April 27, 2001

Engineering Report 21093-2

Construction Metal Products, Incorporated
CMP Series 2500 16-inch Wide Panel
Galvanized Steel with 30-inch Clip Spacing
ASTM E1592 Uniform Pressure Test

SUMMARY

On March 12, 2001, testing was initiated on Construction Metal Products, Incorporated CMP Series 2500 G-90 galvanized steel roof panels to determine their loading characteristics under uniform static uplift loads. The panels were 16-inches wide with nominal 2-inch high ribs and were constructed of 24 gage, 50 KSI yield strength, Grade 50 steel. The panels were installed with 18 gage steel clips attached to the support purlins on spans of 30-inches using two fasteners per clip. The panels were tested with both ends open.

The panels were tested in accordance with ASTM E1592, "Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference." The panels held a maximum one-minute interval load of 161.2 PSF. They failed at approximately 166 PSF when the clips pulled free from the support purlins between the third and fourth panels and the panels ballooned upwards. The seam itself remained closed during failure.

If you have any question or need additional information, please contact us.

Respectfully submitted,

Heather R. Herbig	Phillip B. Plyler	Christopher B. Shiver, P.E.
Engineering Technologist	Staff Engineer	Vice President – Principal Engineer

INTRODUCTION

The 24 gage steel roof panel assembly was tested in conjunction with clips at 30-inches on centers to determine its performance characteristics under uniform static uplift loading conditions. The panels were tested in accordance with ASTM E1592, "Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference." The panels were assembled on the test fixture by Construction Metal Products, Incorporated (CMP) personnel and tested to failure. Deflections of the panel rib and pan were monitored on the top surface of the panel. Tensile tests were performed on representative samples of panels to determine the mechanical properties; those results are provided in Cerny & Ivey Engineers, Inc. Laboratory Report 21093-4. Photographs of the test specimen and failure mode are included in this report.

SPECIMEN

The specimen tested was an assembly of G-90 galvanized steel roof panels manufactured by CMP. The panels were installed on a steel support structure with zee stiffeners on each edge, clips between panels, and the appropriate fasteners following the manufacturer's instructions. Self-drilling screws were placed through the top of each rib at the ends of the panels to prevent premature "unzipping" of the panel seams during testing.

The symmetrical panels covered a nominal 16-inches and had nominal 2-inch high ribs (CMP Drawing 1, Figure 21093-2A, Photograph 1). The material specified for forming the panels was 24 gage, 50 KSI yield strength, Grade 50, galvanized sheet steel. The steel supports used for the testing were zee section purlins. The zee purlins were made of cold-formed 16 gage steel and were spaced at 30-inches on centers.

The panels were attached to the formed zee purlins using Buildex 1/4 - 14 x 7/8 Maxiseal TEKS/1 Climaseal screws at 12-inches on centers along the first edge of the panel assembly (Photographs 2 through 5). The screws were provided by Cerny & Ivey Engineers, Inc. Clips were seated against the second rib of the first panel and fastened to the support purlin (Photograph 6). The clips were fabricated from 18 gage steel (CMP Drawing 1). The clips were attached at 30-inches on centers to the support purlins with two of the same type Buildex 1/4 - 14 x 7/8 screws. This process was repeated with the remaining panels and clips until the assembly was completed (Photograph 7). The remaining rake edge was also fastened with the same type Buildex 1/4 - 14 x 7/8 screws at 12-inches on centers (Photographs 8 and 9).

As the panels were assembled, the panel ribs were mechanically seamed using a hand seamer at each clip location and halfway between clips (Photographs 10 and 11). An electrical seamer was used to completely seam each panel connection after the hand-seaming procedure (Photographs 12 and 13). The same type Buildex 1/4 - 14 x 7/8 screws were then placed through the top flange of each seamed rib at the ends of the panels to prevent premature unzipping of the seams during testing (Photographs 14 and 15). The completed panel assembly was 6-feet, 8-inches wide (5 panels) by 21-feet, 0-inches long (8 spans at 30-inches and 6-inch overhangs at either end) (Photographs 16 and 17).

PROCEDURE

The panels were assembled on the test chamber by CMP personnel. A 6-mil thick sheet of plastic film was placed by Cerny & Ivey Engineers, Inc. personnel during panel installation to seal the panel against air leakage (Photograph 18). The plastic film was

pleated into the standing seams and under the panel flat section so that it would not affect the test results by creating filets or non-uniform pressure distribution by bridging across members. The panel edges and the plastic sheet were sealed to the edge of the test chamber.

