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CONTINUOUS PURLIN TESTS

by

T. Peköz

for

METAL BUILDING MANUFACTURERS

ASSOCIATION

January 1975

Other personnel who participated in
various phases of this project are:
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A. Alvi and S. Ramamurthy

Ithaca, New York

1. INTRODUCTION

The results of the first phase of an experimental investigation are presented in this report. The objective of this investigation is to study the applicability of a theoretical approach developed at Cornell and implemented in a computer program developed by T. Pekoz for Diaphragm Braced Channel and Z-Section Purlins. In this phase of the experimental program three "full-scale" assemblies were tested under simulated wind-uplift loading. In addition, several supplementary tests were carried out to determine various physical parameters utilized in the analytical solution.

The reported results are restricted to those tests that have direct bearing on correlating the test results with computer analysis. Several additional preliminary and supplementary tests were conducted in order to establish the procedures used or to verify the results obtained.

2. ASSEMBLY TESTING

2.1 *General*

Wind uplift loading was simulated in three tests on continuous, lapped purlins of three-25 feet spans, one with channel and two with Z-section purlins. Schematics of the assemblies are given in Figs. 1a, 2a, 3 and 4. A photograph of the overall view is given in Fig. 52. Cross-sectional dimensions of purlins and the roof deck are shown in Figs. 1b, 2b, and 1c. The roof deck was cantilevered out over the purlins to reflect the cupping of the roof deck in a prototype around the screw connection under uplift loading. Several tests had to be carried out as described in Section III

to determine a feasible and desirable span for this cantilever.

The loading was applied by vacuum with the purlins supported by a frame as shown in Figs. 3 and 4. In setting up the full scale test, first the purlins were connected with 1/2 inch diameter bolts to the members simulating the building frame. These members were W 10x15 sections as shown in Figs. 1 through 3. Next, starting from one end of the assembly, the roof deck was connected to the purlins by #14 self tapping sheet metal screws. The purlins of the first Z-section purlin assembly were observed to have a large initial sweep and twist. The initial sweep and twist were due to the fact that the purlins themselves were initially imperfect and the assembly had to be constructed in upside down form of the normal configuration. Therefore, the C-section and second Z-section purlin assemblies were constructed using temporary wood bracing to minimize the initial sweep and twist. The purlins were also straightened out prior to assembly.

Polyethylene sheet and tape for sealing was placed between the purlin and the roof deck as shown in Fig. 3. To complete the set-up, polyethylene was taped securely to the floor to create an airtight space for pulling the vacuum needed to simulate wind uplift loading. Erection details on the manufacturers drawings were carried out to the maximum possible extent. Before each test, a representative from the purlin manufacturer was invited to inspect and approve the details of assembly and testing.

Braces were used at supports in all tests to prevent lateral displacement and twist of the purlins at all the supports. Braces are illustrated in Fig. 52. At the ends of the purlins, rake channels were used in the channel assembly but not in the Z-section

assembly.

2.2 First Z-Section Purlin Test

Z-section purlins were tested first. The Z-section assembly purlins had significant initial sweep and twist as shown in Fig. 5. Dial and strain gages were located as shown in Figs. 6 and 13. Two preliminary tests with loadings up to 15 psf were conducted first. Only the first preliminary tests were carried out without braces at supports to prevent lateral displacement and twist. These tests indicated that a steady load could be maintained as desired and hence the final test was carried out. Displacements, rotations and stresses are plotted in Figs. 7 through 12 and 14 to 20. In these plots the vertical axis is the load axis. The numbers to the right of this axis indicate the magnitude of the vacuum applied. The dead load per square foot of the horizontal projection of the test assembly was 2.25 lbs. The origin of the vertical axis is, therefore, taken as 2.25 psf below the zero vacuum pressure. The stresses and displacements are with respect to the state with dead loading only. Only the maximum compression and tension stresses are plotted for each section investigated. Appendix A presents the detailed test data, deflections and stresses at any point where strain gages were applied (Fig. 13) can be obtained from Appendix A. In some instances, readings should be disregarded because of obvious gage malfunction or observation error.

Although the last gage readings were taken at 36 psf loading, the failure occurred at about 40 psf. At failure a plastic buckle of very short wave length appeared at 10 feet from the outside end

of the end spans (indicating yielding) and some tearing was observed in the roof deck around the screws in the vicinity of the same location.

Specimens were taken from the middle span for cantilever shear test and material properties tests. The middle span did not show any sign of failure or permanent set in the assembly test.

No intermediate braces were used in the Z-section tests.

2.3 C-Section Purlin Test

Using the same set-up and general procedure as above, an assembly using C-section purlins as shown in Fig. 2a and b fabricated. Several precautions were taken for this assembly to improve initial straightness of the purlins. Prior to assembling, the purlins were straightened. Wooden 2" x 6" braces were used at three points in each span to prevent rotations and lateral displacements during assembly. These braces were taken out before testing. Initial sweep was observed as shown in Fig. 21. Braces, same as those used for the Z-section purlins, were provided at supports to eliminate lateral deflections and twist.

Prior to final testing two preliminary tests with loading up to 9 psf were carried out. In the first preliminary tests an intermediate brace was used to investigate potential experimental problems that might arise in tests contemplated for the future. The results were satisfactory. Dial and strain gage locations used in the final test are shown in Figs. 22 and 28. Test results are plotted in Figs. 23 to 28 and 30 to 34. The dead weight of the assembly was 2.52 psf for the end spans and

2.32 psf for the center span. The comments made for vertical and horizontal coordinates of similar plots for the Z-section Purlin Assembly test in section 2.2 are also valid here. Only the maximum compression or tension stresses are plotted for each section. A complete record of all the gage readings is presented in Appendix B. As in the Z assembly test, a few readings should be disregarded because of obvious gage malfunction or observation error. Fig. 35 gives a plot of the vertical deflection of the roof deck itself.

The last readings of the gages were taken at 39 psf and failure occurred at about 42 psf. A simultaneous sudden increase in the rate of deflections and the twist and pull-over type failure was observed in one end span around 10 feet from the outside end. It was not clear whether the pull-over failure precipitated the purlin failure or vica versa. In the other outside span, failure did not occur even though an increased rate of deformations were observed.

Specimens for another cantilever shear test and material properties tests were taken from undamaged portions of the assembly.

2.4 Second Z-Section Purlin Test

A second Z-Section Purlin Assembly was constructed with special care to minimize the initial sweep and twist as discussed in Section 2.3 for the C-Section Purlins. As discussed in Section 2.1, the initial sweep and twist that was present in the first test was thought to be too excessive for an actual structure. The assembly braces and all the dimensions were as described in Section 2.2. The initial sweep and twist observed after the braces were removed is shown in Fig. 36. Dial gage and strain gage locations are shown in Figs. 37 and 44. Test results are plotted in Figs. 38

through 43 and 45 through 51. The dead weight of the assembly was 2.25 psf. The comments made for vertical and horizontal coordinates of similar plots for the first test in Section 2.2 are also valid here. Only the maximum compression and tension stresses are plotted for each section. A complete record of all the gage readings is presented in Appendix C. A few of the strain gages malfunctioned at low loads, but were subsequently fixed and functioned properly. The results corresponding to this range of malfunction were extrapolated and interpolated from the proper results. These ranges of values are shown by dashed lines in the plots.

The last readings were taken at 48 psf and the failure occurred at about 50 psf. At failure plastic buckles of very short wave lengths appeared at 10 feet from the outside supports of the end spans. Photographs of the local buckles as well as the overall view of this test are given in Figs. 52 through 54.

3. TESTS TO DETERMINE ROTATIONAL RESTRAINT PARAMETER F

The intent of this test is to evaluate the relationship between the applied twisting moment and the twist angle as a result of local deformations around the screw.

Since it was felt that the set-up and procedure used in the earlier Cornell research did not reflect the effect of "cupping" of the roof deck around the screws, a new test set-up and procedure was developed. Several tests were carried out to explore possible problems and to determine a feasible and desirable cantilevering span (overhand distance L , in Fig. 56) for the roof deck over the purlins on the sides (Figs. 1a and 1b.). The set-up shown in Fig.

55 appears feasible for evaluating the rotational restraint in a prototype roof assembly. The distance L should be as large as possible without causing beam type failure of the roof deck under imposed loads.

For the evaluation of the rotational restraint in the test assembly, the set-up shown in Fig. 56 is more desirable and was used. Since the overhand distance L influences the value of F obtained, the overhand distance actually used in the full scale test assembly was used in the test to determine F.

Rotation resulting from the deflection of the roof deck as a cantilever has to be measured and subtracted from the total rotation because only the rotation due to local effects is representative of the full scale test behavior. Cross-bending rotation in the full scale test has to be computed and included in the value of F used. Rotation in the test for F due to cantilever bending and cross bending rigidity in the full scale test proved to be negligible compared to local effects.

The details of the connection between the purlin and the roof deck were the same in both the test for F and the full scale test. These details include location of the screw on the flange, tape and polyethylene between the roof deck and the purlin and the direction of rotation.

Procedure for computing F is outlined in Fig. 57. Only those results that will be of direct use in the evaluation of full scale tests are given in this report. They are shown in Figs. 58 through 67.

