



ASTM E1592 TEST RESULTS

SL1500 PANEL

Zimmerman Metals, Inc.

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

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January 22, 1997

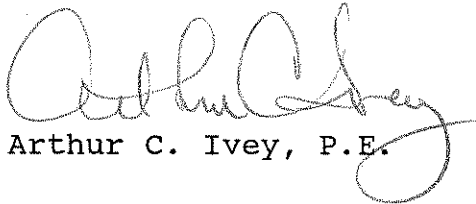
Engineering Report 96505-1


Zimmerman Metals, Inc.,
SL1500 Snap Lock Panel Uplift Test

SUMMARY

Beginning November 19, 1996, testing of Zimmerman Metals, Inc. SL1500 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 1/2 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 31.2 PSF when a seam separated. The 1 foot span test specimen failed similarly at a load of 29.1 PSF.

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 19, 1996, testing of SL1500 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 SL1500 Snap Lock panels supplied by Zimmerman Metals. The panels were installed on a support structure using the appropriate formed sections, clips, and fasteners.

The SL1500 Snap Lock 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, 56.6 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 1/2 inch 24 ga. steel Snap Lock clips) were used to attach the panels to the formed cee and zee sections (Photograph A). Each clip was attached to the support with two 1 inch by No.8 self drill and tap pancake head screws (Photographs B through D). 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 E and F). 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 G). A panel was split to finish the field edge. No additional fasteners were installed on the field edge. 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 H through I).

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. 96505-1 (Photographs J through M)
 Specimen: Zimmerman Metals 1 1/2-inch Snap Lock panel,
 24 gage, 56.6 KSI Painted galvanized steel,
 3 1/2 foot supports
Date: November 19, 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 |
| 7.8 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| 10.4 | 0.04 | 0.05 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 |
| 13.0 | 0.06 | 0.07 | 0.06 | 0.04 | 0.05 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| 15.6 | 0.10 | 0.10 | 0.10 | 0.08 | 0.07 | 0.08 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| 18.2 | 0.13 | 0.12 | 0.12 | 0.10 | 0.08 | 0.09 | 0.04 | 0.03 | 0.04 | 0.03 | 0.02 | 0.02 |
| 20.8 | 0.17 | 0.16 | 0.16 | 0.13 | 0.12 | 0.12 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| 26.0 | 0.26 | 0.23 | 0.24 | 0.20 | 0.18 | 0.19 | 0.09 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 |
| 31.2 | 0.53 | 0.47 | 0.50 | 0.43 | 0.40 | 0.42 | | | | | | |

| LOAD (PSF) | <u>MIDPANEL DEFLECTION (INCHES)</u> | | <u>MIDPANEL SET (INCHES)</u> | |
|---------------|-------------------------------------|----------------|------------------------------|----------------|
| | <u>MIDSPAN</u> | <u>SUPPORT</u> | <u>MIDSPAN</u> | <u>SUPPORT</u> |
| | <u>5</u> | <u>2</u> | <u>5</u> | <u>2</u> |
| 5.2 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7.8 | 0.00 | 0.30 | 0.01 | 0.00 |
| 10.4 | 1.04 | 0.96 | 0.02 | 0.00 |
| 13.0 | 1.11 | 1.05 | 0.03 | 0.00 |
| 15.6 | 1.26 | 1.19 | 0.03 | 0.01 |
| 18.2 | 1.40 | 1.33 | 0.03 | 0.01 |
| 20.8 | 1.57 | 1.51 | 0.04 | 0.02 |
| 26.0 | 1.84 | 1.79 | 0.07 | 0.04 |
| 31.2 | 2.34 | 2.31 | | |

OBSERVATIONS

7.8 PSF Visible pan deflection
5.2 PSF Panels return to initial shape
18.2 PSF Increased pan deflection, visible spreading
of ribs
5.2 PSF Panels return to initial shape
20.8 PSF Ribs appear to begin separating
5.2 PSF Panels return to initial shape
31.2 PSF First panel rib unseams to midpoint

Test No. 96505-8 (Photographs N through O)
 Specimen: Zimmerman Metals 1 1/2-inch Snap Lock panel,
 24 gage, 56.6 KSI Painted galvanized steel,
 1 foot supports
 Date: November 22, 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 |
| 7.8 | 0.01 | -0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | -0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| 10.4 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| 13.0 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 15.6 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| 20.8 | 0.05 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 |
| 26.0 | 0.07 | 0.06 | 0.06 | 0.07 | 0.06 | 0.06 | 0.03 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 |