Deflection gages, readable to 0.0005-inch, were installed (Photograph 17) above the ribs on each edge of the third panel at the center of the center span (gages 1 & 3) and the adjacent support location (gages 4 & 6). Two gages were placed on the center of the third panel flat section at these same lines (gages 2 & 5). Pan deflections were measured (1/16-inch tolerance) along the center-line of the fourth panel every 24-inches. The chamber pressure was measured at both ends (diagonal corners) of the chamber using water manometers accurate to 0.1-inches 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 increased to the next load increment, where it was maintained for 60 seconds; deflections were then read. The load was returned to actual zero for a recovery period and then brought back to the reference zero load and maintained for 60 seconds; set deflections were then read. This procedure was repeated, with increasing uniform loads, until failure of the panel occurred. The procedure was performed in accordance with ASTM E1592, "Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference."

RESULTS

The panel is shown at various test pressures in Photographs 19 through 28. The panels held a maximum one-minute interval load of 161.2 PSF. They failed during loading

at approximately 166 PSF when the clips pulled free from the support purlins between the third and fourth panels and the panels ballooned upwards. The seam itself remained closed during failure. Samples of the roof panel material were cut from the failed panels and tensile testing was performed to determine material properties (see Cerny & Ivey Engineers, Inc. Laboratory Report 21093-4).

The test results are presented in the tables and graphs on the following pages. All deflection measurements were normalized to a zero reference. Readings of rib deflections were averaged and plotted as a function of load. Rib deflection and rib permanent set at a clip location (support) and at a midpoint between clips (mid-span) was plotted. Deflections of the panel flat (mid-panel) were plotted as a function of location and load.

Table 1: Panel Rib Deflections and Permanent Sets

	RIB DEFLECTION (inches)						RIB SET (inches)					
LOAD	MIDSPAN			SUPPORT			MIDSPAN			SUPPORT		
(PSF)	1	3	AVG	4	6	AVG	1	3	AVG	4	6	AVG
0	0.0000	0.0000	0.000	0.0000	0.0000	0.000	0.0000	0.0000	0.000	0.0000	0.0000	0.000
7.8	0.0135	0.0045	0.009	0.0100	0.0030	0.007	0.0005	0.0000	0.000	0.0015	0.0000	0.001
10.4	0.0280	0.0360	0.032	0.0100	0.0260	0.018	0.0030	0.0000	0.002	0.0045	0.0050	0.005
13.0	0.0335	0.0650	0.049	0.0335	0.0240	0.029	0.0055	0.0000	0.003	0.0085	0.0055	0.007
15.6	0.0470	0.0965	0.072	0.0445	0.0505	0.048	0.0075	0.0035	0.006	0.0085	0.0065	0.008
18.2	0.0595	0.1325	0.096	0.0690	0.0950	0.082	0.0090	0.0040	0.007	0.0105	0.0070	0.009
20.8	0.0815	0.1705	0.126	0.1055	0.1320	0.119	0.0120	0.0040	0.008	0.0135	0.0060	0.010
26.0	0.1570	0.2160	0.187	0.1855	0.2190	0.202	0.0145	0.0060	0.010	0.0170	0.0020	0.010
31.2	0.3380	0.2460	0.292	0.3040	0.3640	0.334	0.0210	0.0120	0.017	0.0185	0.0025	0.011
36.4	0.4230	0.2420	0.333	0.4405	0.3045	0.373	0.0350	0.0265	0.031	0.0450	0.0255	0.035
41.6	0.4790	0.5415	0.510	0.4885	0.4570	0.473	0.0550	0.0430	0.049	0.0715	0.0445	0.058