4. TESTS TO DETERMINE SHEAR RIGIDITY OF ROOF DECK Q

The objective of this test program is to correlate the full scale tests results with analytical results. Therefore, special framing that reflects the conditions in the full scale tests was used in the cantilever shear tests to determine the shear rigidity, Q , of the roof deck. The general set-up is shown in Figs. 68 and 69.

Three cantilever shear tests were conducted. The set-up for the first test is shown in Fig. 68 and the results are shown in Fig. 70. The second test set-up and the results are shown in Figs. 69 and 71, respectively. The third test had a set-up similar to the second test, but the roof deck was not connected to the edge beam on the far side (that is, the edge parallel to the line of action of the load and opposite from the side where the load was applied). On the near side the roof deck was connected to the edge beam. The results of this test are shown in Fig. 72.

The connection details in the full scale test between the purlins and the roof deck, as well as at the seam connections, were used in the cantilever shear test specimen. The connections between the edge beams and the roof deck in Tests 2 and 3 were the same as the seam connections with one screw added close to the corner of the side connected.

5. CONNECTION LOAD AND ROTATION CAPACITY TESTS

Three pilot tests were conducted for this purpose. Two tests were conducted using a fixture that was recommended in a recent Cornell project for uplift-pull-over simulation. This fixture gives good and consistent results for concentrically applied loads on the

connection. The screw connections in the test specimen as well those in the prototype are subjected to a significant prying action due to the twisting of the purlin. In one of the tests using the Cornell fixture the load was applied concentrically and in the other with a 3/4 in. eccentricity. The ultimate loads of 700 lbs. and 446 lbs. per screw, respectively, were observed. The author believes that the simulation of the prying action was not satisfactory in these tests. Therefore, these tests will not be described in detail. The third test was conducted using the fixture illustrated in Fig. 56. The connection failed at a combination of loads $P = 80$ lbs/screw and $V = 125$ lbs/screw. In this test V was kept constant at 125 lbs/screw while P was increased. Due to the sudden nature of the failure, the rotation angle at failure could not be measured accurately. It is estimated to be between .2 to .3 radians (11 to 17 degrees).

6. MATERIAL PROPERTIES

After each full scale test, standard tensile coupons were taken from unyielded portions of the purlins. Three coupons (one from each flange and the web) were cut from each type of purlin.

Coupons from the Z-section purlin had yield stresses of 55.4, 55.5, and 55.7 ksi.

Coupons from .0773 inches thick channel section purlin (used for the interior span) had yield stresses 47.5, 45.0 and 48.9 ksi.

Coupons from .1119 inches thick channel section purlin (used for the end spans) had an average yield stress of 40 ksi.

