ASTM E1592 TEST RESULTS

SL1000 PANEL

Zimmerman Metals, Inc.

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

5650 PEACHTREE PARKWAY, NORCROSS (ATLANTA), GA. 30092
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January 22, 1997

Engineering Report 96505-2

Zimmerman Metals, Inc.,
SL1000 Snap Lock Panel Uplift Test

SUMMARY

Beginning November 19, 1996, testing of Zimmerman Metals, Inc. SL1000 Snap Lock roof panels was performed to determine their loading characteristics under uniform static uplift loads. The panels were 16 inches wide with a nominal 1 inch Snap Lock 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 41.1 PSF when a clip straightened and disengaged. The 1 foot span test specimen failed when a seam seperated at a load of 41.6 PSF.

Respectively submitted,

Arthur C. Ivey, P.E.

Todd Breedlove
Senior Laboratory Technician

INTRODUCTION

On November 19, 1996, testing of SL1000 Snap Lock 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 SL1000 Snap Lock panels supplied by Zimmerman Metals. The panels were installed on a support structure using the appropriate formed sections, clips, and fasteners.

The SL1000 Snap Lock panels covered a nominal 16 inches and had 1 inch ribs (Figure 1). The material used to form the panels was 24 gage, 62.6 KSI average yield strength (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 inch 24 ga. steel Snap Lock clips) were used to attach the panels to the formed cee and zee sections (Photographs A and B). Each clip was attached to the support with two 1 inch by No. 8 self drill and tap pancake head screws (Photographs C). 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 (Photographs D and E). 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 (Photograph F). A panel was split to finish the leading edge. No additional fasteners were installed on the leading edge. The final specimen size was 21 feet, 0 inches long (11 feet, 0 inches for 1 foot centers) by 6 feet, 8 inches (five panels) wide

(Photographs G and H).

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. 96505-2 (Photographs I through K)
Specimen: Zimmerman Metals 1 inch Snap Lock panel, 24 gage, 62.6 KSI Painted galvanized steel, 3 1/2 foot supports
Date: November 19, 1996

LOAD	RIB DEFLECTION (INCHES)						RIB SET (INCHES)					
	MIDSPAN			SUPPORT			MIDSPAN			SUPPORT		
(PSF)	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	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.00
10.4	0.05	0.05	0.05	0.02	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01
13.0	0.07	0.07	0.07	0.02	0.05	0.04	0.02	0.02	0.02	0.01	0.02	0.02
15.6	0.08	0.09	0.08	0.02	0.05	0.04	0.03	0.02	0.02	0.02	0.02	0.02
18.2	0.11	0.11	0.11	0.04	0.07	0.06	0.04	0.04	0.04	0.02	0.03	0.02
20.8	0.13	0.13	0.13	0.05	0.08	0.06	0.04	0.04	0.04	0.03	0.03	0.03
26.0	0.18	0.19	0.18	0.09	0.12	0.10	0.06	0.07	0.06	0.04	0.05	0.04
31.2	0.23	0.25	0.24	0.12	0.16	0.14	0.08	0.09	0.08	0.05	0.08	0.06
36.4	0.32	0.36	0.34	0.20	0.24	0.22	0.11	0.12	0.12	0.10	0.10	0.10

LOAD	MIDPANEL DEFLECTION (INCHES)		MIDPANEL SET (INCHES)	
	MIDSPAN	SUPPORT	MIDSPAN	SUPPORT
(PSF)	5	2	5	2
5.2	0.00	0.00	0.00	0.00
7.8	0.06	0.32	0.01	0.01
10.4	0.88	0.76	0.02	0.04
13.0	1.00	0.87	0.02	0.06
15.6	1.06	0.94	0.03	0.06
18.2	1.15	1.03	0.26	0.10
20.8	1.22	1.09	0.26	0.10
26.0	1.38	1.25	0.27	0.08
31.2	1.53	1.40	0.30	0.07
36.4	1.74	1.62	0.34	0.04

OBSERVATIONS

7.8 PSF	Visible deflection of pans
5.2 PSF	Panels return to initial shape
18.2 PSF	Increased deflection of pans, visible spreading of ribs
5.2 PSF	Panels return to initial shape
41.1 PSF	Clip seperation at 3-4 and 4-5 panel ribs

Test No. 96505-7 (Photographs L through M)
Specimen: Zimmerman Metals 1 inch Snap Lock panel, 24 gage, 62.6 KSI Painted galvanized steel, 1 foot supports
Date: November 22, 1996

LOAD	RIB DEFLECTION (INCHES)						RIB SET (INCHES)					
	MIDSPAN			SUPPORT			MIDSPAN			SUPPORT		
(PSF)	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.4	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00
13.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
15.6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
20.8	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
26.0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.02
31.2	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
36.4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.03	0.03	0.02	0.02
41.6	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.04

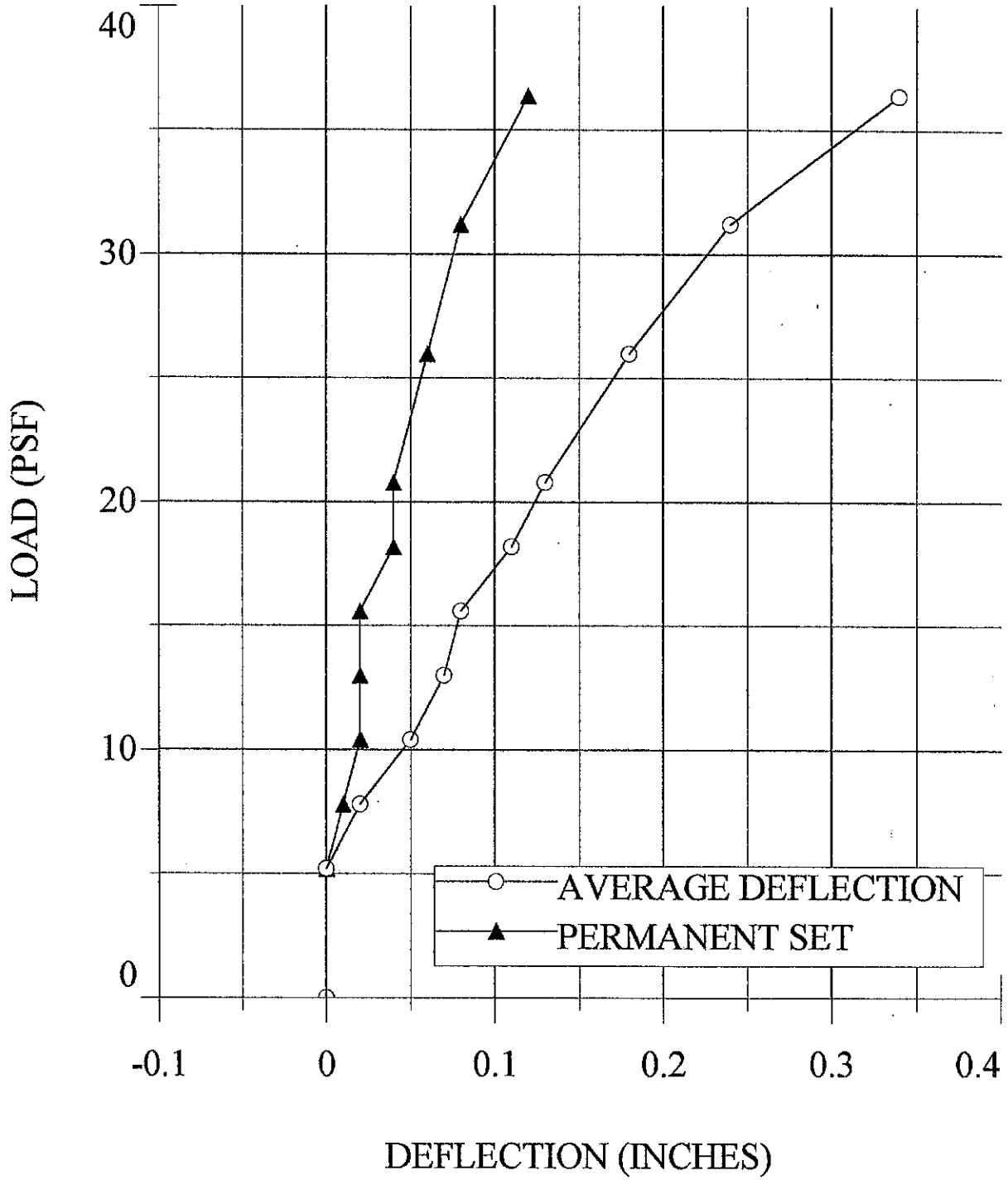
LOAD	MIDPANEL DEFLECTION (INCHES)		MIDPANEL SET (INCHES)	
	MIDSPAN	SUPPORT	MIDSPAN	SUPPORT
(PSF)	5	2	5	2
5.2	0.00	0.00	0.00	0.00
7.8	0.09	-0.02	0.02	-0.02
10.4	0.85	0.86	0.10	-0.04
13.0	0.95	0.97	0.11	-0.04
15.6	1.01	1.03	0.12	-0.04
20.8	1.12	1.13	0.12	-0.03
26.0	1.21	1.22	0.10	-0.03
31.2	1.29	1.31	0.08	-0.02
36.4	1.40	1.41	0.08	-0.02
41.6	1.47	1.48	0.08	-0.01