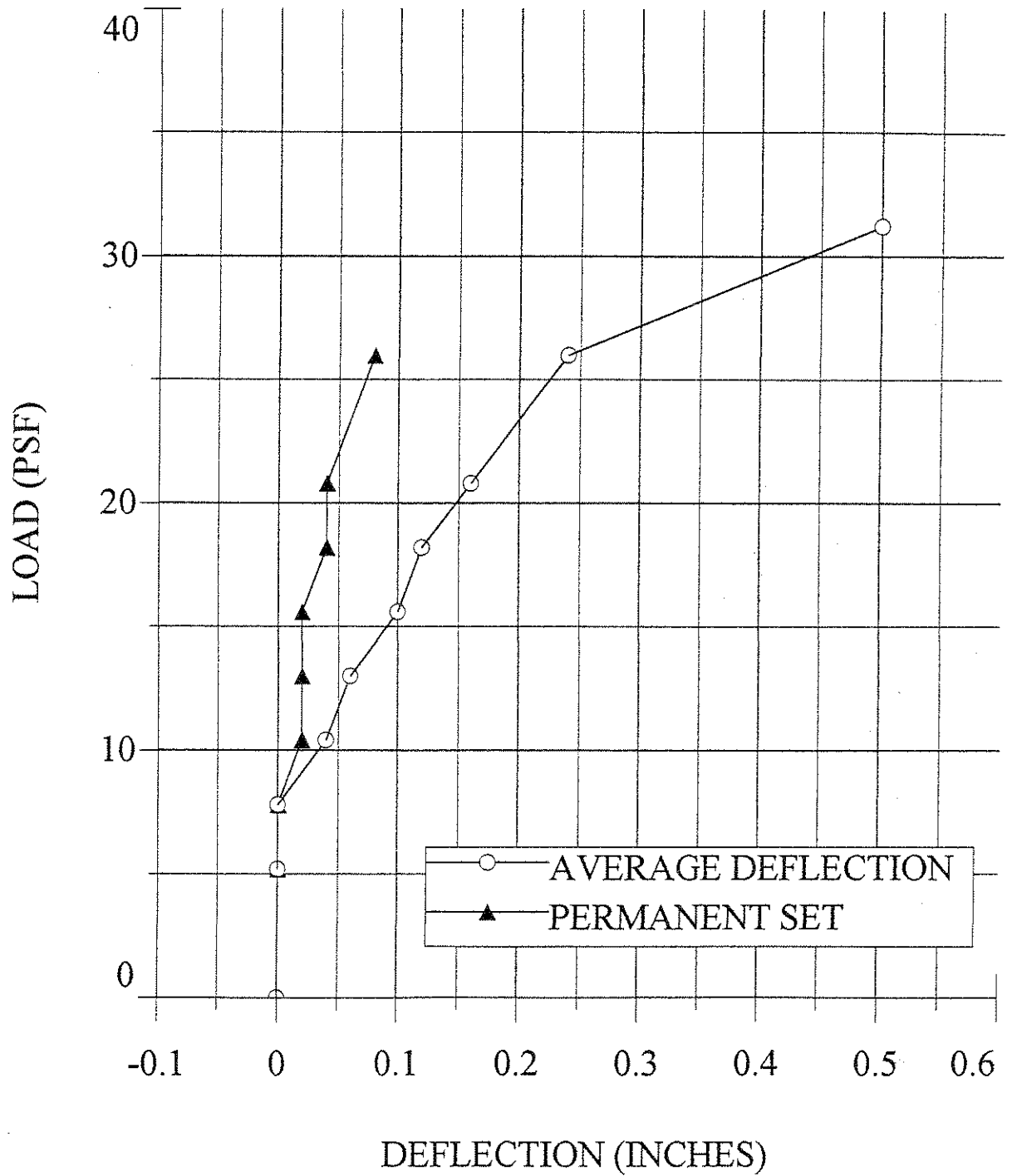
| LOAD (PSF) | <u>MIDPANEL DEFLECTION (INCHES)</u> | | <u>MIDPANEL SET (INCHES)</u> | |
|---------------|-------------------------------------|----------------|------------------------------|----------------|
| | <u>MIDSPAN</u> | <u>SUPPORT</u> | <u>MIDSPAN</u> | <u>SUPPORT</u> |
| | <u>5</u> | <u>2</u> | <u>5</u> | <u>2</u> |
| 5.2 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7.8 | 0.07 | 0.06 | -0.03 | 0.03 |
| 10.4 | 0.90 | 0.91 | -0.03 | 0.10 |
| 13.0 | 1.09 | 1.09 | -0.03 | 0.04 |
| 15.6 | 1.23 | 1.22 | 0.01 | 0.04 |
| 20.8 | 1.44 | 1.42 | 0.01 | 0.03 |
| 26.0 | 1.58 | 1.56 | 0.02 | 0.03 |

OBSERVATIONS

7.8 PSF Visible pan deflection
5.2 PSF Panels return to initial shape
13.0 PSF Increased pan deflection. Visible spreading
of ribs
5.2 PSF Panels return to initial shape
15.6 PSF Increased pan deflection and rib spread
5.2 PSF Audible sound as ribs rotate during return
20.8 PSF 2-3 seam deflects noticeably
5.2 PSF 2-3 seam does not return fully
29.1 PSF 2-3 seam separates