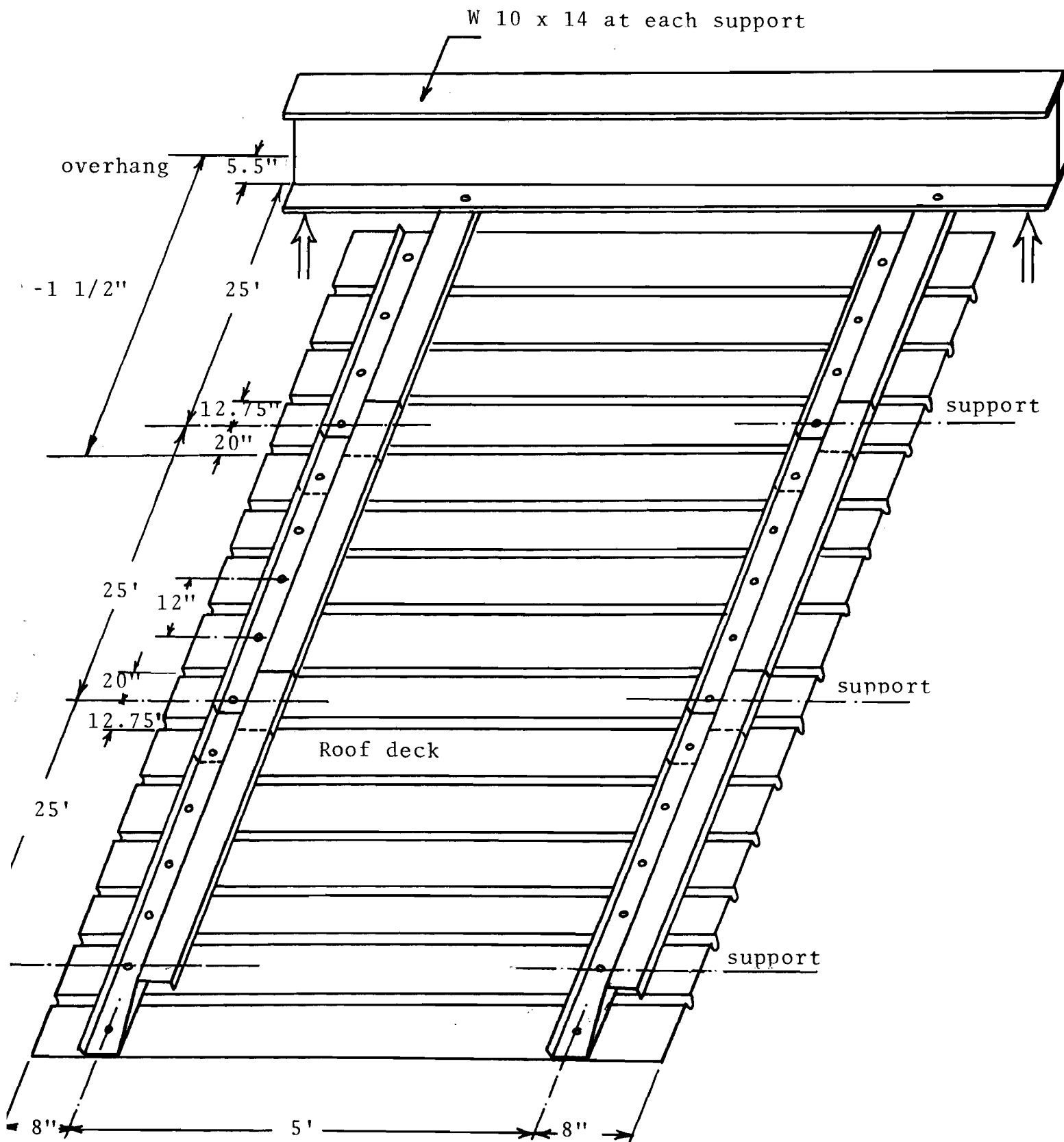


Fig. 1a Z-Section Purlin Assembly

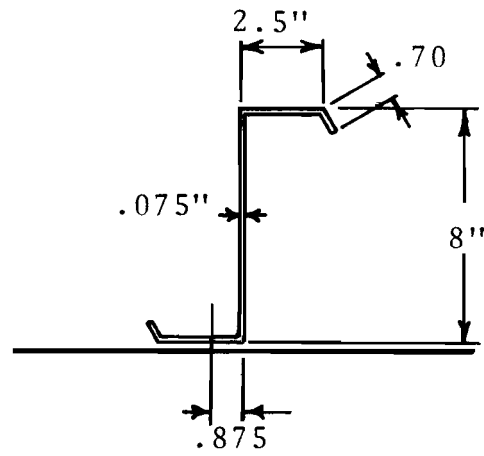


Fig. 1b Z-Section Purlins

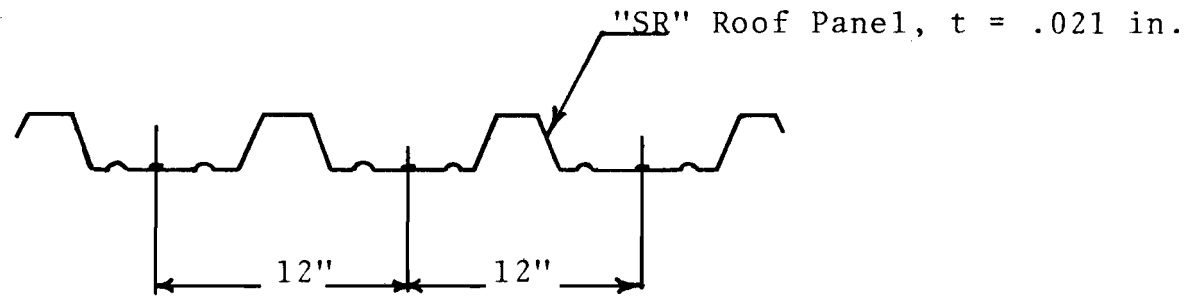


Fig. 1c Roof Deck Configuration

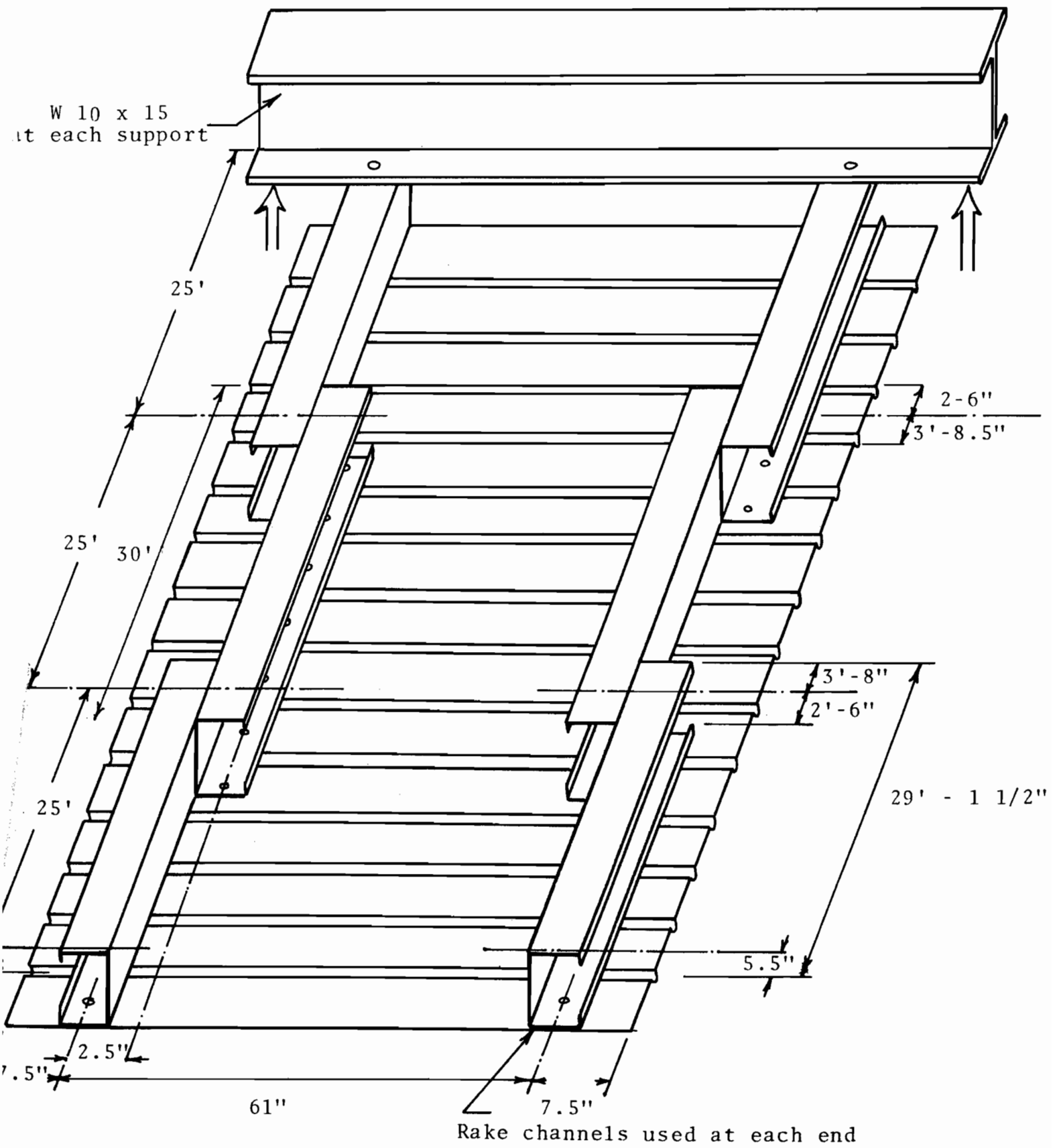


Fig. 2a C-Section Purlin Assembly