OBSERVATIONS

7.8 PSF	Visible deflection of pans
5.2 PSF	Panels return to initial shape
15.6 PSF	Increased deflection of pans. Visible spreading at ribs
5.2 PSF	Panels return to initial shape
20.8 PSF	Increased deflection of pans
5.2 PSF	Audible sound as ribs rotate during return
36.4 PSF	Increased pan deflection and rib spread
5.2 PSF	3-4 panel rib begins to unlock at end
41.6 PSF	Increased pan deflection and rib spread
5.2	Seams do not return fully. Ribs unseam during re-loading

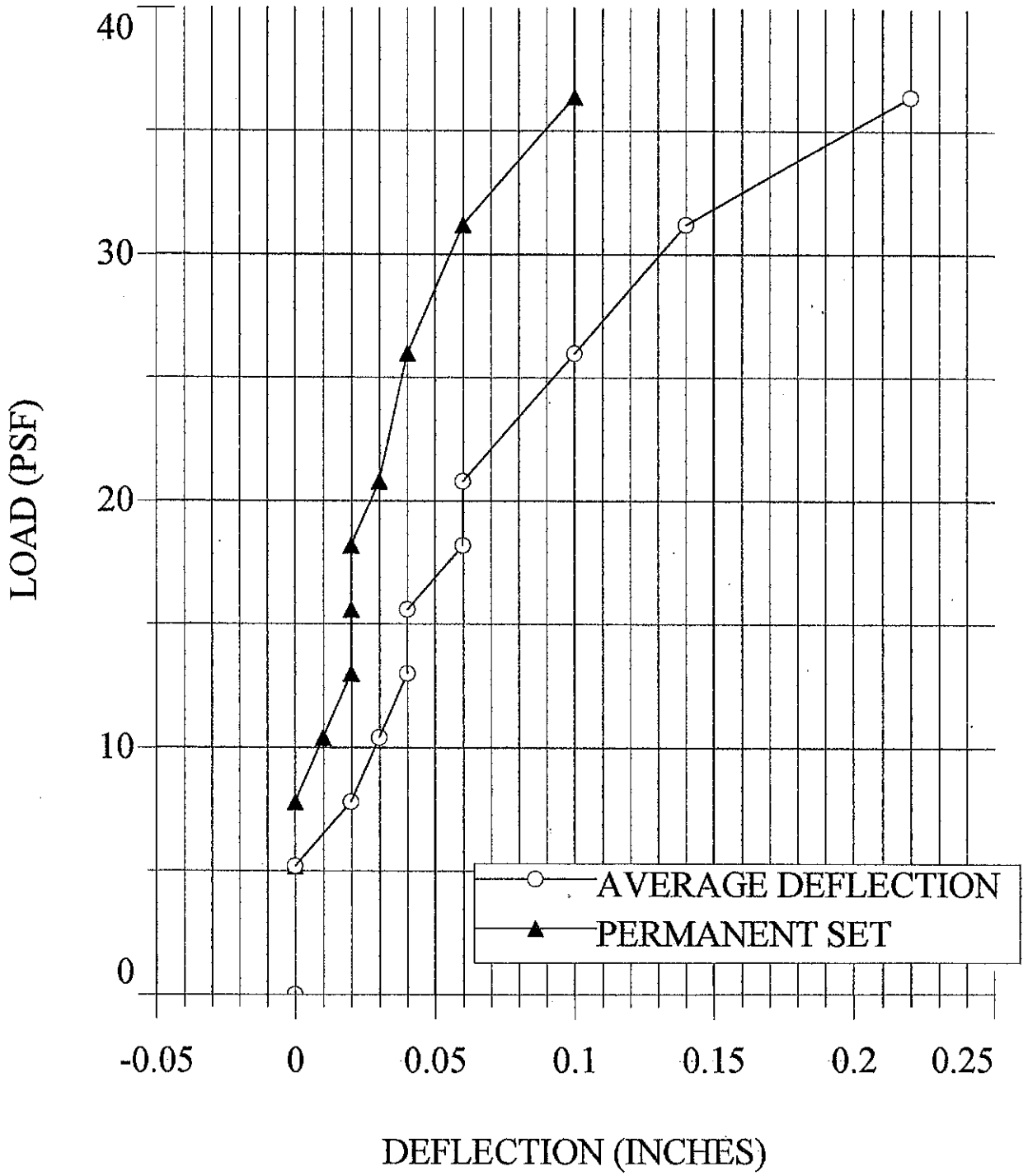
The deflection of the panels during testing is represented graphically in the pages that follow:

PANEL TEST
96505-2



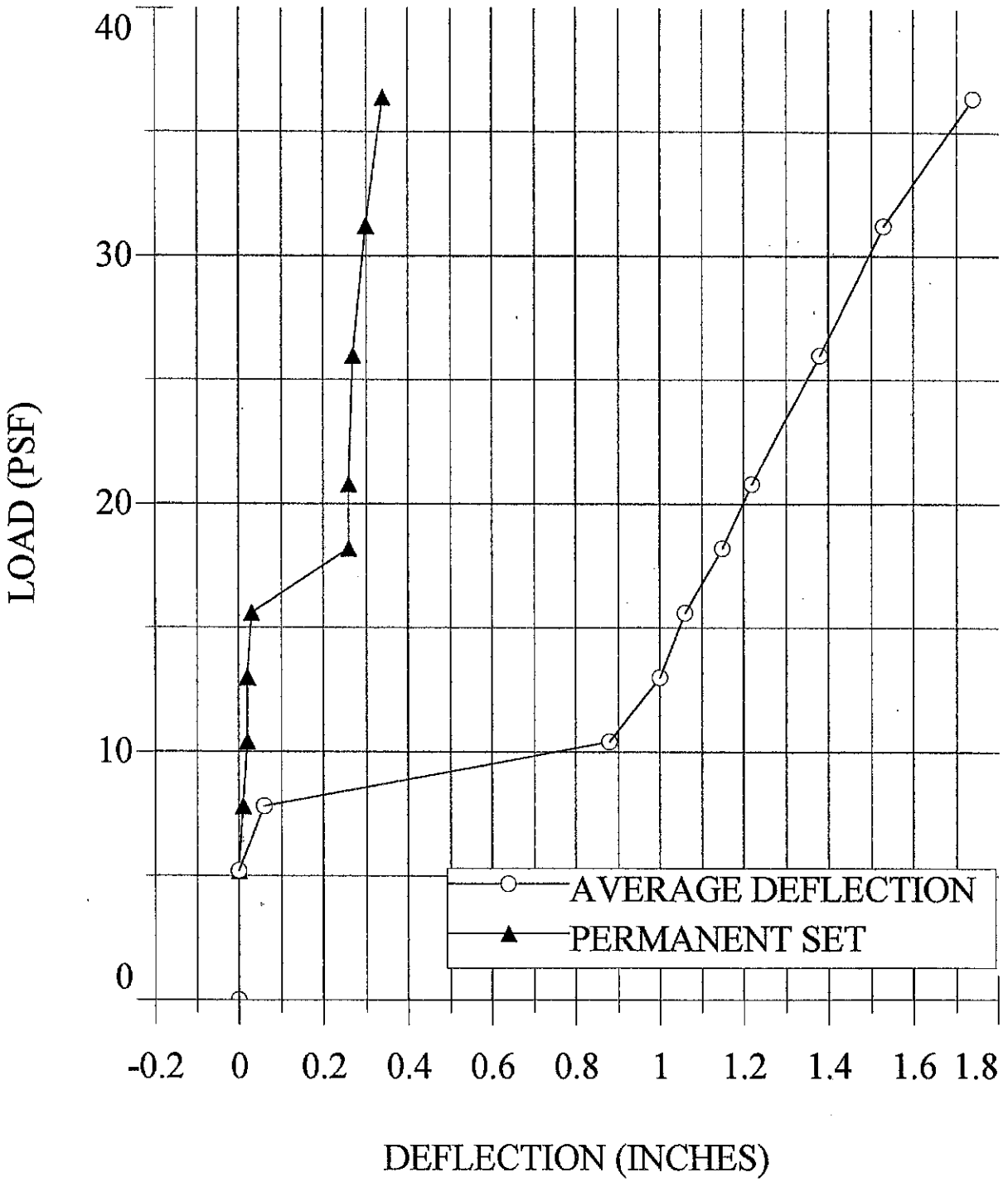
RIB MIDSPAN

PANEL TEST
96505-2



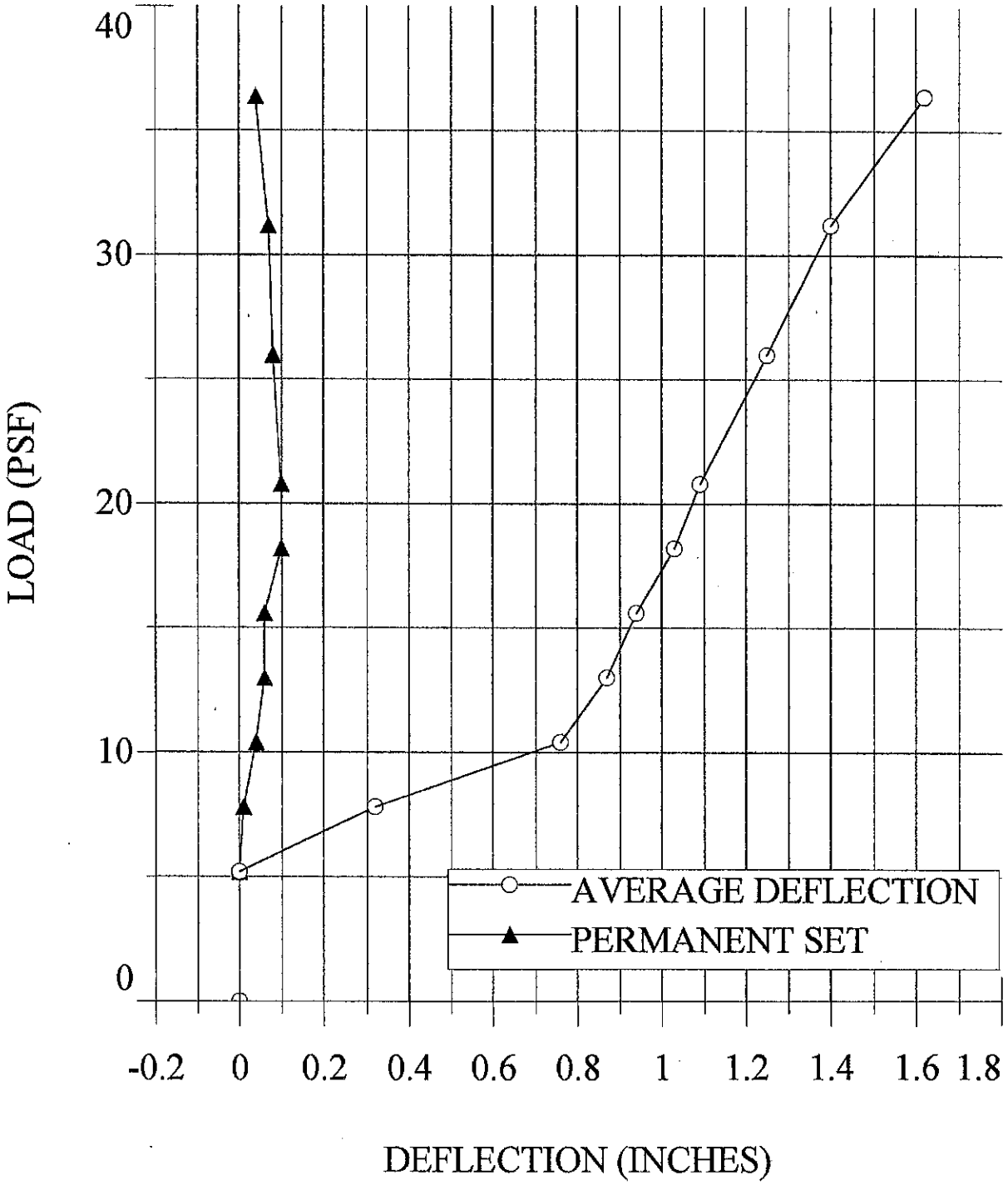
RIB SUPPORT

PANEL TEST
96505-2



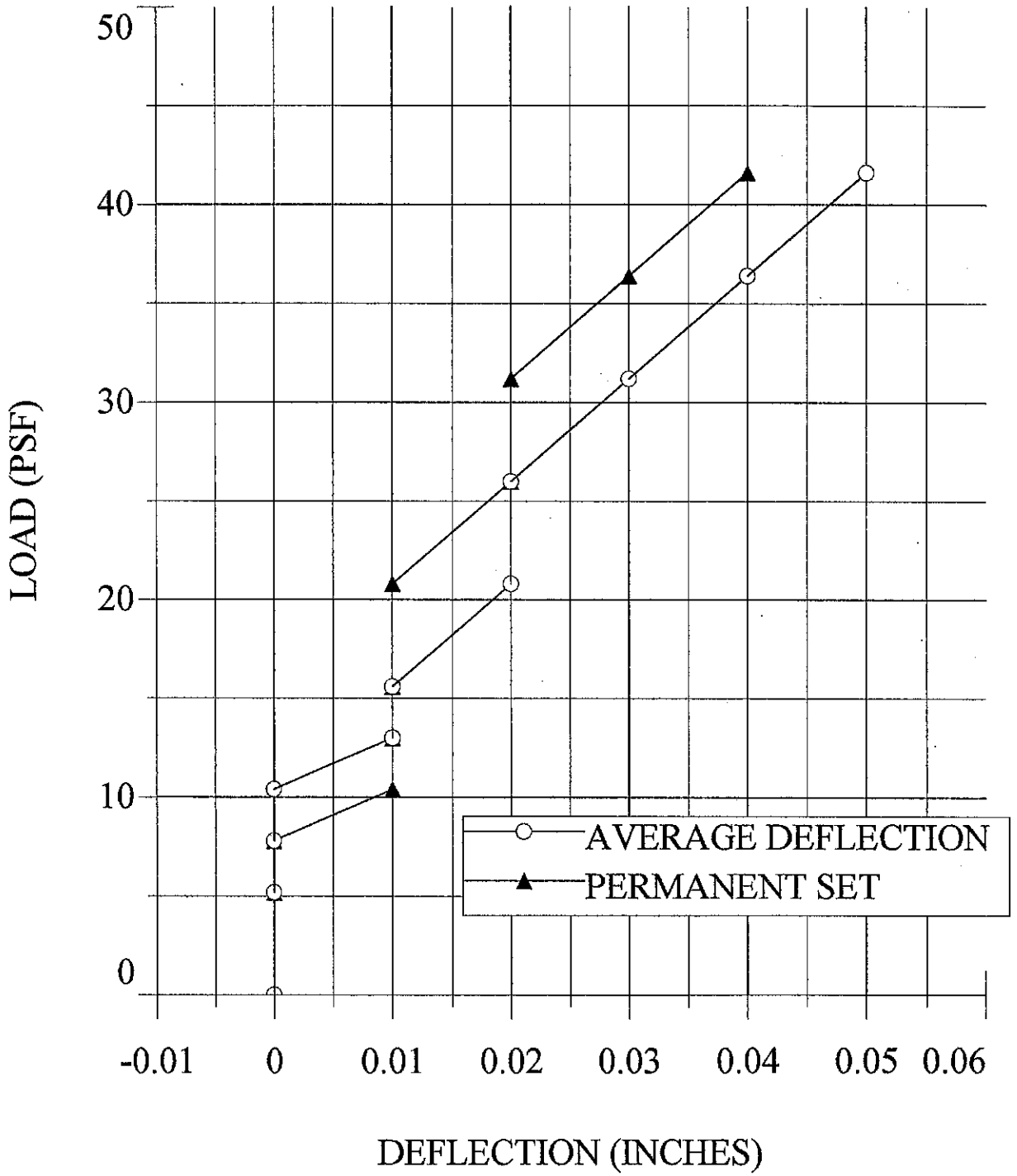
MID PANEL MIDSPAN

PANEL TEST
96505-2



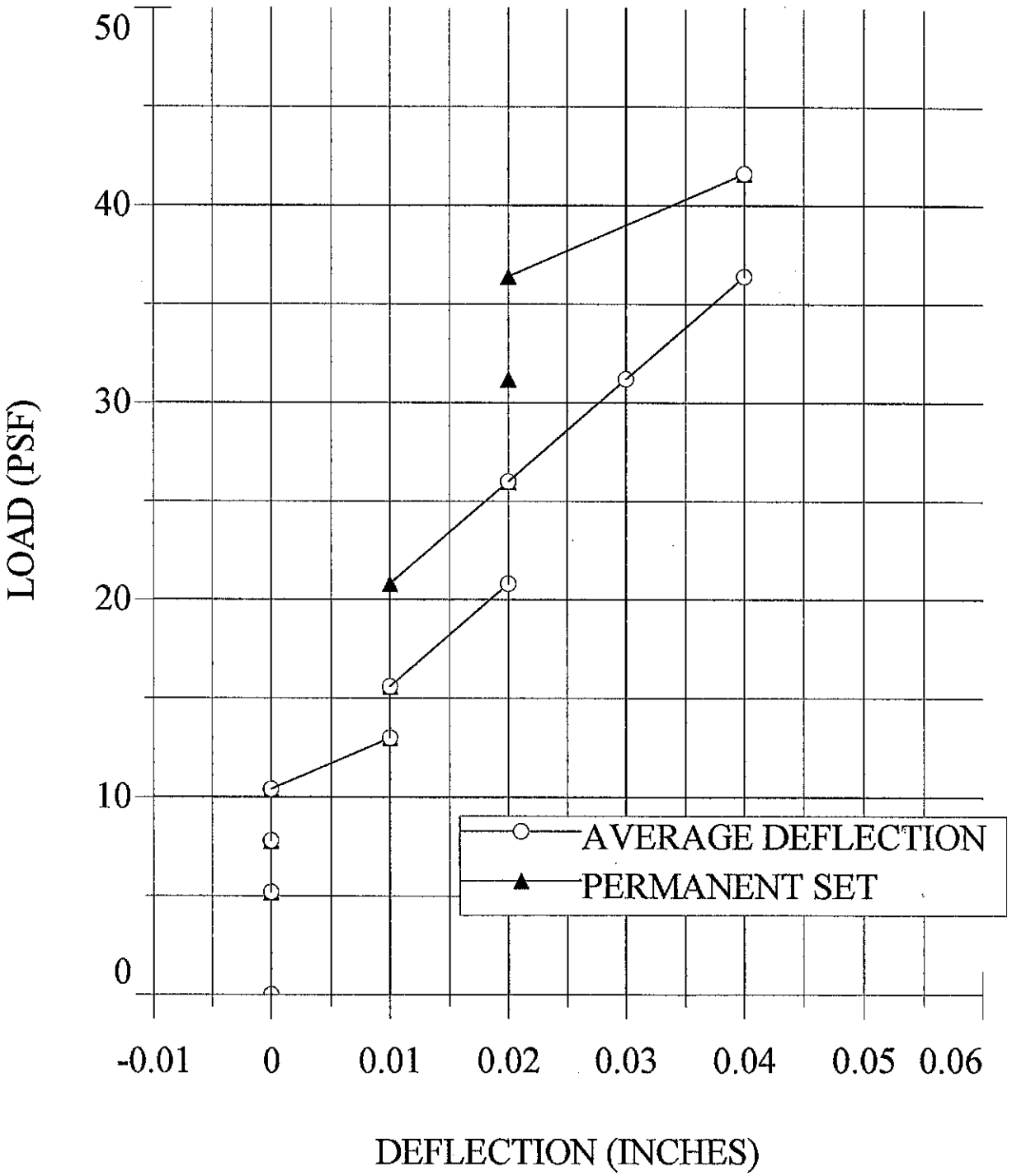
MID PANEL SUPPORT

PANEL TEST
96505-7



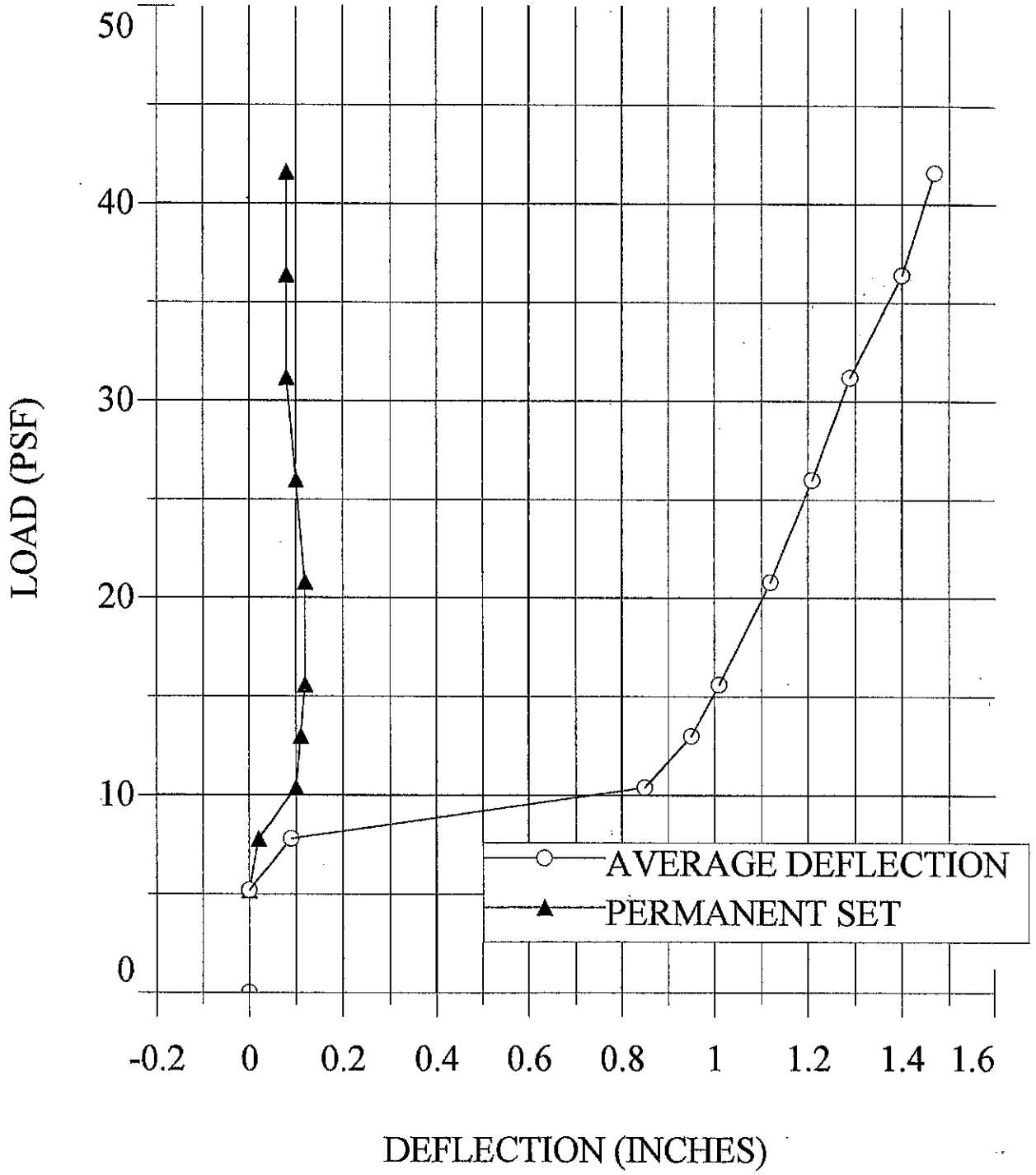
RIB MIDSPAN

PANEL TEST
96505-7



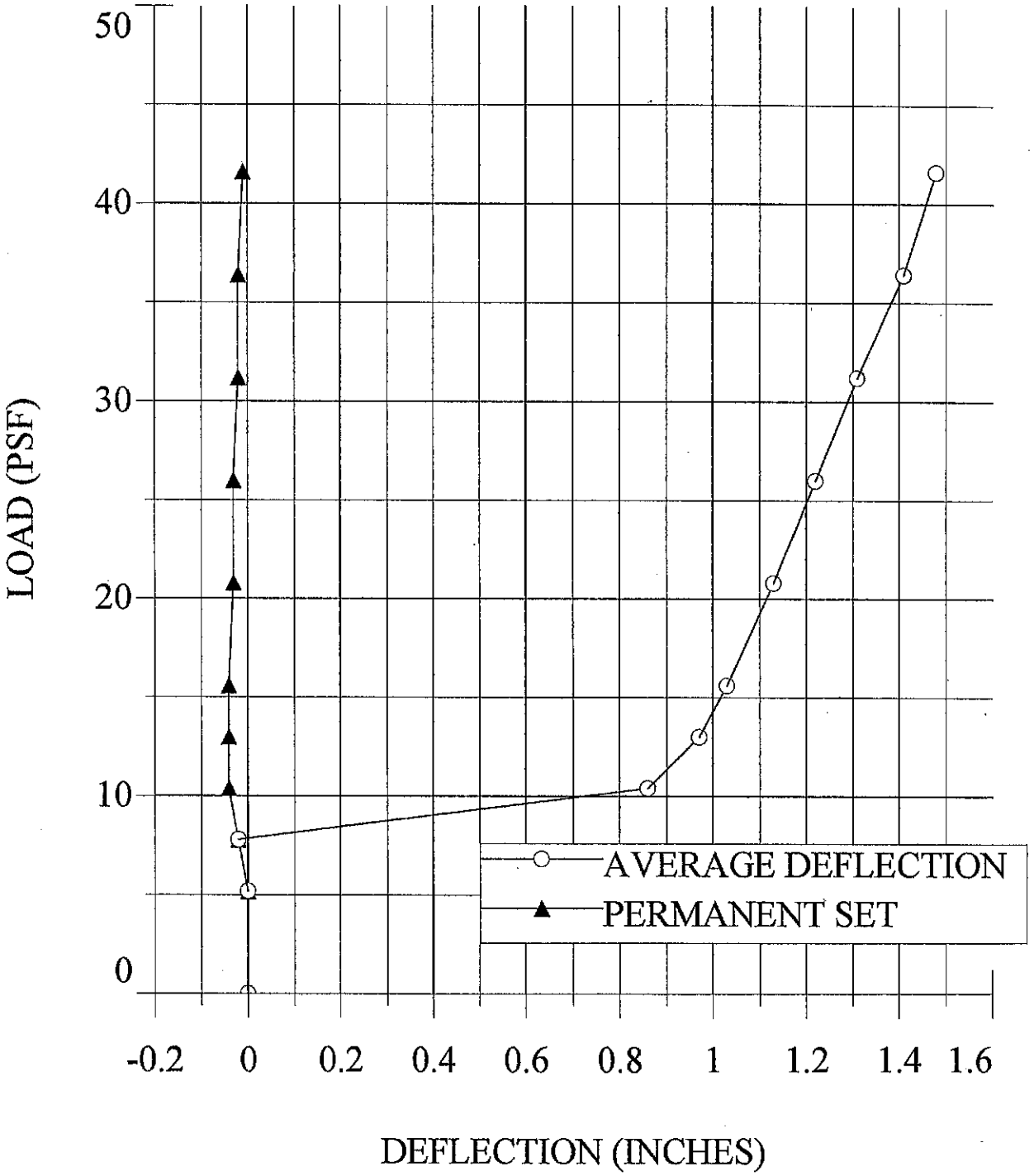
RIB SUPPORT

PANEL TEST
96505-7



MID PANEL MIDSPAN

PANEL TEST
96505-7



MID PANEL SUPPORT