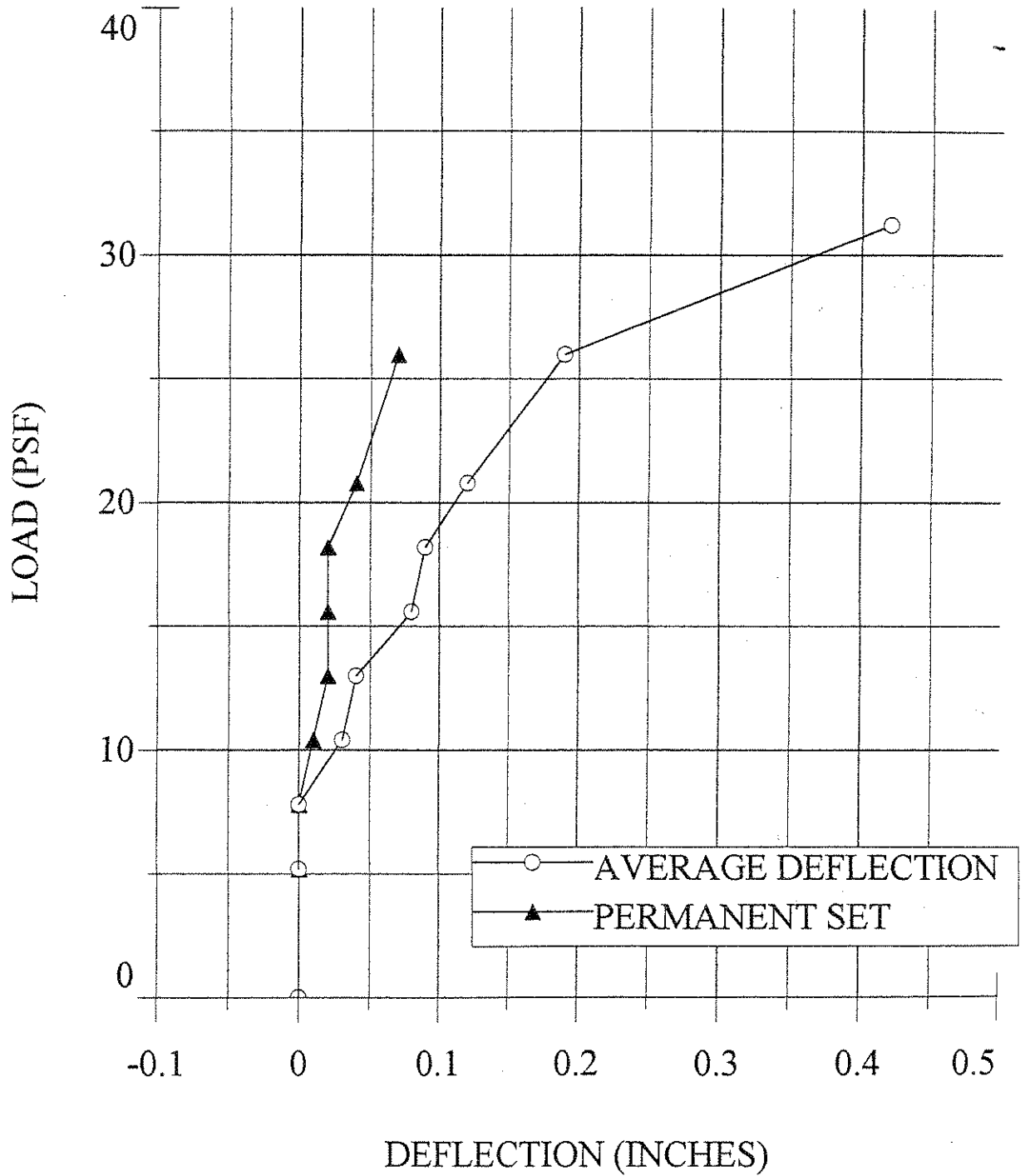
The deflection of the panels during testing is
represented graphically in the pages that follow:

