000B	0.024	19.40	60.8	66.6
NS 1000C	0.024	18.15	64.4	66.3
AVERAGE		19.72	62.6	66.1
SS 1500A	0.023	21.50	61.0	65.7
SS 1500B	0.023	21.75	63.3	66.3
SS 1500C	0.023	23.00	63.6	66.3
AVERAGE		22.08	62.6	66.1
SS 1500D	0.024	23.8	56.1	66.7
SS 1500E	0.024	22.2	56.1	67.0
SS 1500F	0.024	23.6	56.1	66.2
AVERAGE		23.2	56.1	66.6

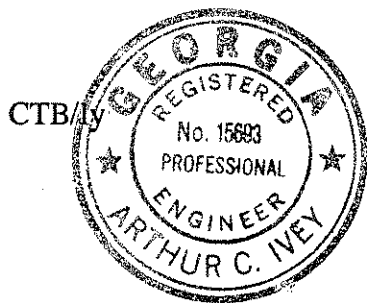
NOTE: THE SAMPLES AND/OR ITEMS PROVIDED FOR ANALYSIS WILL BE DISCARDED THIRTY (30) DAYS AFTER DATE OF THIS REPORT UNLESS FURTHER NOTIFICATION IS RECEIVED.

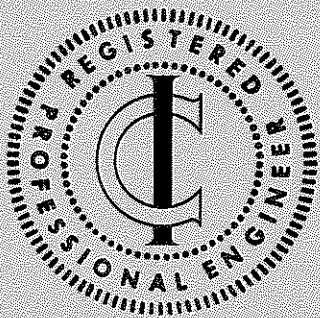
If we can be of further service in this matter, please do not hesitate to call.

Respectfully submitted,

  
Todd Breedlove  
Senior Laboratory Technician

  
Arthur C. Ivey, P.E.





ENGINEERING REPORT 97505-4  
SS1500 Standing Seam Panel Uplift Test

CERNY & IVEY ENGINEERS, INC.

ATLANTA, GEORGIA

*Consulting Engineers  
Testing Laboratory*