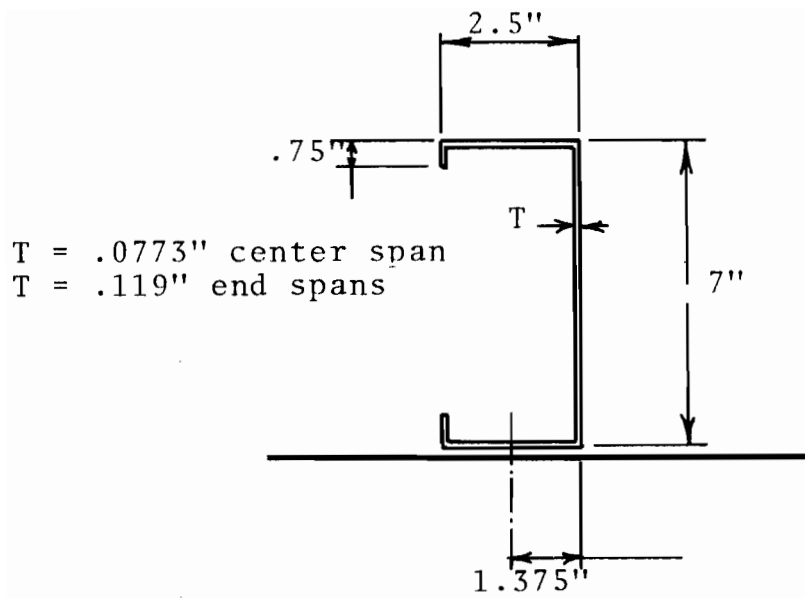


Fig. 2b C-Section Purlins

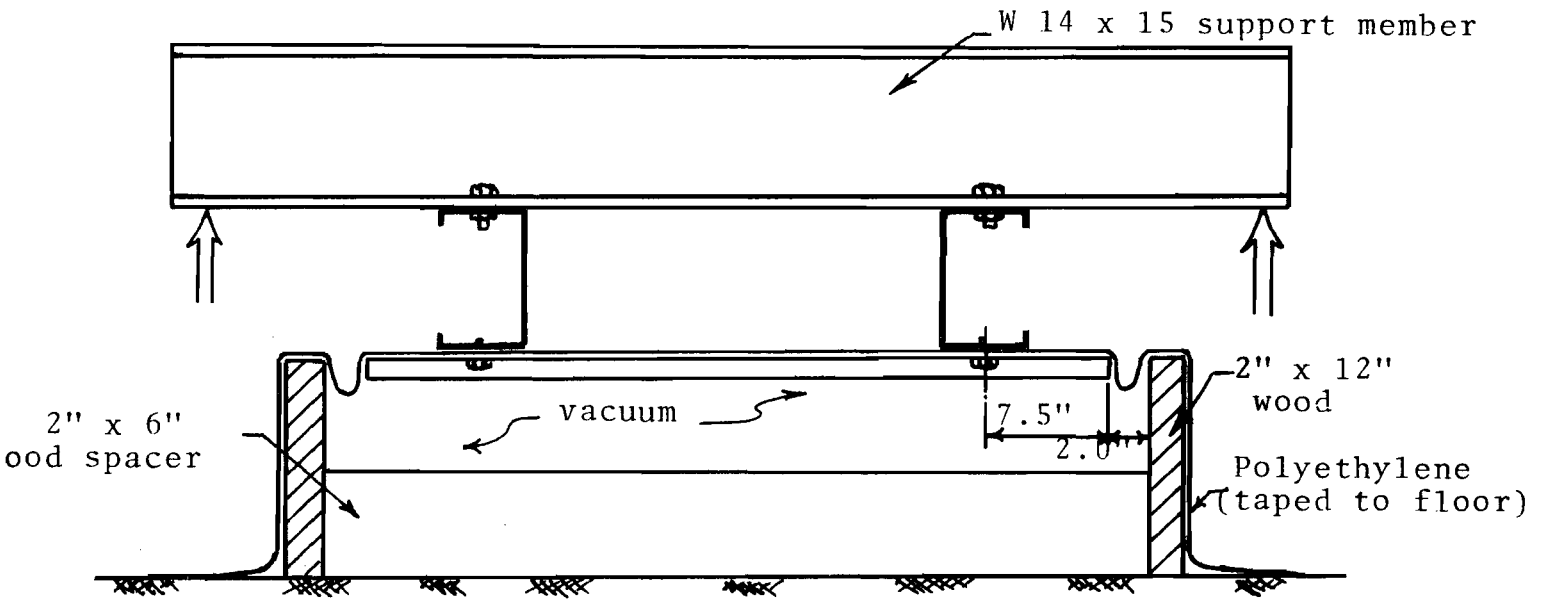


Fig. 3 Section of Test Setup

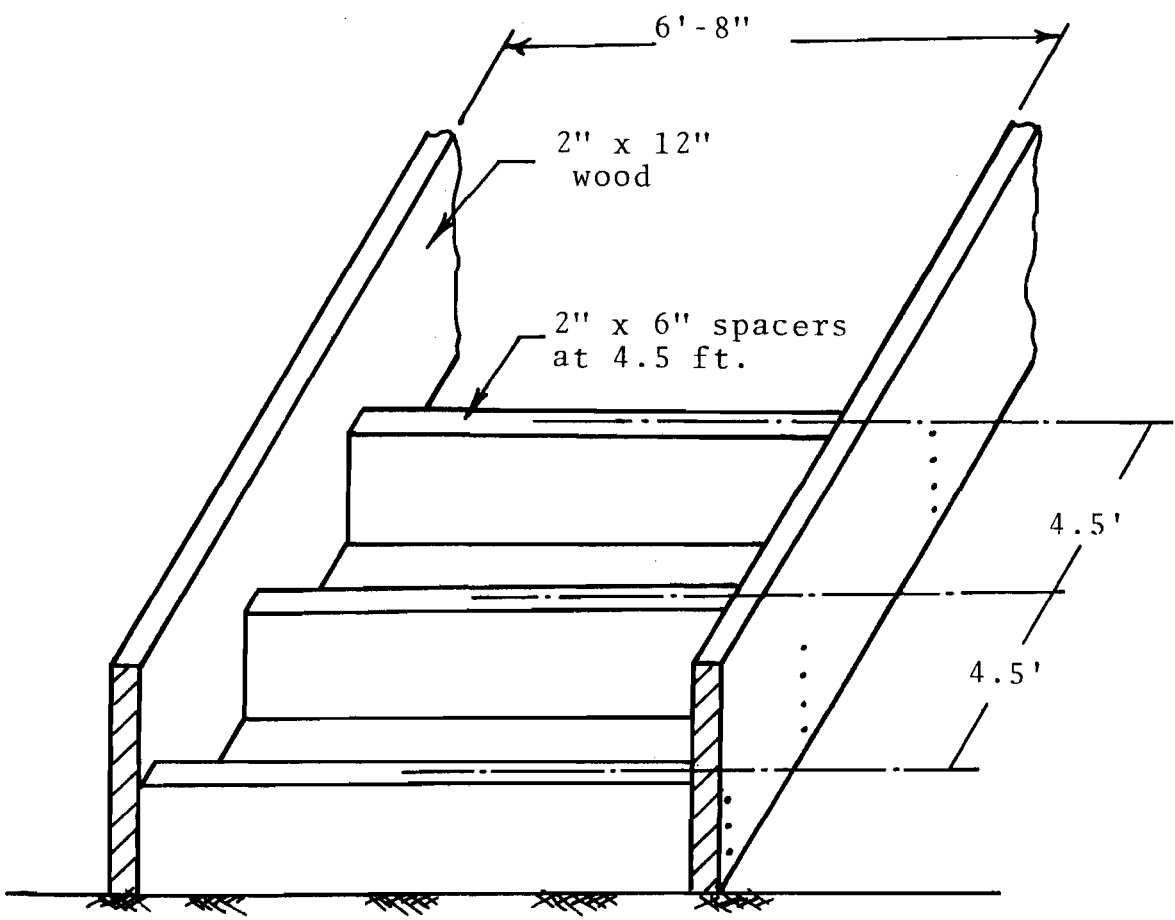


Fig. 4 Vacuum Box

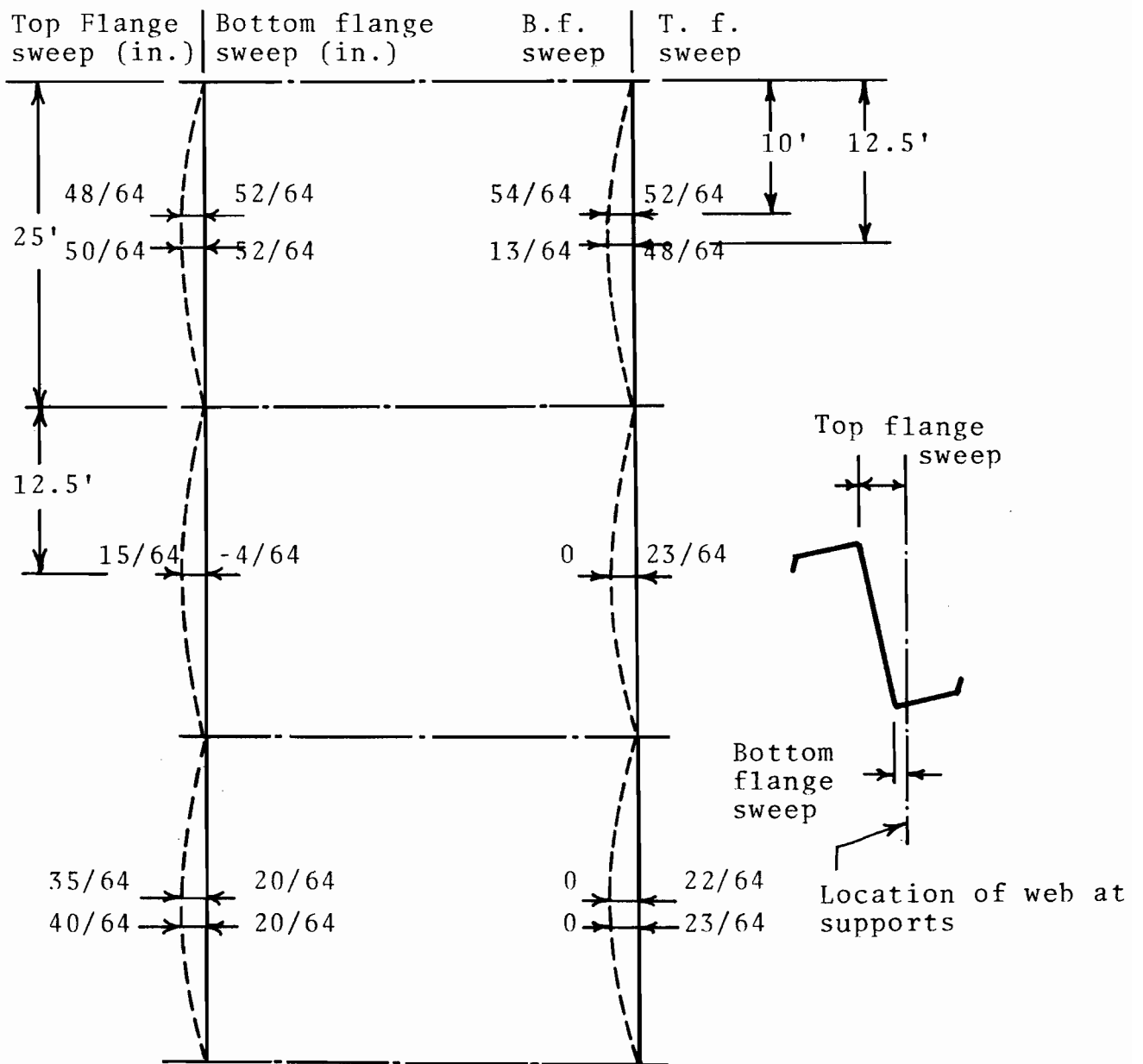


Fig. 5 Initial Sweep of Z-Section Purlins - First Test