Figure 1: CMP Series 2500 Panel Deflection and Set at Rib Midspan

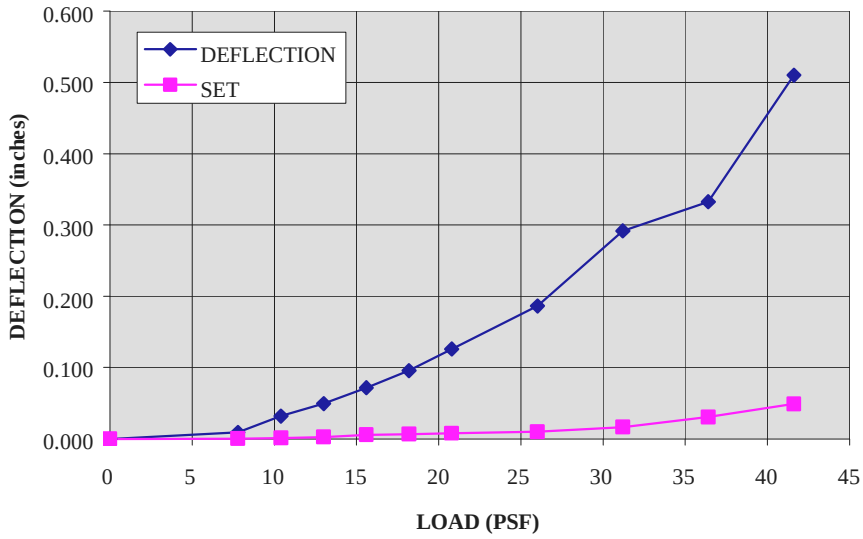

Figure 2: CMP Series 2500 Panel Deflection and Set at Rib Support

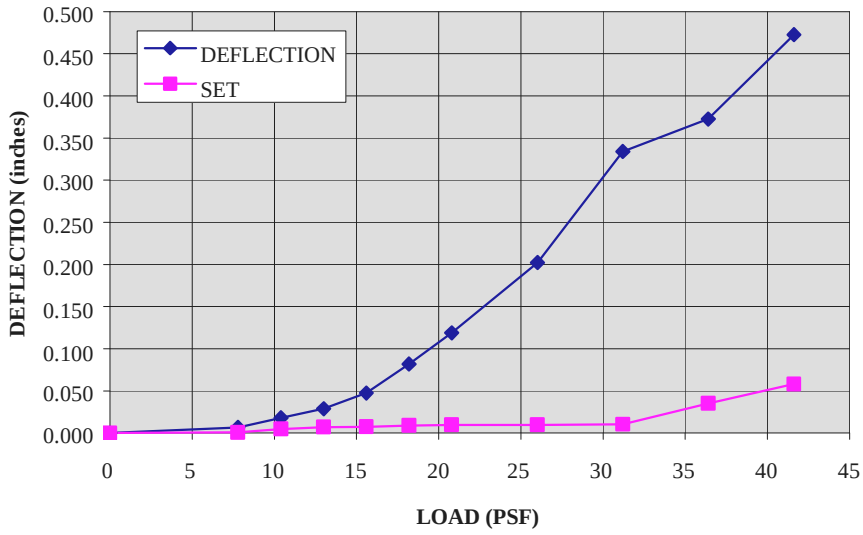

Table 2: Panel Midpanel Deflections and Permanent Sets

LOAD (PSF)	MIDPANEL DEFLECTION (inches) MIDSPAN 2	MIDPANEL DEFLECTION (inches) SUPPORT 5	MIDPANEL SET (inches) MIDSPAN 2	MIDPANEL SET (inches) SUPPORT 5
0	0.0000	0.0000	0.0000	0.0000
7.8	0.1440	0.0105	0.0215	0.0135
10.4	0.4680	0.5505	0.0150	0.0235
13.0	0.8555	0.9560	0.0125	0.0235
15.6	1.3370	1.4355	0.0295	0.0045
18.2	1.7275	1.8315	0.0405	0.0010
20.8	2.1020	2.2240	0.0375	0.0050
26.0	2.7095	2.8335	0.0595	0.0040
31.2	4.3145	4.4710	0.0965	0.0095
36.4	4.7075	4.8295	0.1445	0.0220
41.6	4.9410	5.0550	0.1615	0.0355