PANEL TEST 96505-1



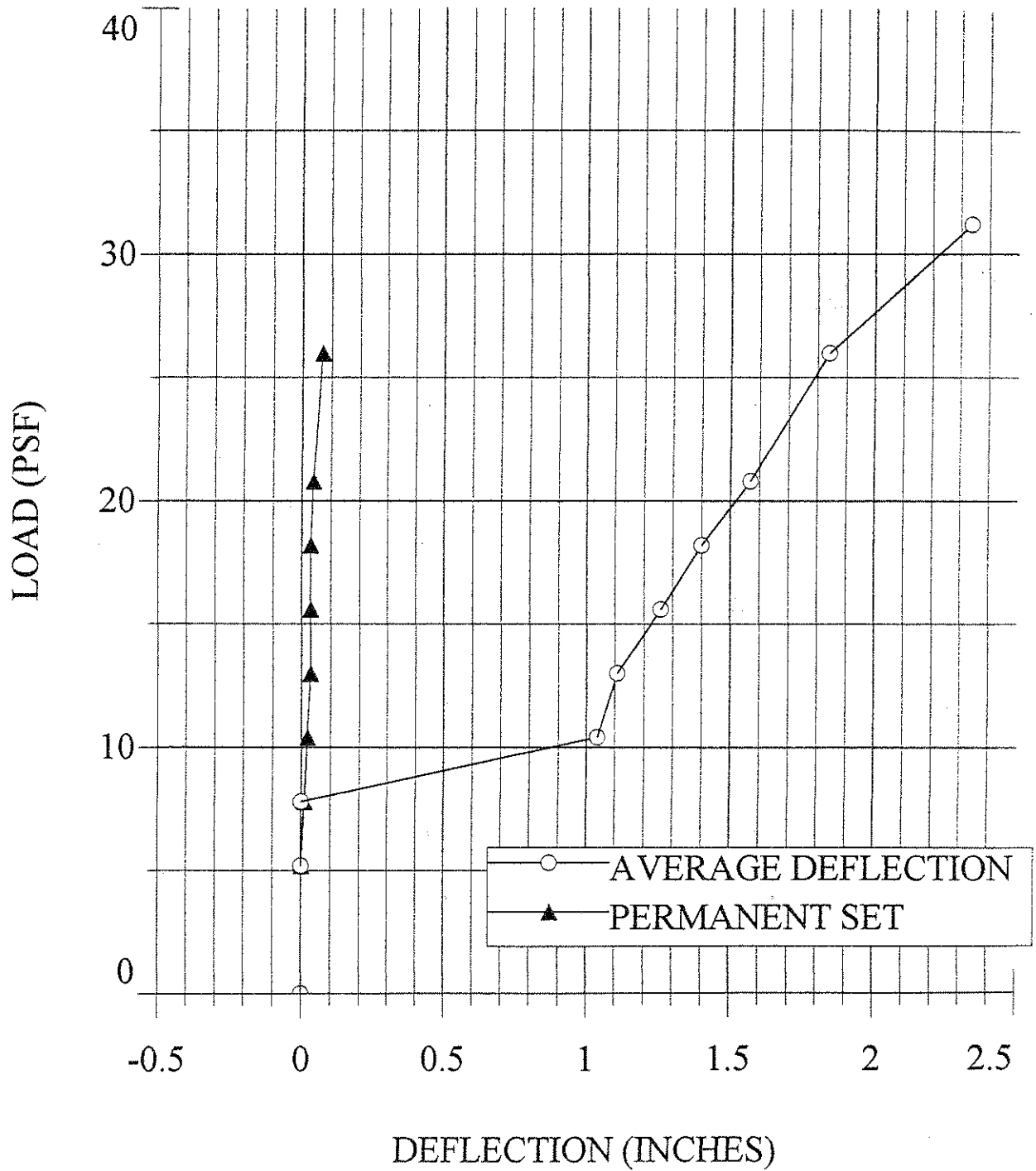
RIB MIDSPAN

PANEL TEST 96505-1



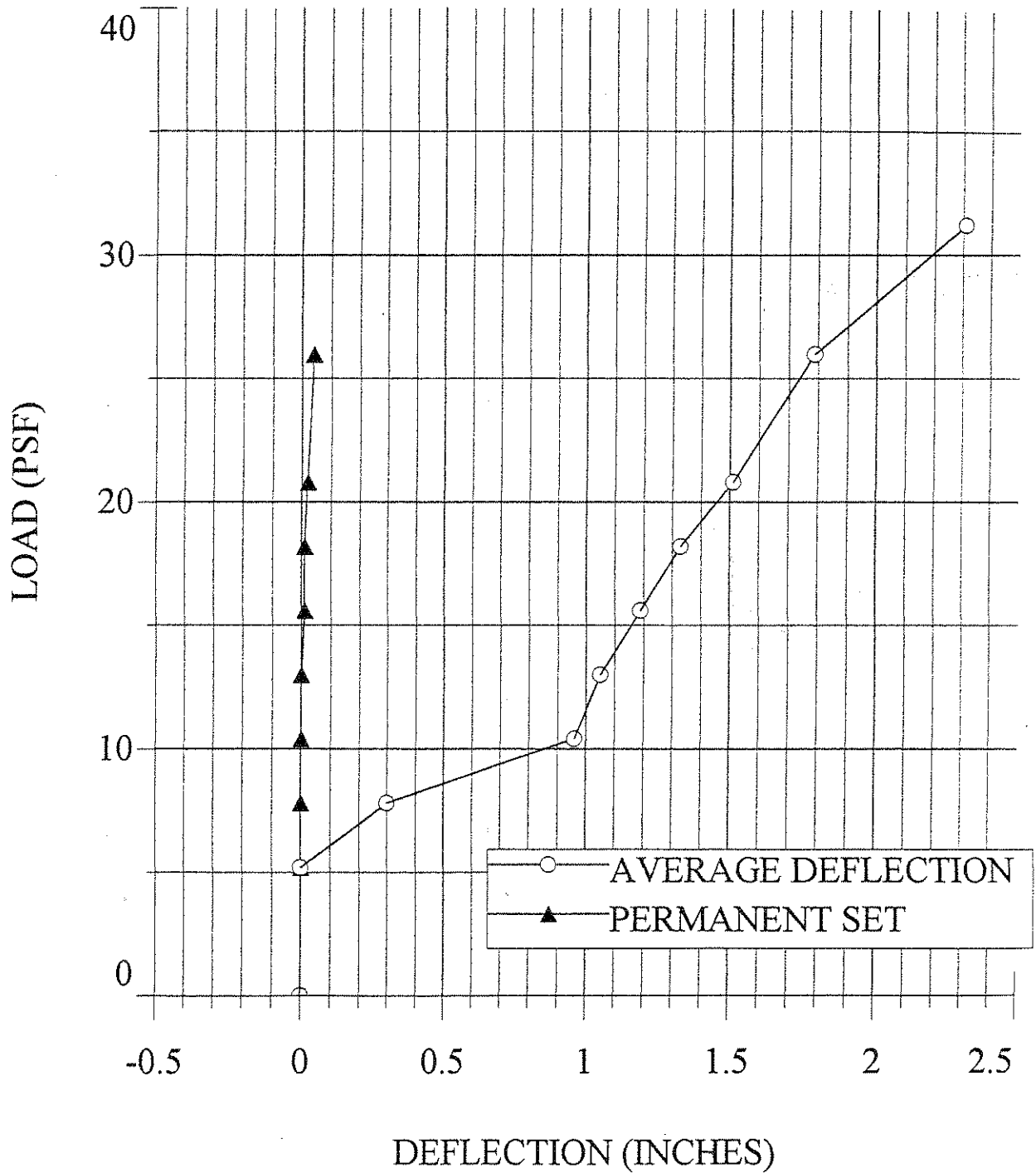
RIB SUPPORT

PANEL TEST 96505-1



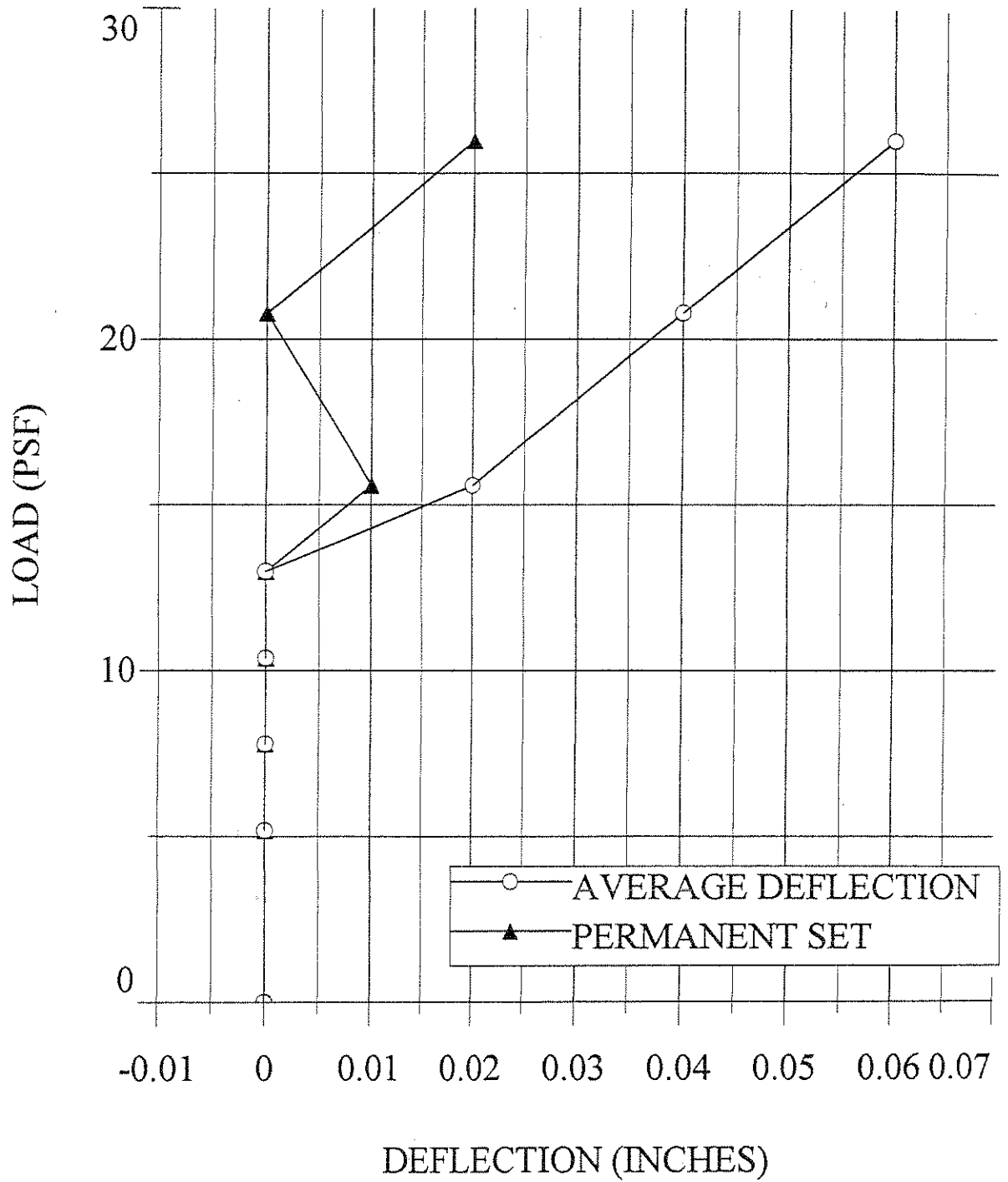
MID PANEL MIDSPAN

PANEL TEST 96505-1



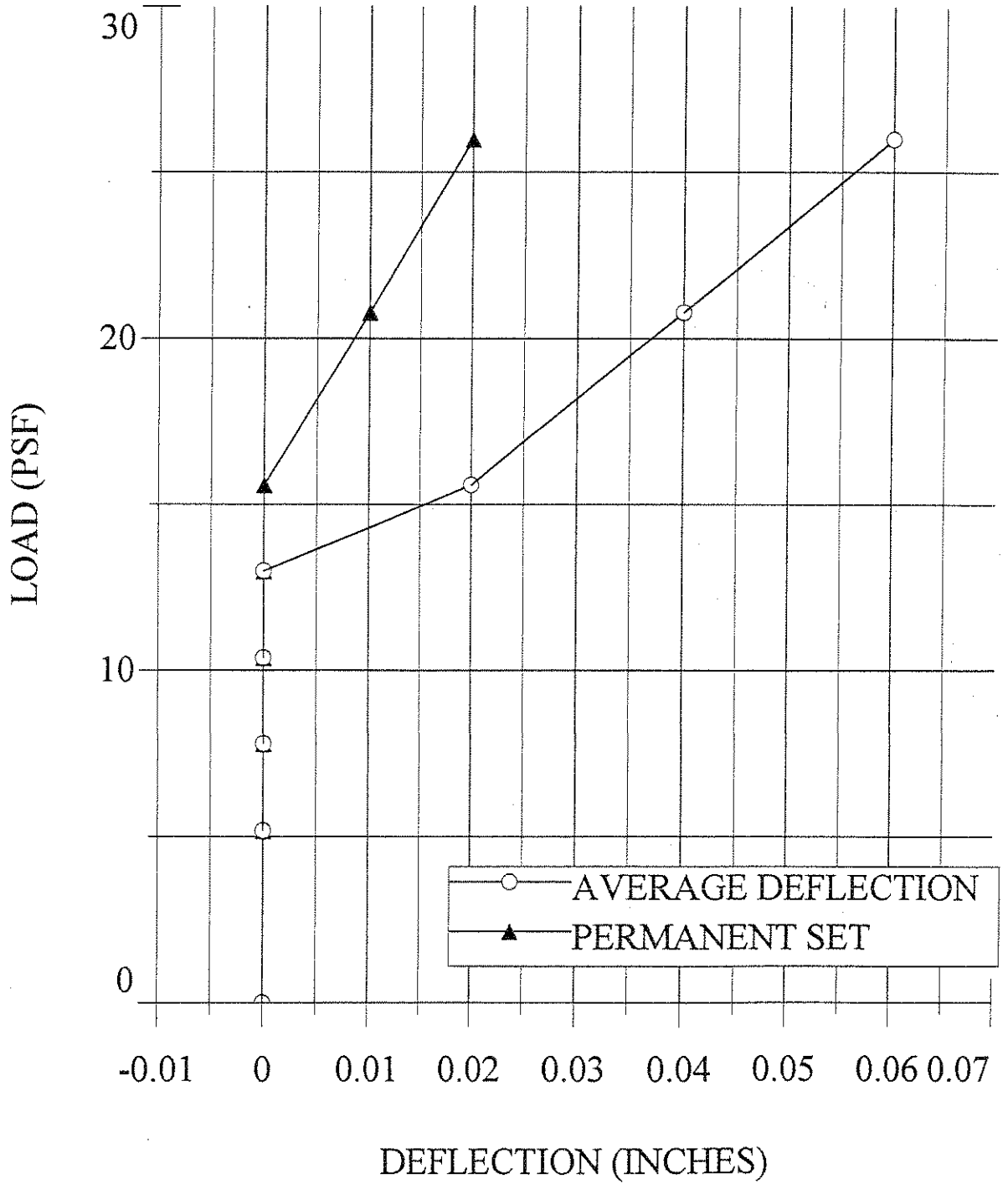
MID PANEL SUPPORT

PANEL TEST 96505-8



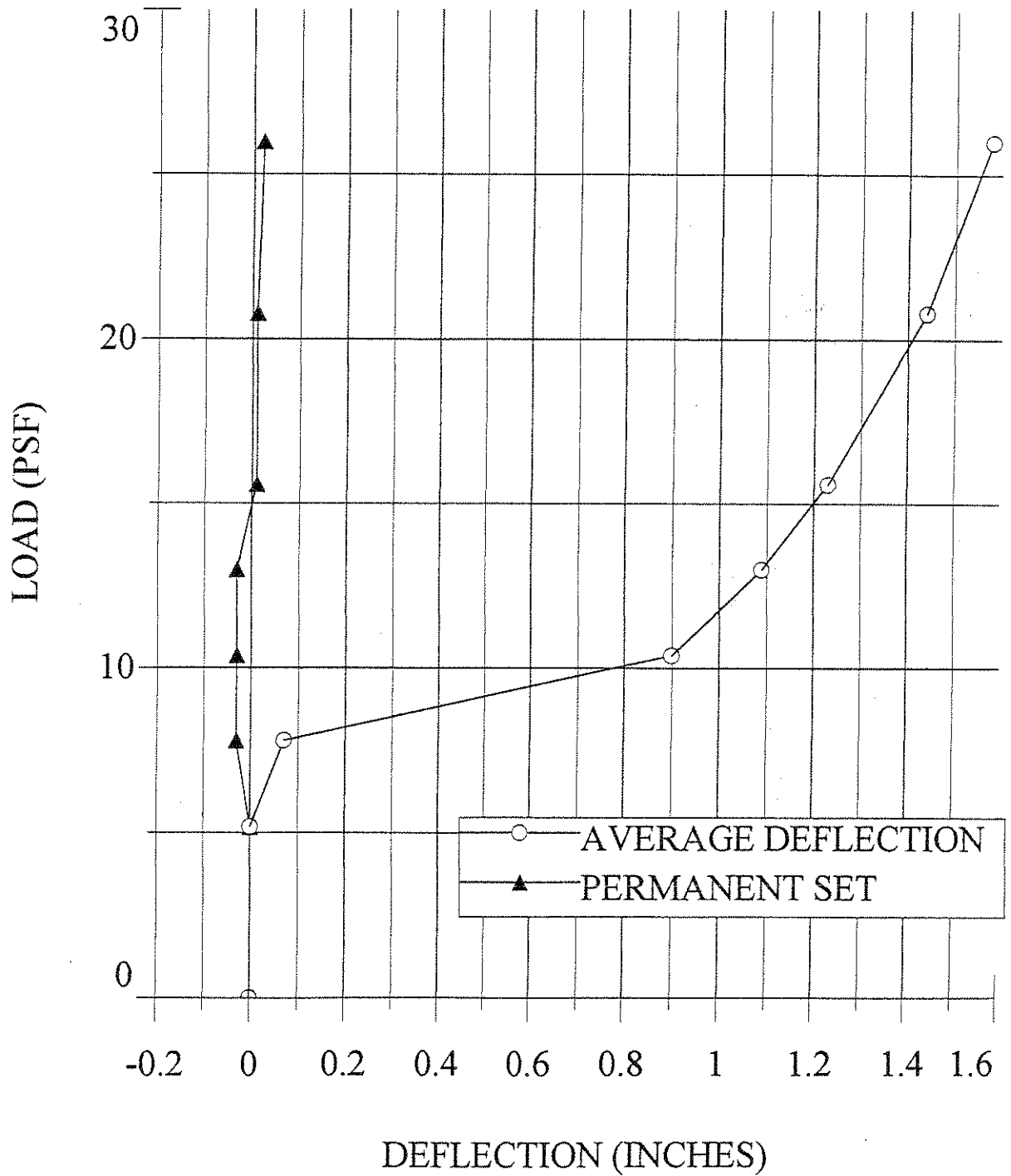
RIB MIDSPAN

PANEL TEST 96505-8



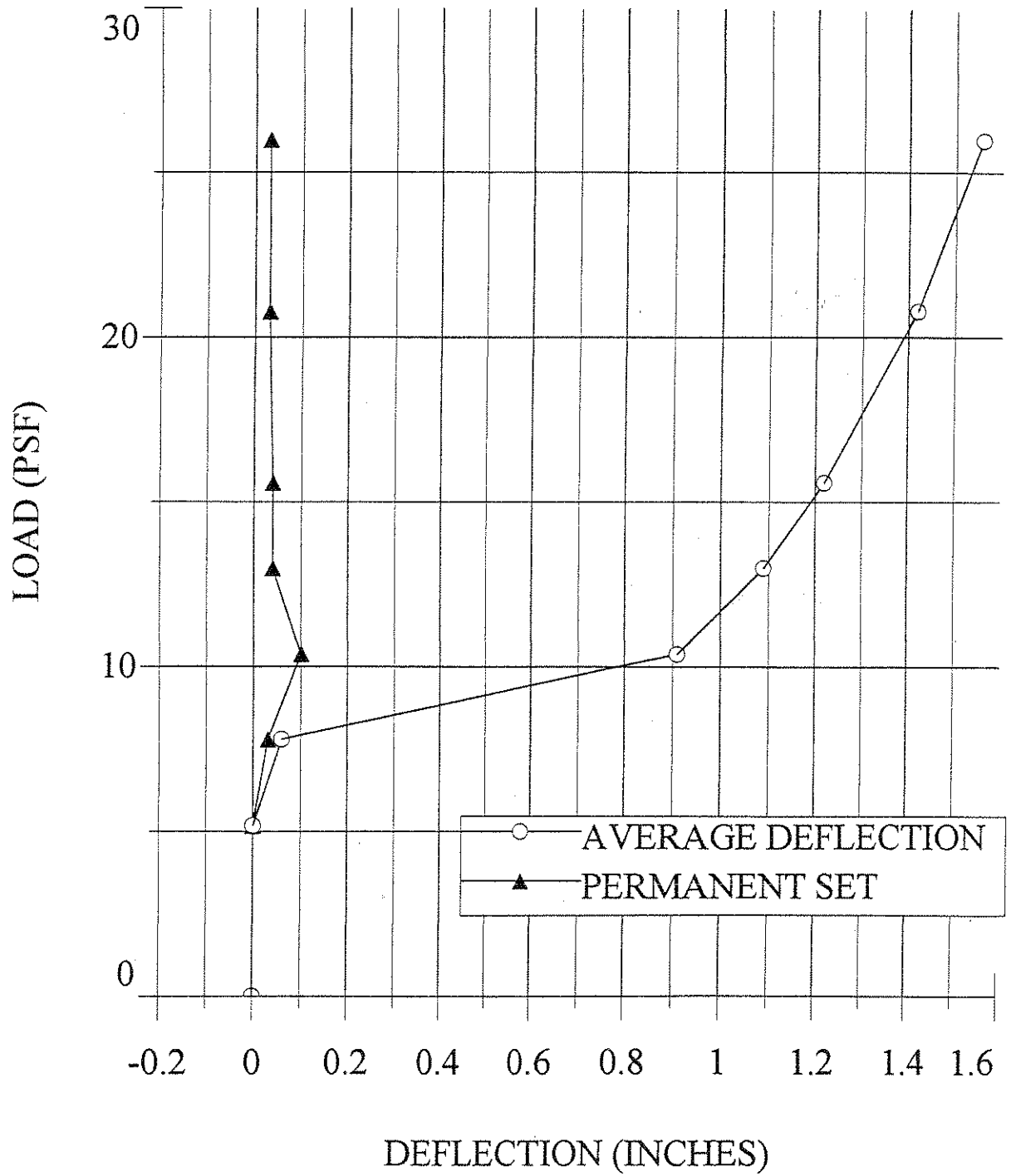