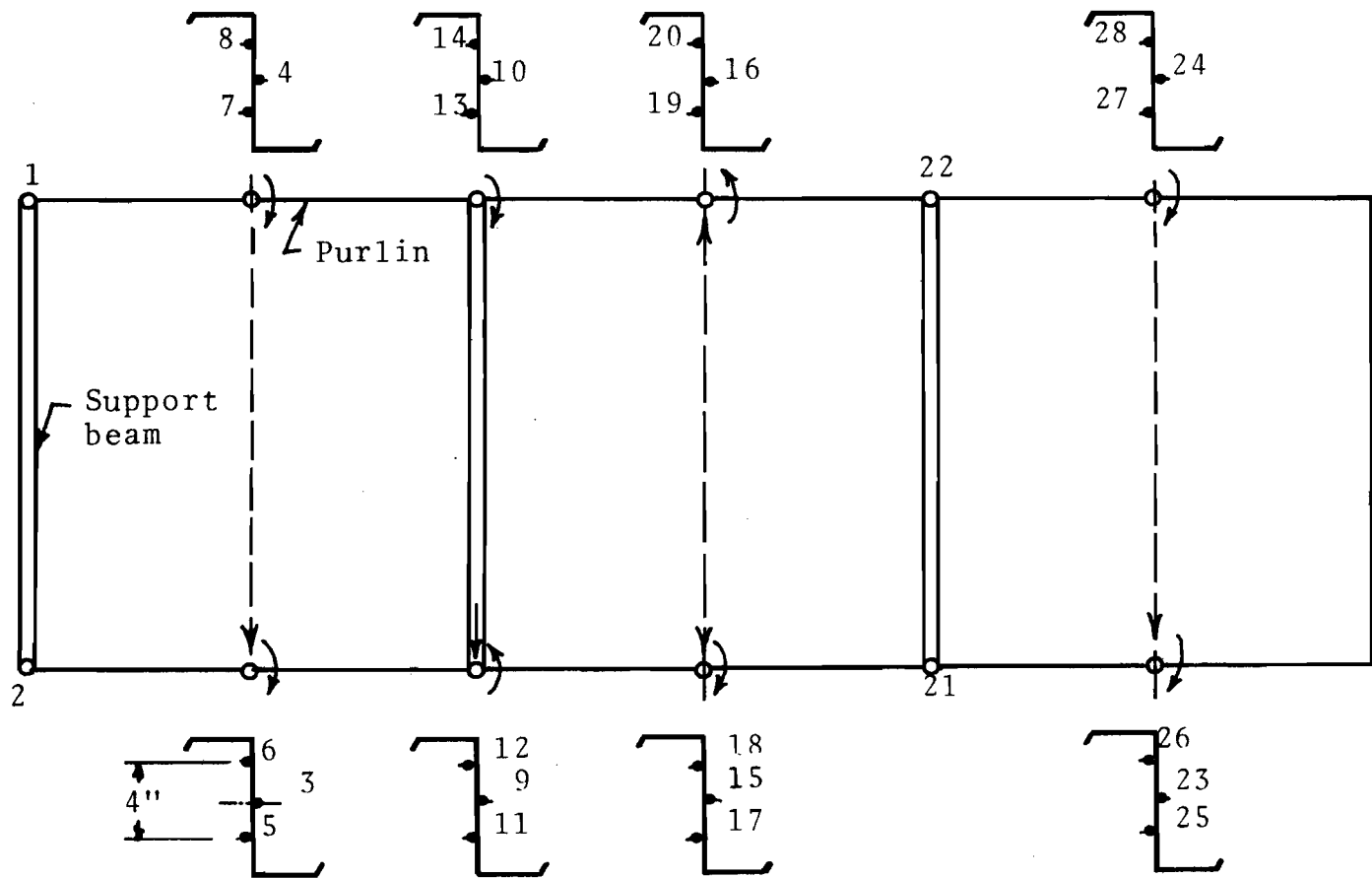


Fig. 6 Dial Gage Location - First Z-Section Purlin Test

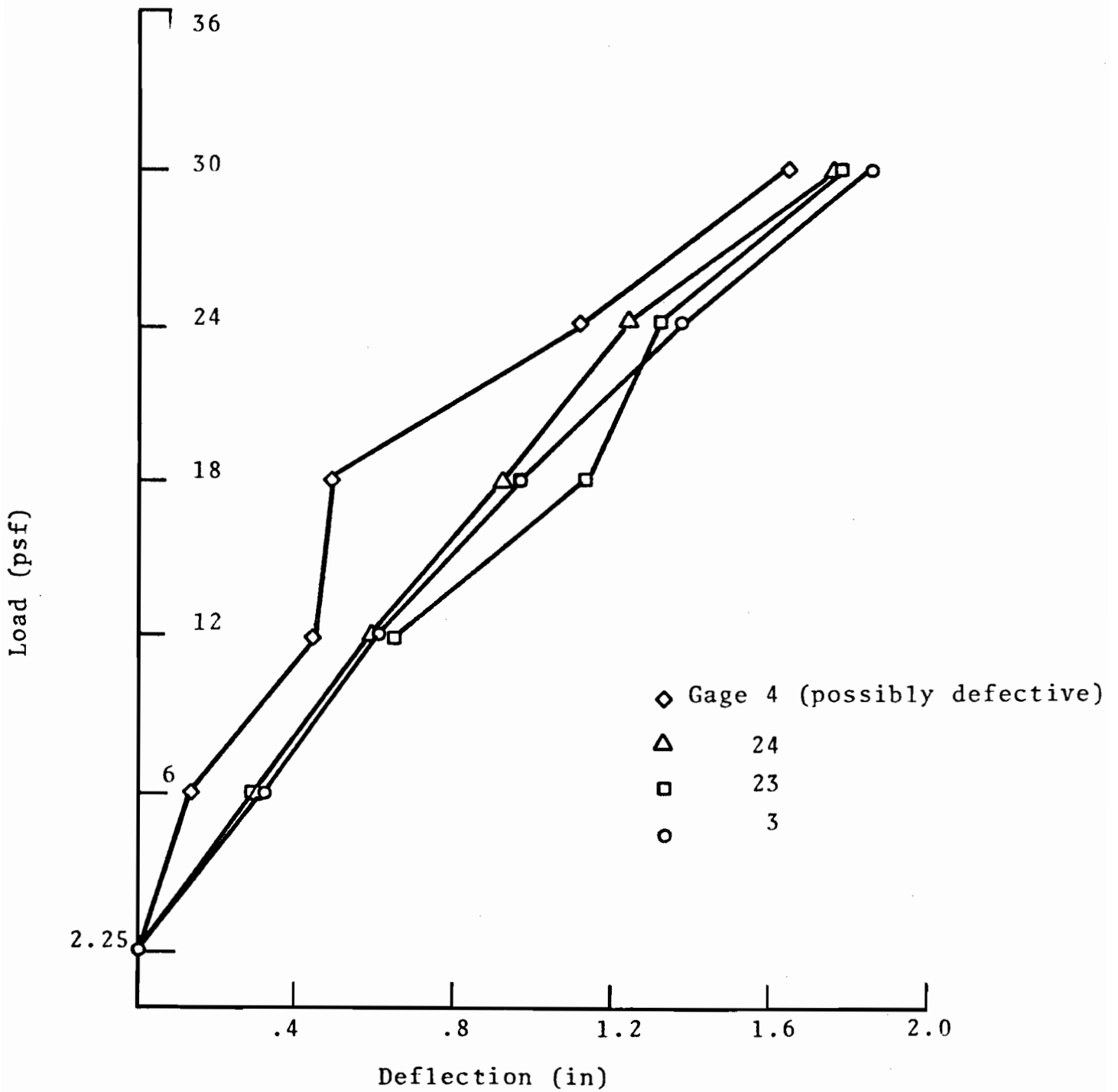


Fig. 7 Vertical Deflection, Midspan of End Spans - First Z-Section Purlin Test

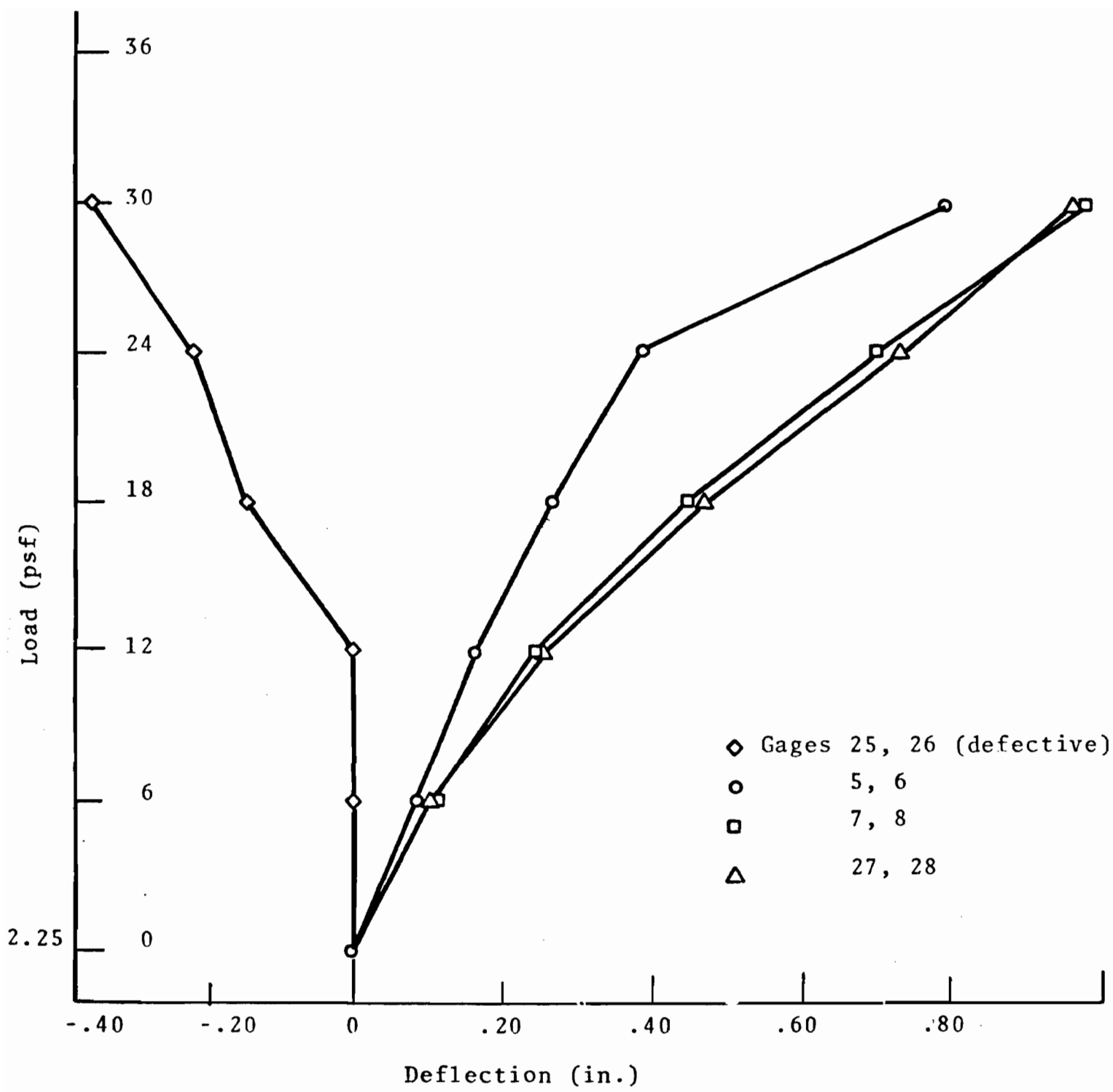