Figure 3: CMP Series 2500 Panel Deflection and Set at Midpanel Midspan

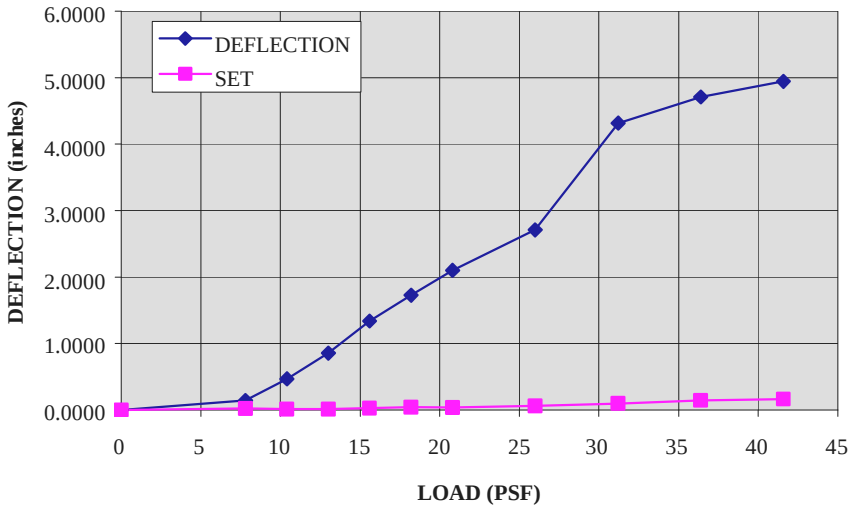

Figure 4: CMP Series 2500 Panel Deflection and Set at Midpanel Support

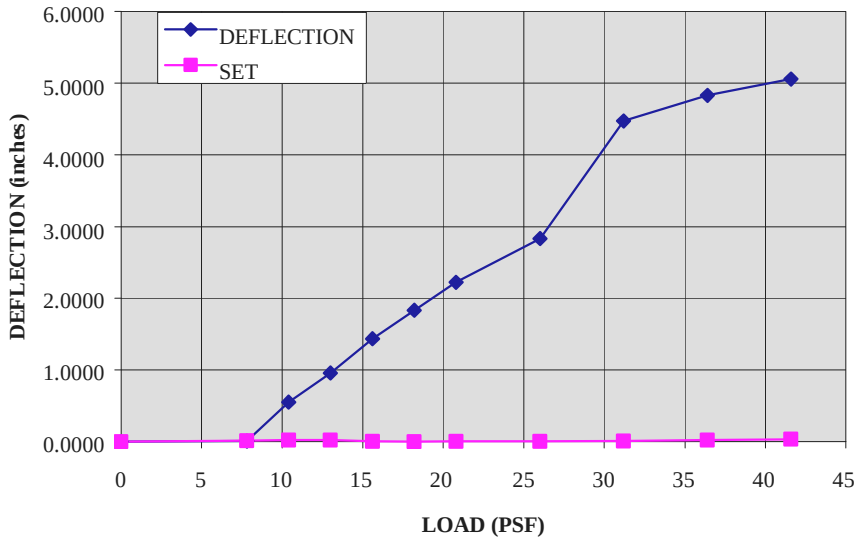

Table 3: Deflection of the Panel Flat

	PANEL DEFLECTION									
LOAD (PSF)	**EAVE (INCHES)**	**2 FT (INCHES)**	**4 FT (INCHES)**	**6 FT (INCHES)**	**8 FT (INCHES)**	**10 FT (INCHES)**	**12 FT (INCHES)**	**14 FT (INCHES)**	**16 FT (INCHES)**	**18 FT (INCHES)**	**20 FT (INCHES)**
7.8	1/8	1/4	1/2	3/4	1/2	3/8	1/4	3/8	1/4	1/4	1/4
10.4	5/8	5/8	1 1/8	1 3/8	1 1/8	7/8	7/8	7/8	3/4	5/8	5/8
13.0	1 1/8	1 1/8	1 3/8	1 7/8	1 5/8	1 3/8	1 1/4	1 1/4	1 1/8	1	3/4
15.6	1 1/2	1 5/8	2	2 1/4	2	1 3/4	1 3/4	1 3/4	1 1/2	1 3/8	1 1/4
18.2	2	2	2 3/8	2 5/8	2 3/8	2 1/8	2 1/8	2 1/8	1 7/8	1 3/4	1 5/8
20.8	2 1/4	2 1/4	2 1/2	3	2 5/8	2 3/8	2 3/8	2 3/8	2 1/4	2	1 7/8
26.0	2 3/4	2 5/8	3 1/8	3 1/2	3 1/8	2 7/8	2 7/8	2 7/8	2 5/8	2 1/2	2 3/8
31.2	3 5/8	3 5/8	4	4 3/8	3 3/4	3 3/4	3 5/8	3 5/8	3 1/2	3 1/4	3
36.4	3 3/4	3 7/8	4 1/4	4 5/8	4 3/8	4 1/8	4	4	3 3/4	3 5/8	3 1/2
41.6	4	4 1/8	4 3/8	4 7/8	4 1/2	4 3/8	4 1/4	4 1/4	4	4 1/4	3 5/8

Figure 5: CMP Series 2500 Panel
Deflection Along Panel