RIB SUPPORT

PANEL TEST 96505-8



MID PANEL MIDSPAN

PANEL TEST 96505-8



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:

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

where

R = required panel strength based on tests

D = dead load (included in 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

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

or

$$W = (1.33(31.2))/2.5 = 16.6 \text{ PSF}$$

1 Foot Span

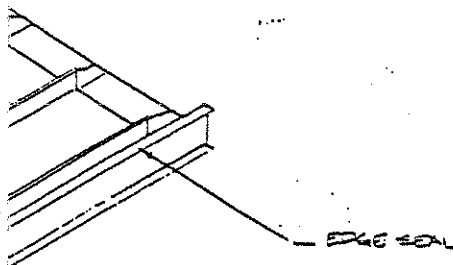
$$W = (1.333(31.2))/2.5 = 15.5 \text{ PSF}$$

Comparison of these values the load carrying capacity of the panel system decreased for the smaller panel span due to the presence of the panel clip in the Snap-Lock seam. The minimum allowable wind load for panel spans (clip spacing) between 1-foot and 3-foot-6 inches is 15.5 PSF. The recommended clip spacing in this span range is 3-foot-6 inches which will give an allowable wind load of 16.6.

* * * * *

2 GENERAL SPECIMEN LAYOUT

SEE MANUFORM FILE



TEST SPECIMEN

IT FOLDED UNDER PANELS IN RIBS

TO

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

| | | | |
|-----------------------------|----------|-------|--------|
| CERNY & IVEY ENGINEERS, INC | | | |
| ATLANTA, GEORGIA | | | |
| SSMS TEST CHAMBER | | | |
| U.S. ARMY CORP OF ENGINEERS | | | |
| STANDARD TEST 2. | | | |
| DATE | SCALE | DRAWN | INCHES |
| 7-2-92 | AS NOTED | ACI | |