CONCLUSIONS

The allowable panel load for wind was calculated using the test results and factors of safety prescribed by section F1 of the "Cold Formed Steel Design Manual" 1986 edition with 1989 addendum American Iron and Steel Institute. The allowable load calculation was based on the following equation:

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

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

The required connection strength was divided by 1 1/3 for wind loading.

Based on this equation, the allowable panel loads were calculated as follows:

3 Foot - 6 Inch Span

$L = (1.333(R))/2.5$

or

$L = (1.333(41.2))/2.5 = 21.92$ PSF

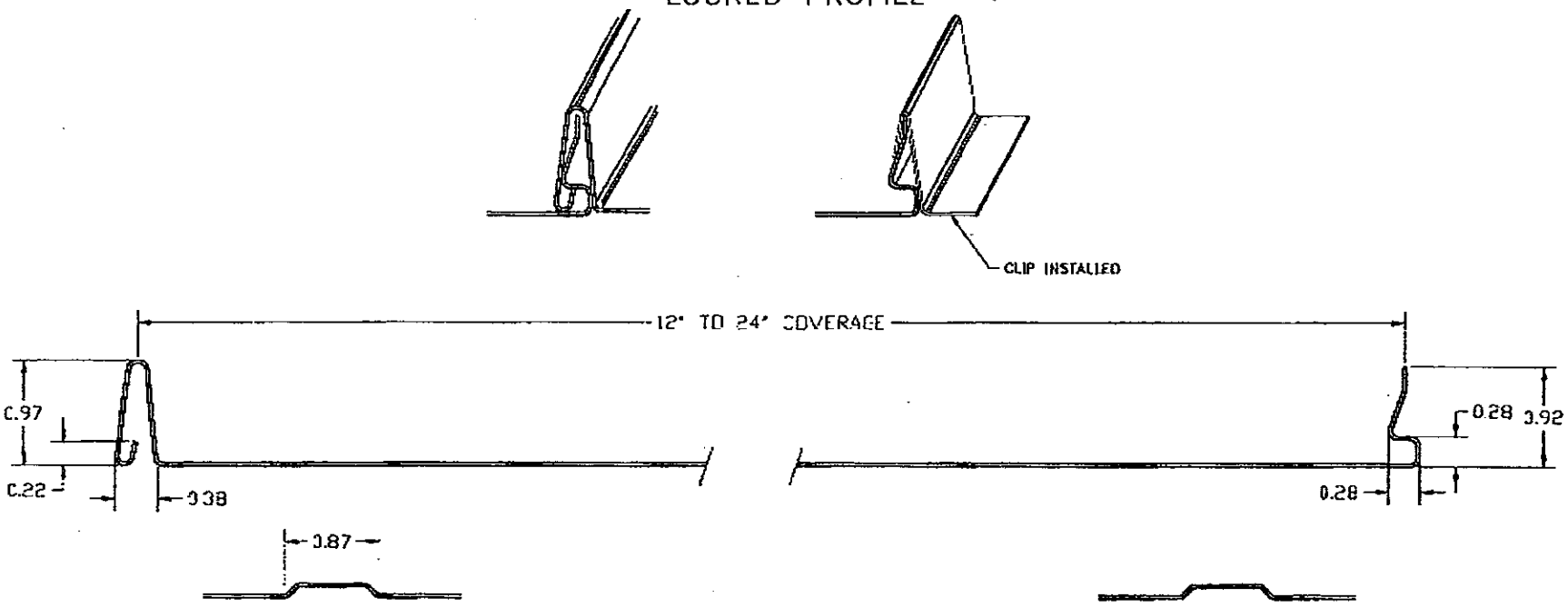
1 Foot Span

$L = (1.333(41.6))/2.5 = 22.18$ PSF

The calculations indicate the allowable wind load for this panel is 22 PSF for panel spans (clip spacings) from 1 foot to 3-foot 6 inches on centers.

* * * * * * * * * * * * * * * * *

SL1000
LOCKED PROFILE

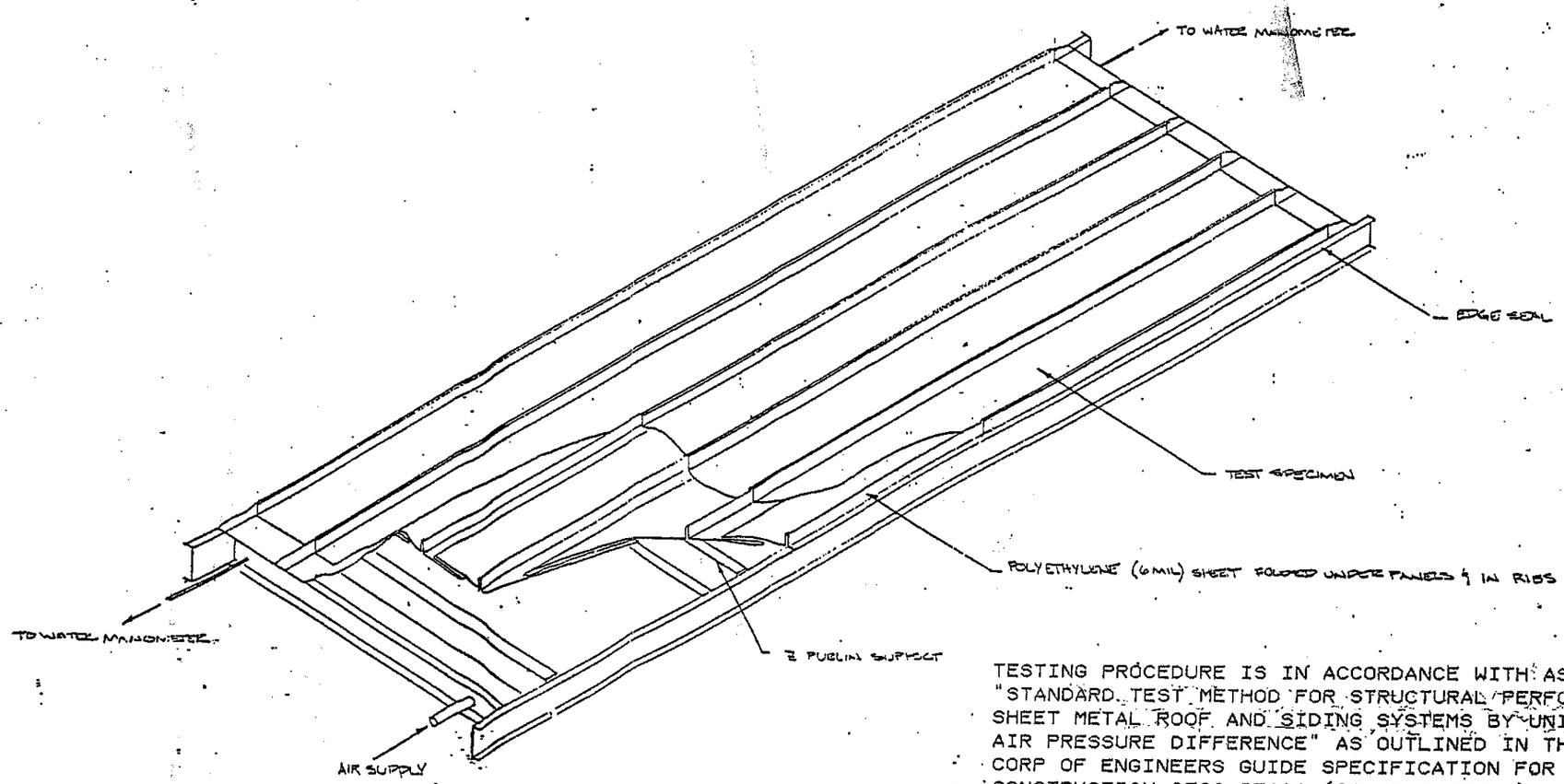


NOTE: ONLY 2 STIFFENING RIBS AVAILABLE
RIBS CAN BE SET IN ANY LOCATION.