Fig. 8 Horizontal Deflection, Midspan of End Spans - First Z-Section Purlin Test

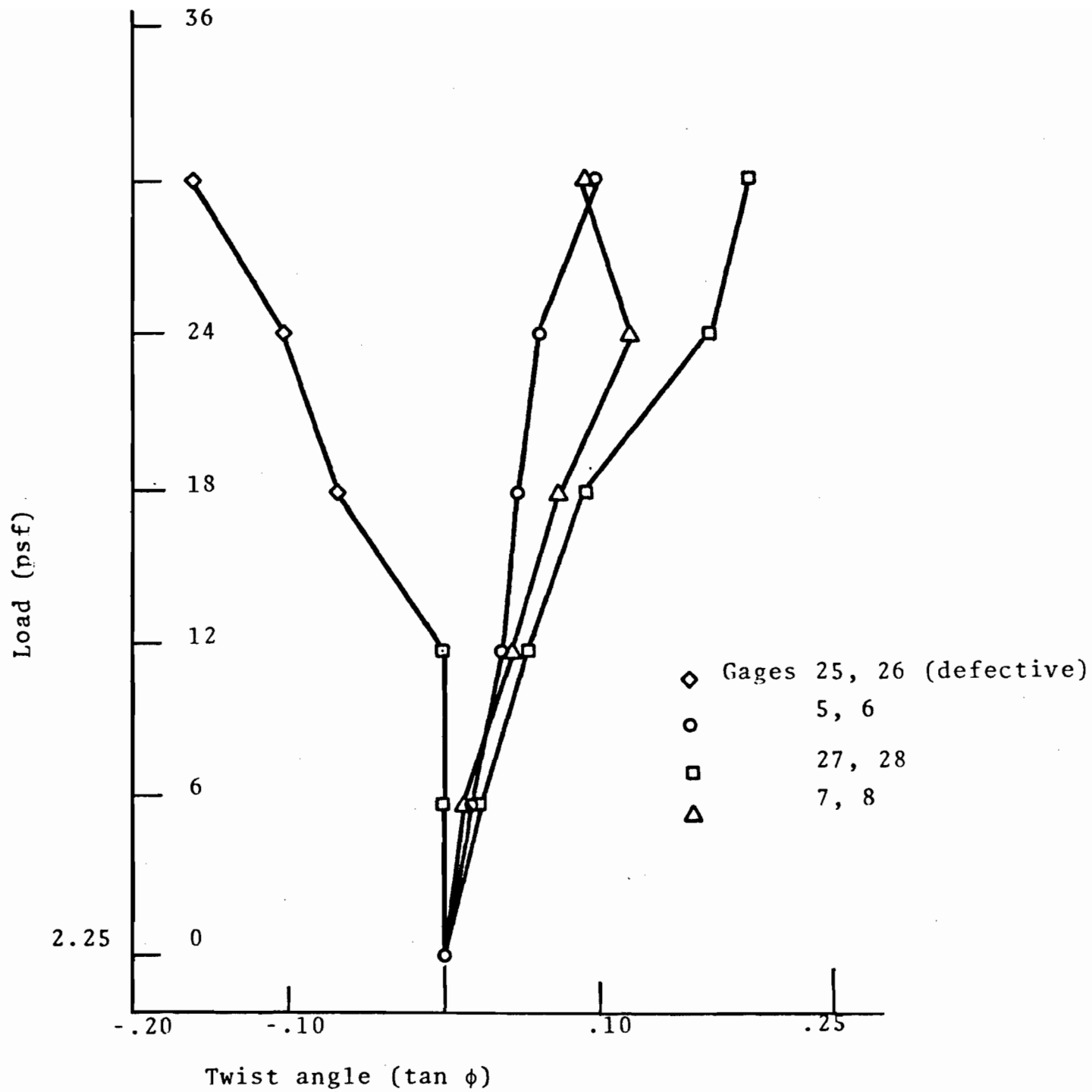


Fig. 9 Twist Angle, Midspan of End Spans - First Z-Section Purlin Test

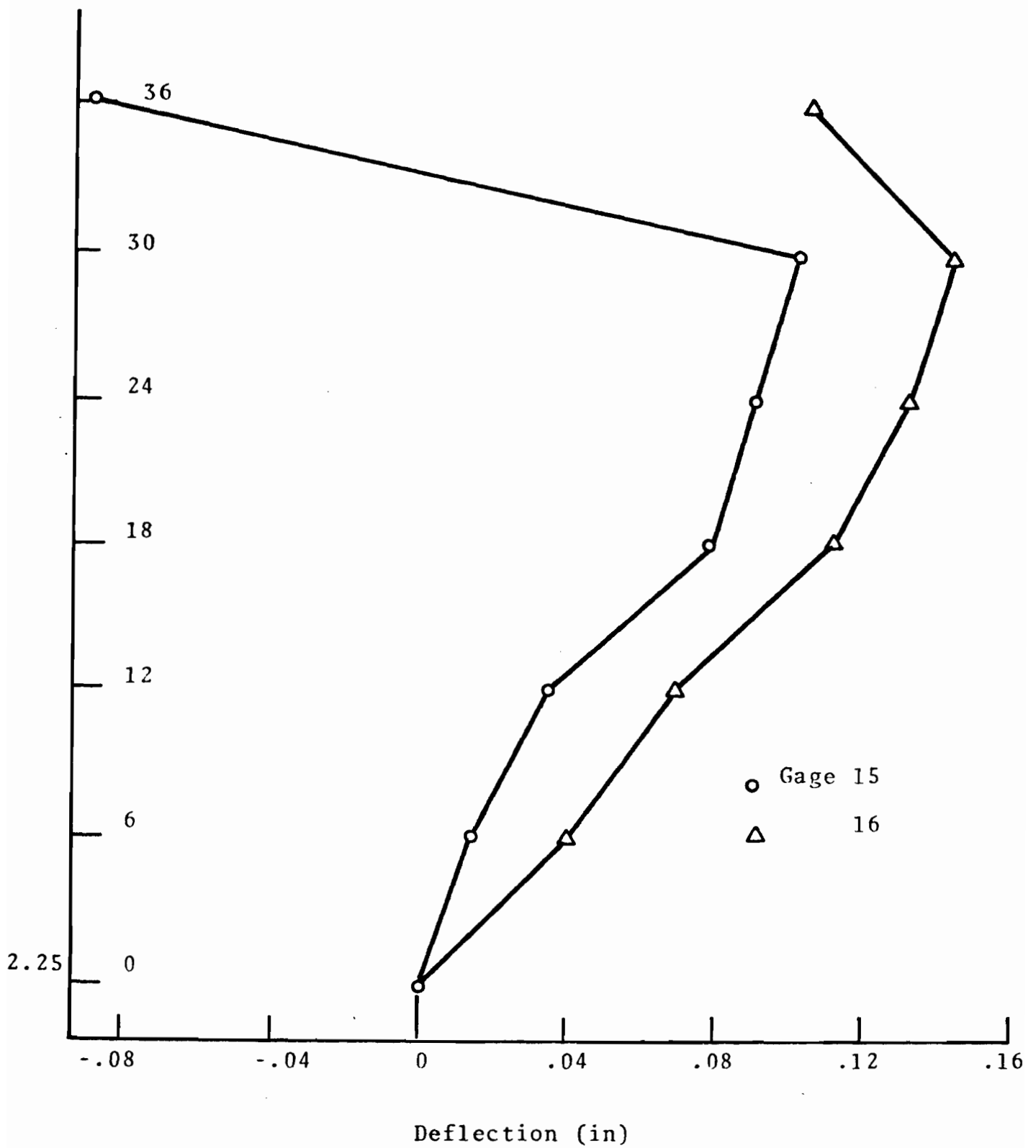


Fig. 10 Vertical Deflection, Midspan of Center Spans - First Z-Section Purlin Test