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SL1500 Panel

ALL OUTSIDE RAD .084

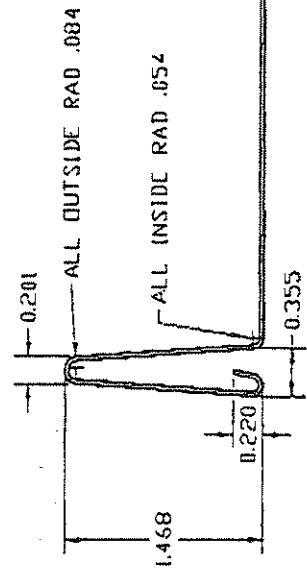
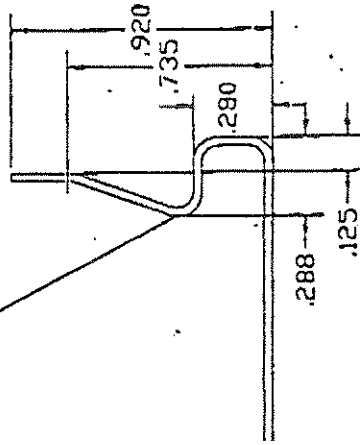
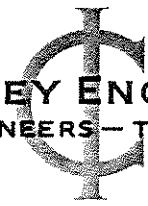


Figure 1

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.

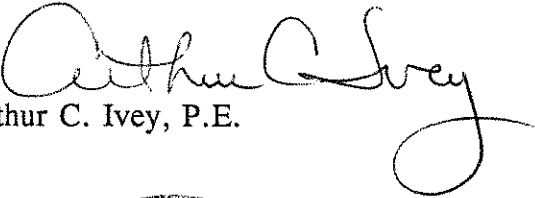
RESULTS


| 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,


Arthur C. Ivey, P.E.


Todd Breedlove
Senior Laboratory Technician