Figure 1

Zimmerman Metals Inc.
201 East 58th Avenue
Denver, Colo. 80216
303-294-0180
FAX 303 292 5013

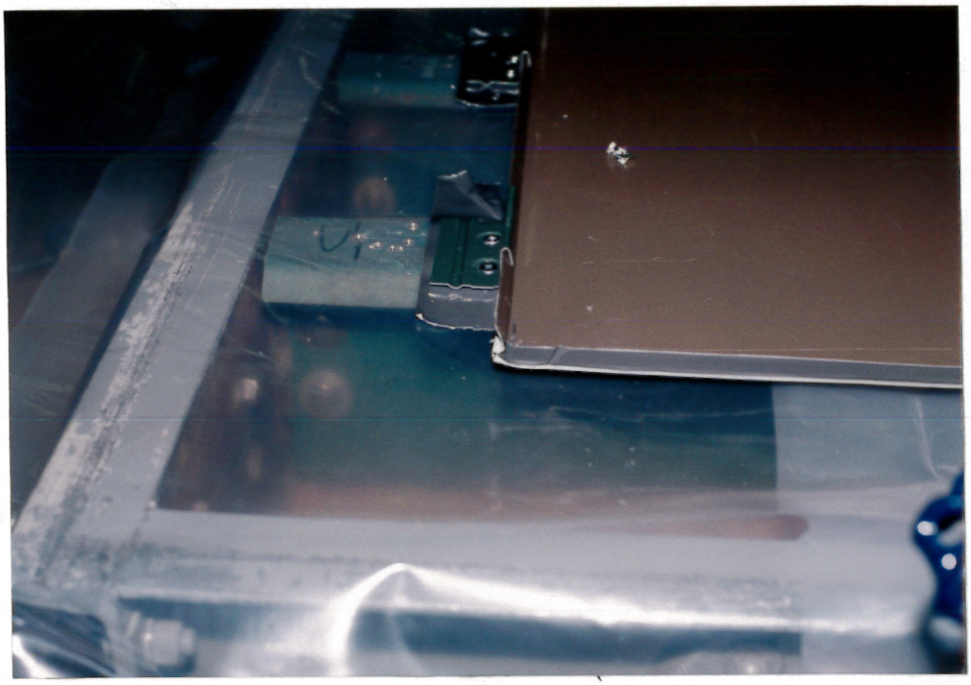
FIGURE 2 GENERAL SPECIMEN LAYOUT



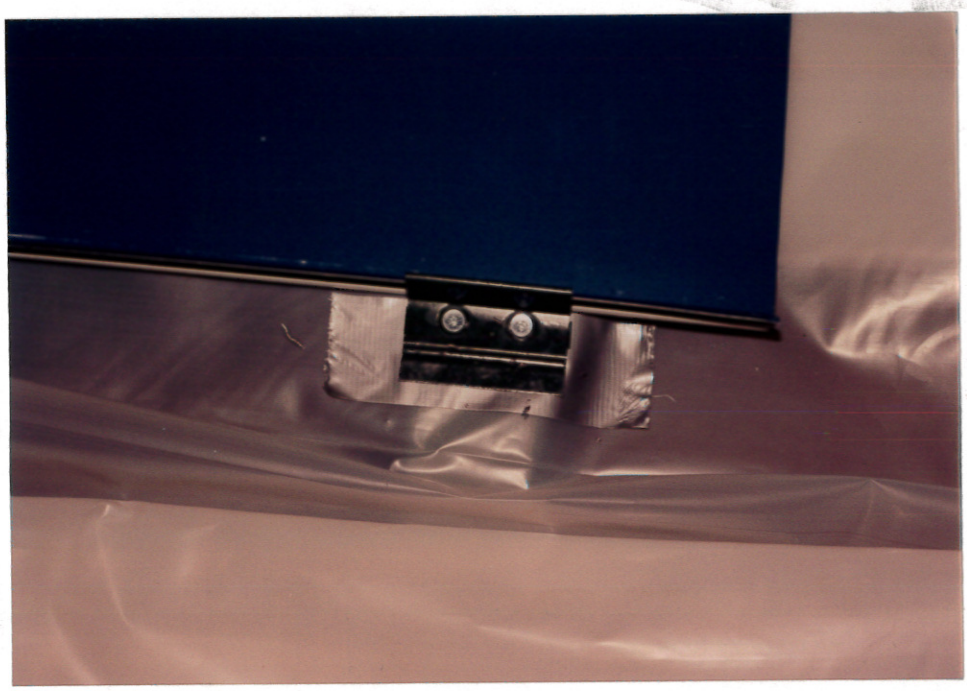
TYPICAL TEST ASSEMBLY

TESTING PROCEDURE IS 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" AS OUTLINED IN THE U.S. ARMY CORP OF ENGINEERS GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION CEGS-07416 (SSSMR SYSTEMS)..

CERNY & IVEY ENGINEERS, INC. ATLANTA, GEORGIA			
SSMRS TEST CHAMBER			
U.S. ARMY CORP OF ENGINEERS STANDARD TEST 2.			
DATE 7-21-92	SCALE AS NOTED	DRAWN AGI	CHECKED