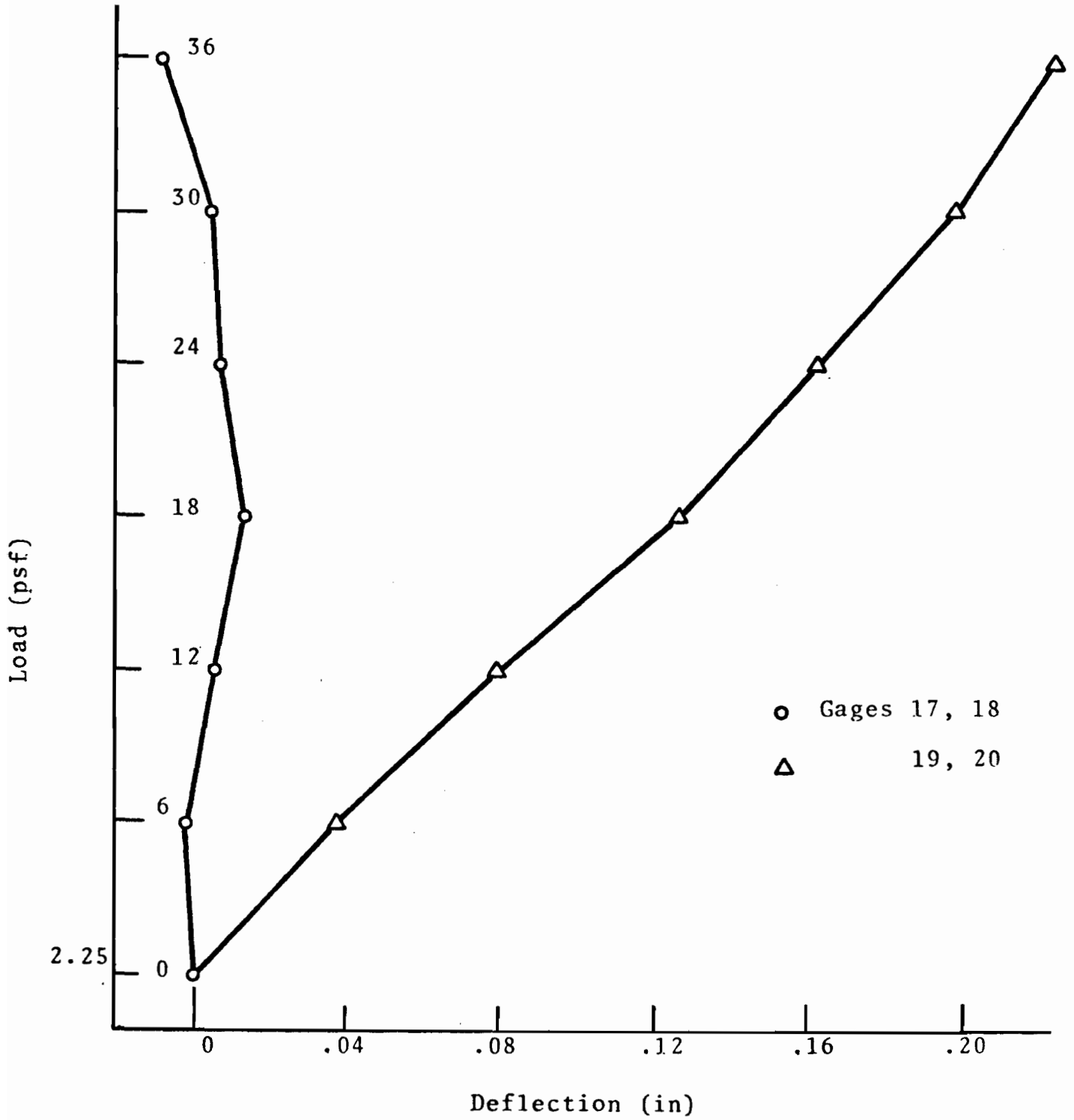


Fig. 11 Horizontal Deflection, Midspan of Center Spans - First Z-Section Purlin Test