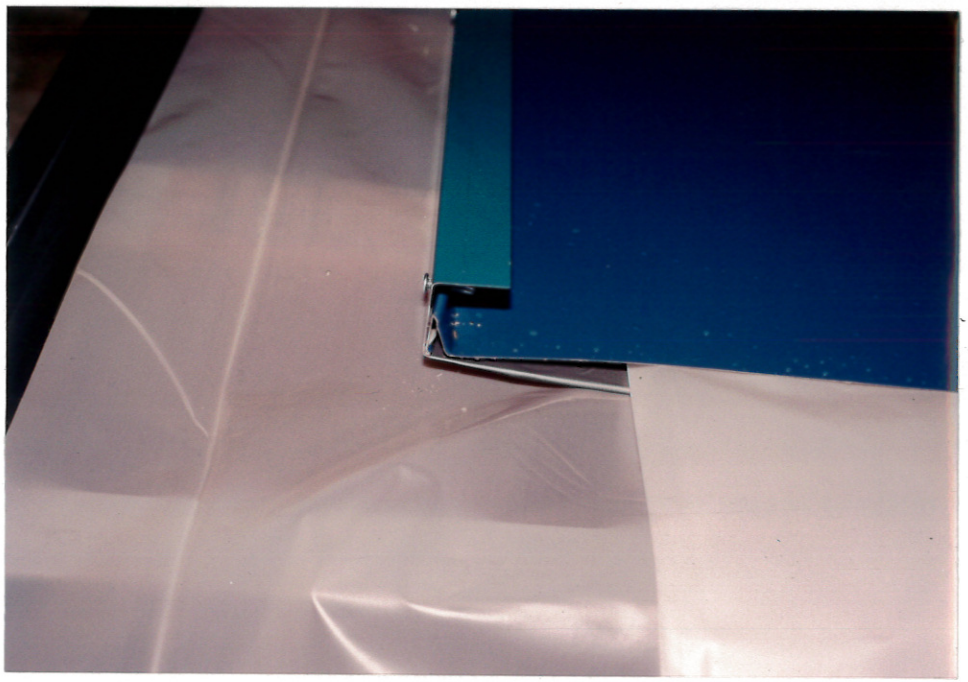


PHOTOGRAPH A
SNAP LOCK CLIP

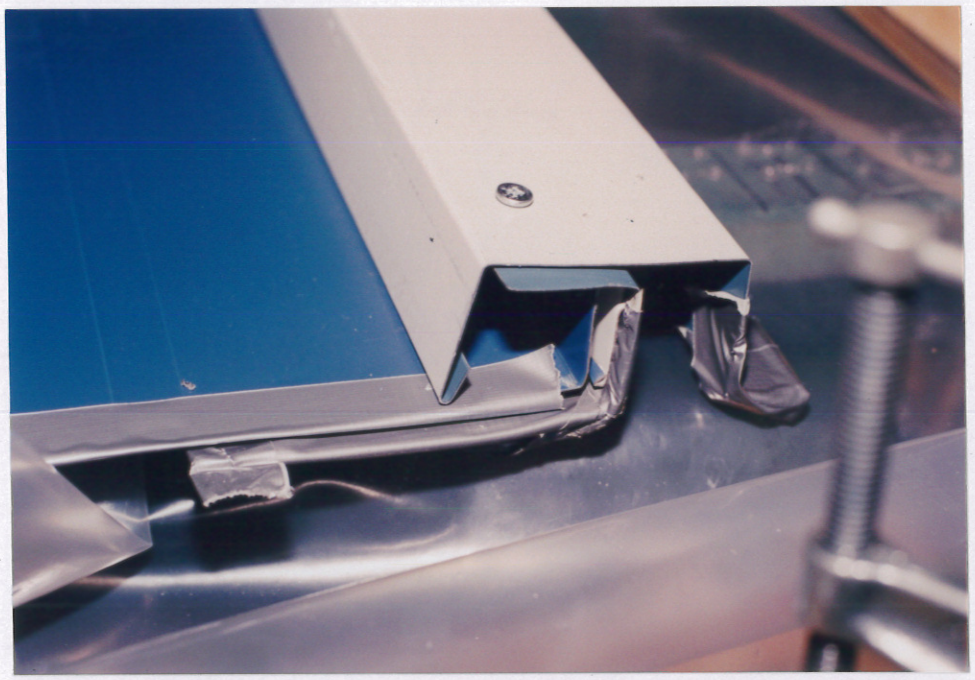


PHOTOGRAPH B
INSTALLED CLIP

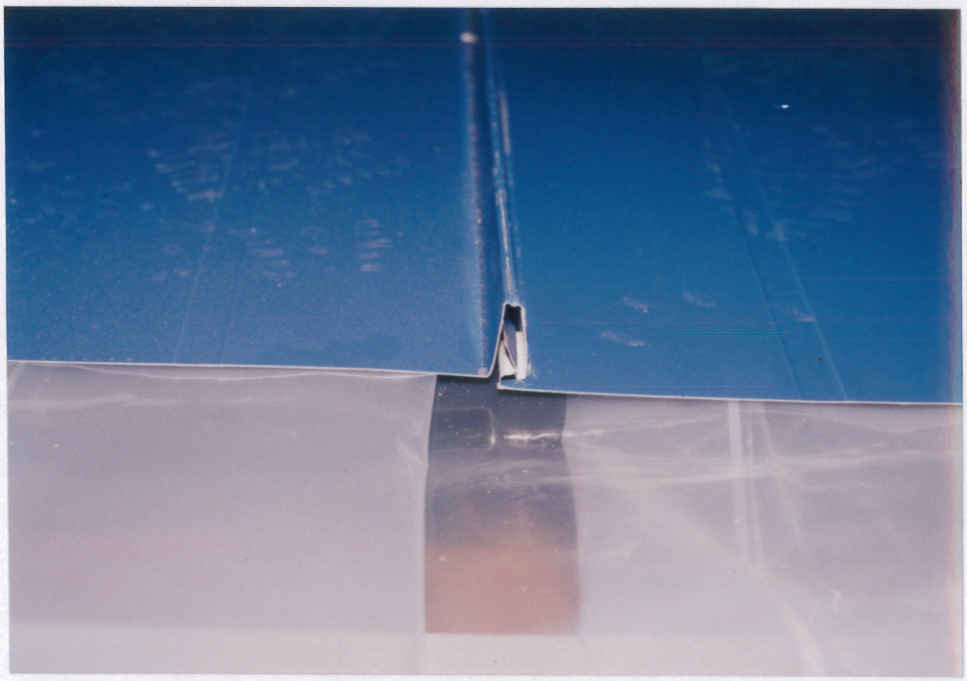
PHOTOGRAPH C
TYPICAL PANCAKE HEAD FASTENER



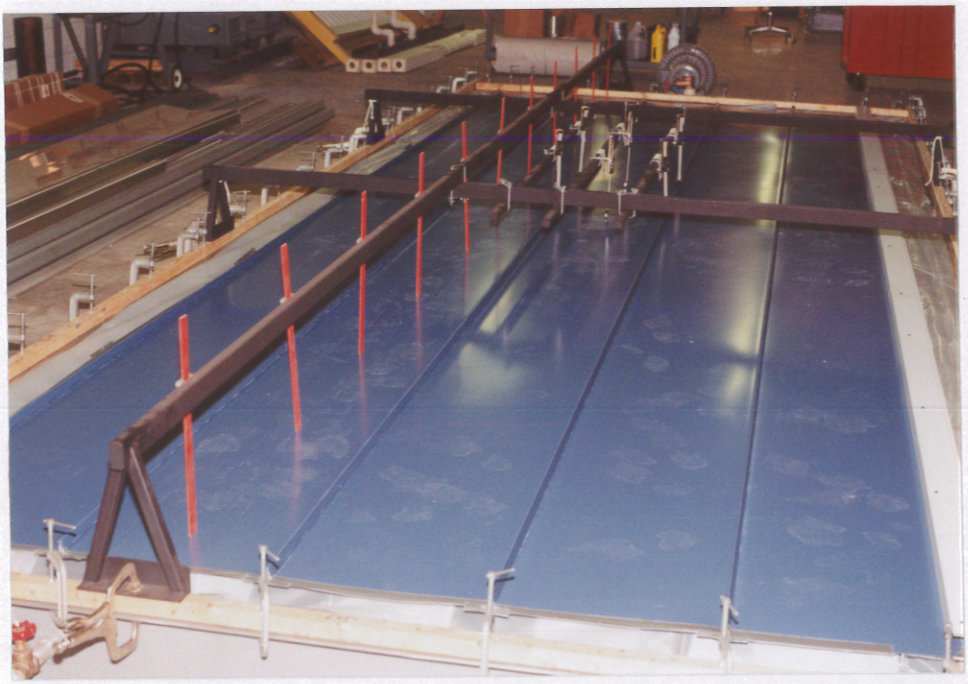
PHOTOGRAPH D
STARTING EDGE WITH J-TRACK



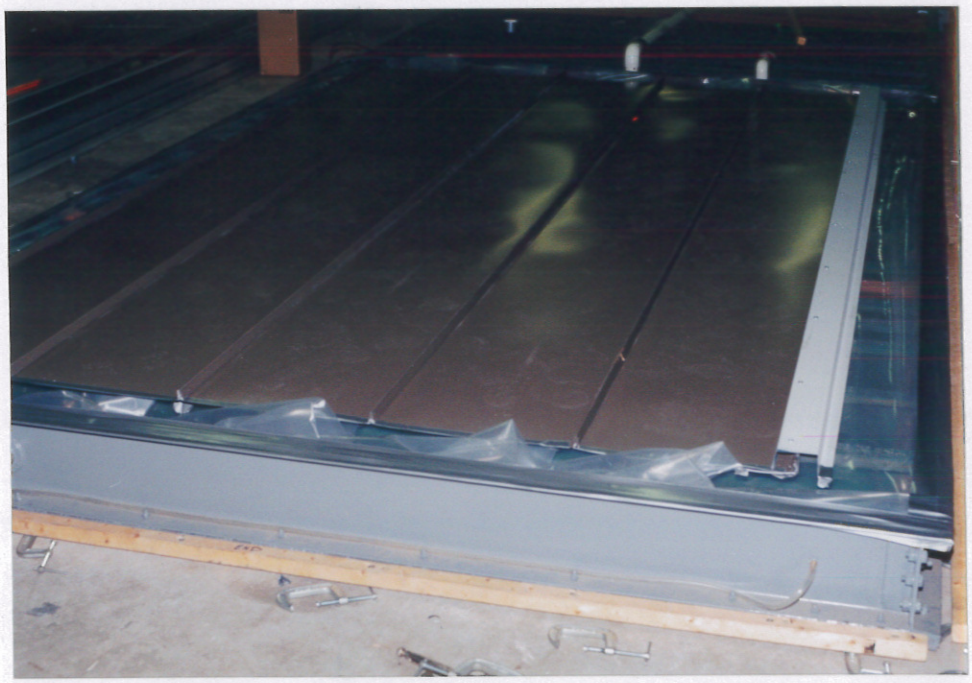
PHOTOGRAPH E
EDGE DETAIL



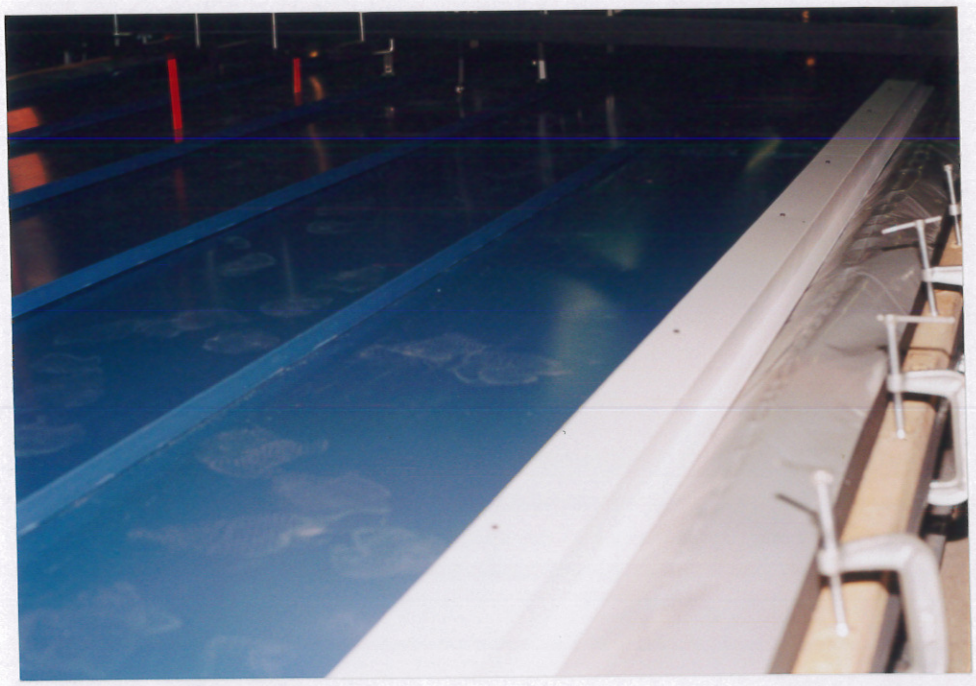
PHOTOGRAPH F
PANELS INTERLOCKED



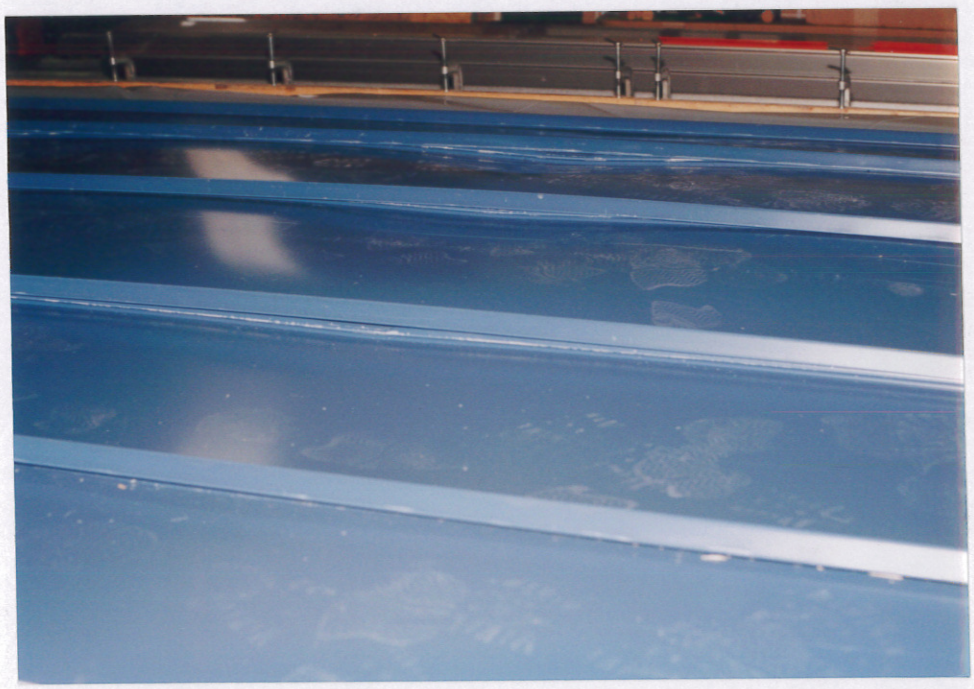
PHOTOGRAPH G
PANEL WITH 3-FOOT 6-INCH SUPPORTS



PHOTOGRAPH H
PANEL WITH 1-FOOT 0 INCHES SUPPORTS

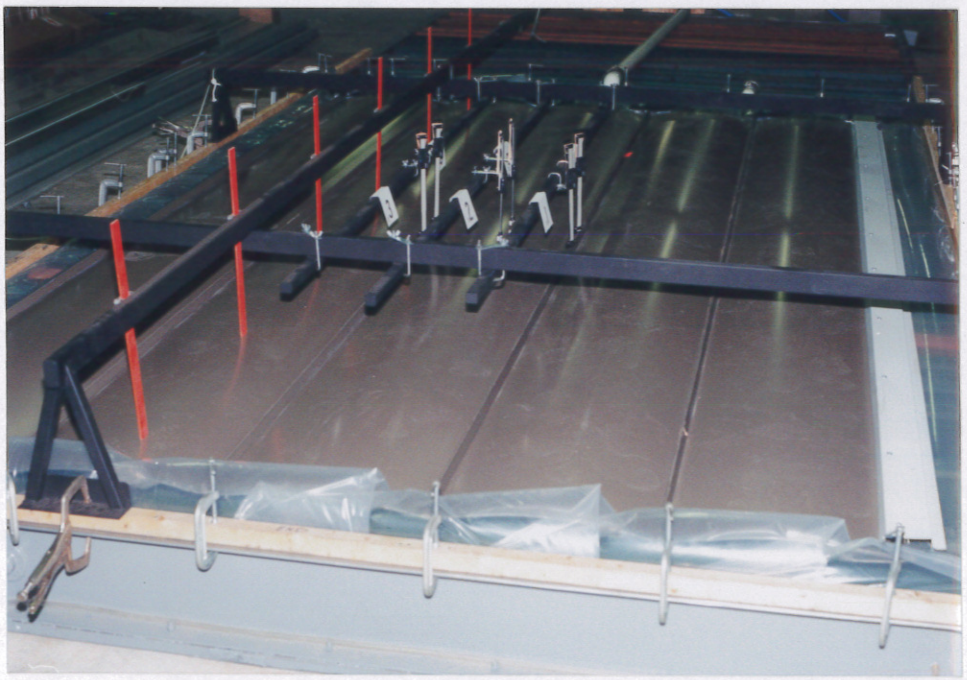


PHOTOGRAPH I
TEST PANEL 96505-2 WITH LOAD APPLIED

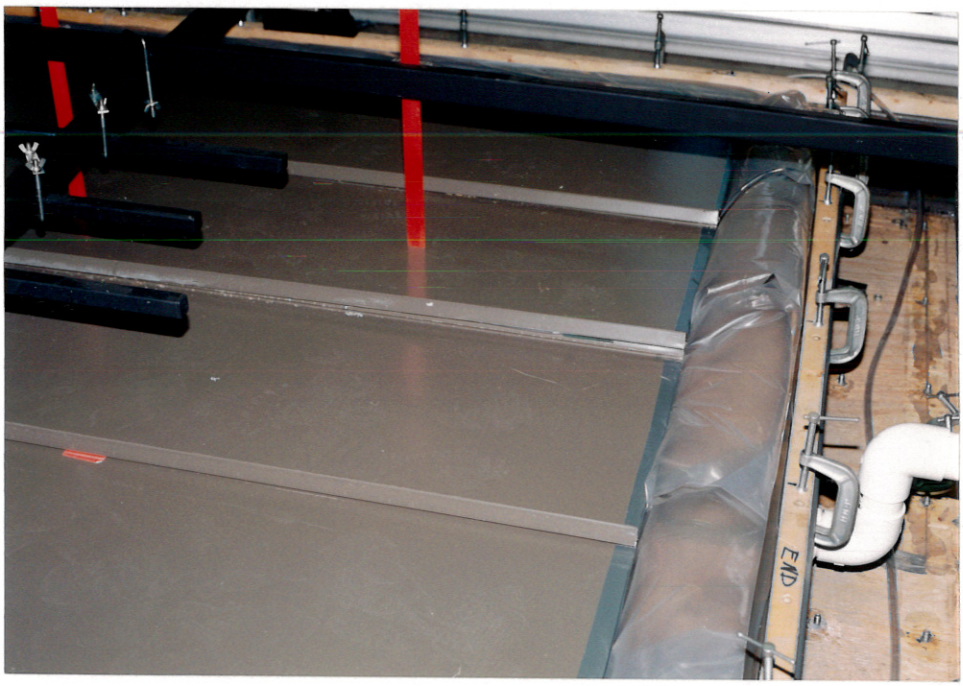


PHOTOGRAPH J
SEPARATION OF PANELS

PHOTOGRAPH K
FAILURE AT CLIP



PHOTOGRAPH L
TEST PANEL 96505-7 WITH LOAD APPLIED



PHOTOGRAPH M
SEPARATION OF PANEL

LABORATORY REPORT

NUMBER: 96505 January 22, 1997

REFERENCE

CERNY & IVEY ENGINEERS, INC.
CONSULTING ENGINEERS — TESTING LABORATORY
5650 PEACHTREE PARKWAY (404)449-6936 NORCROSS (ATL) GA 30092

TEST DESCRIPTION

Tensile Test

SAMPLE(S) RECEIVED IN LABORATORY

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

SAMPLE DESCRIPTION

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

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

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

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

Respectfully submitted,

Arthur C. Ivey, P.E.

Todd Breedlove
Senior Laboratory Technician

CTB/ly

GEORGIA REGISTERED No. 15693 PROFESSIONAL ENGINEER ARTHUR C. IVEY