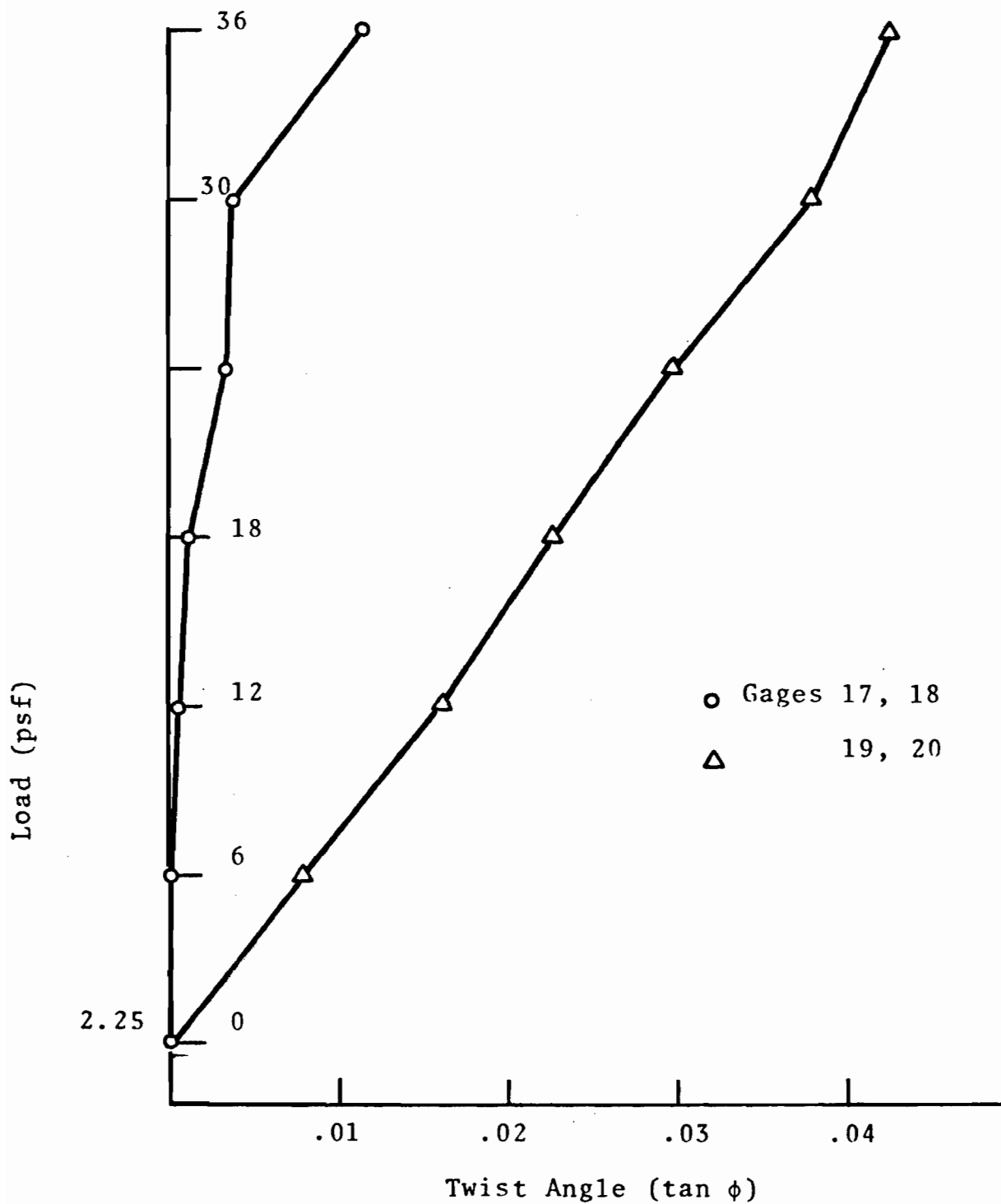


Fig. 12 Twist Angle, Midspan of Center Spans - First Z-Section Purlin Test

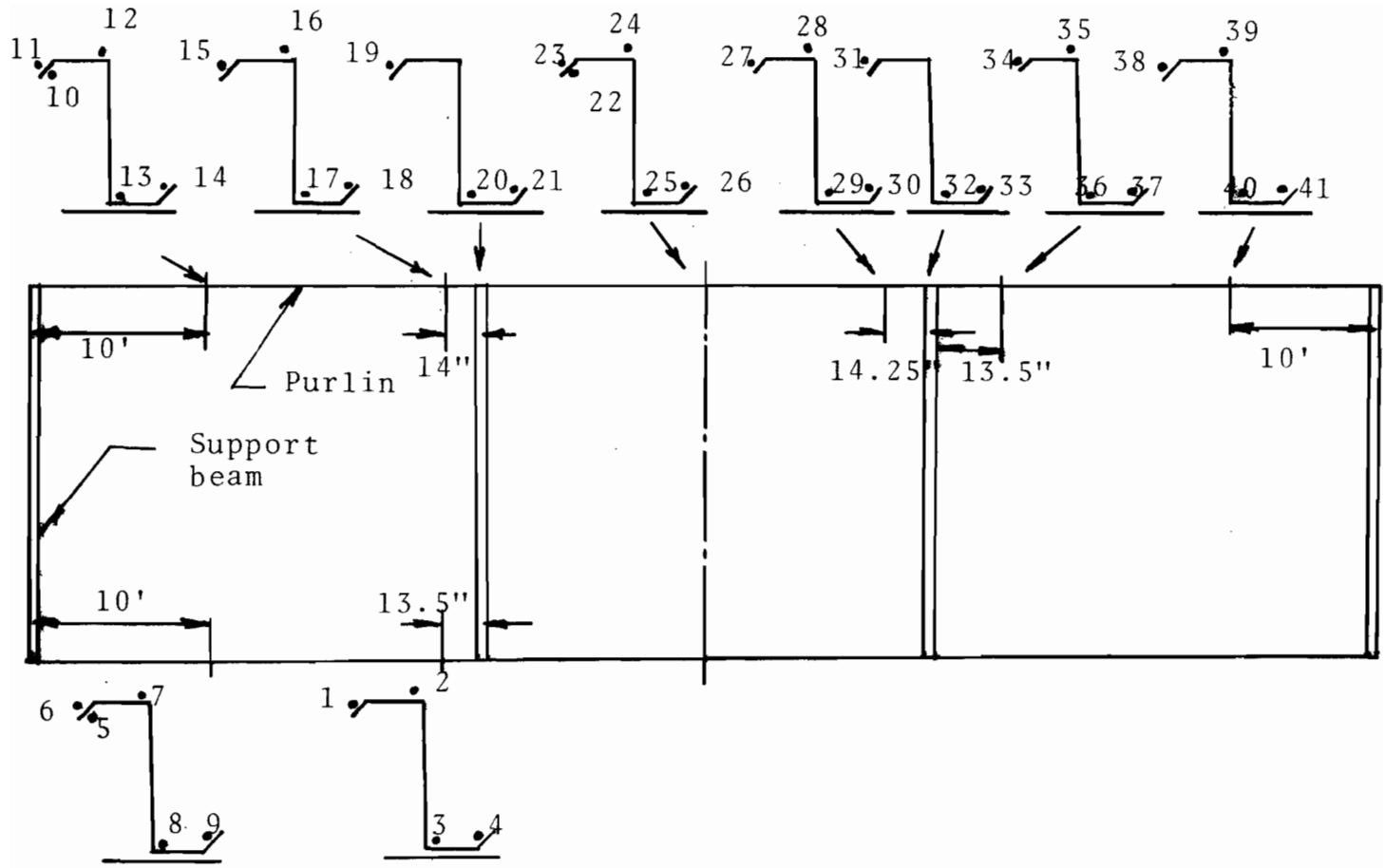


Fig. 13 Strain Gage Locations - First Z-Section Purlin Test

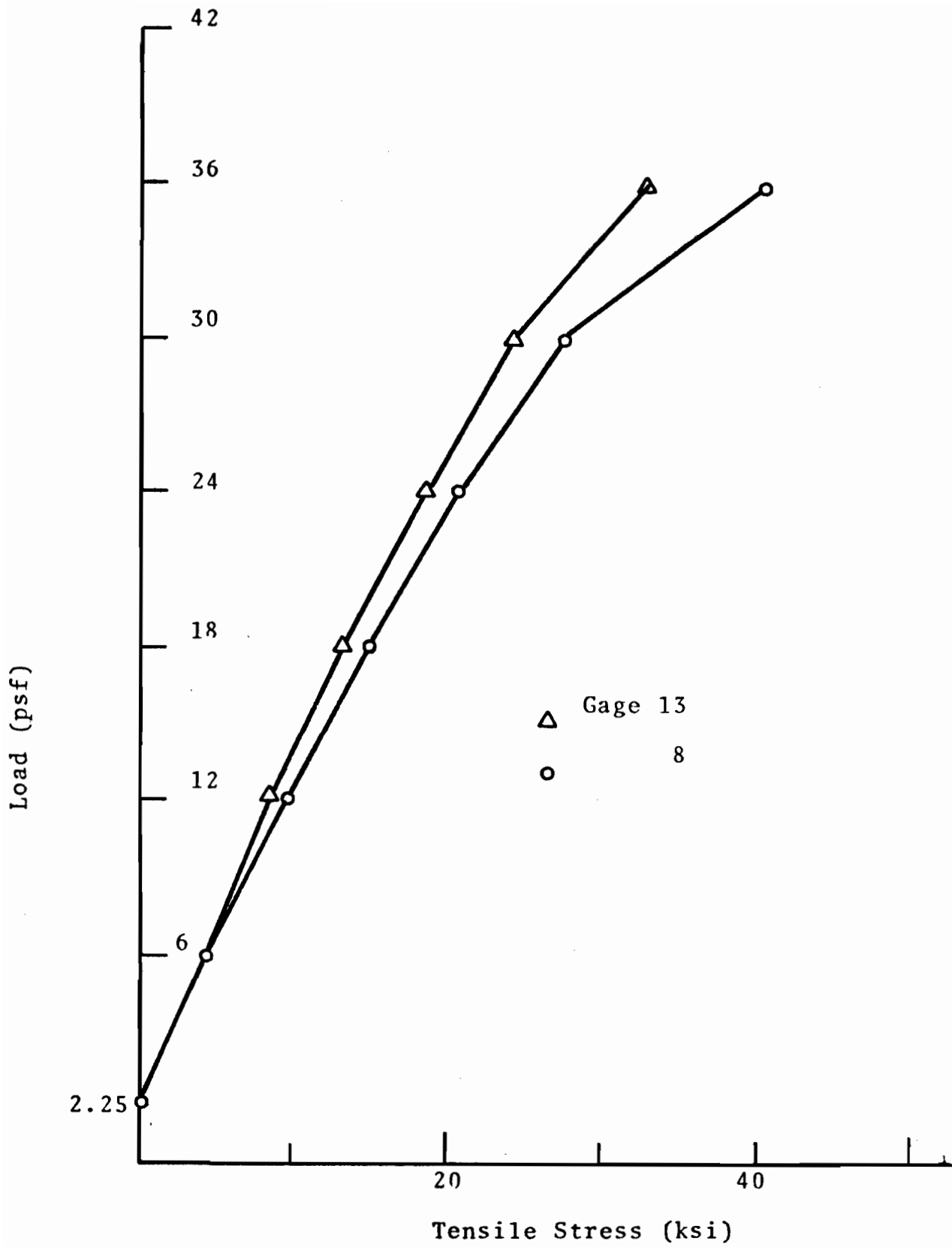


Fig. 14 Stresses at 10 ft. from outside supports, End Spans - First Z-Section Purlin Test

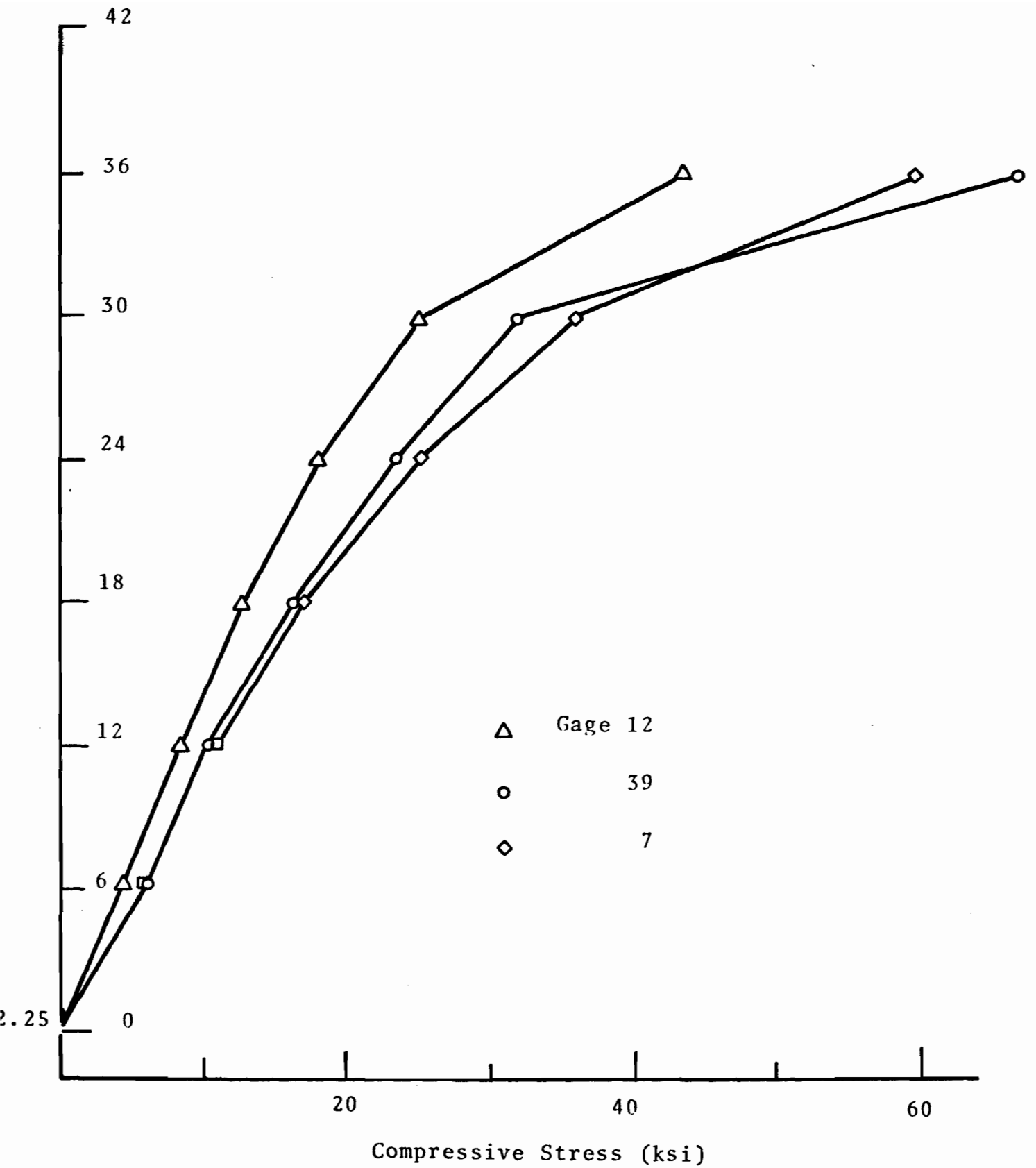


Fig. 15 Stresses at 10 ft. from Outside Supports, End Spans - First Z-Section Purlin Test

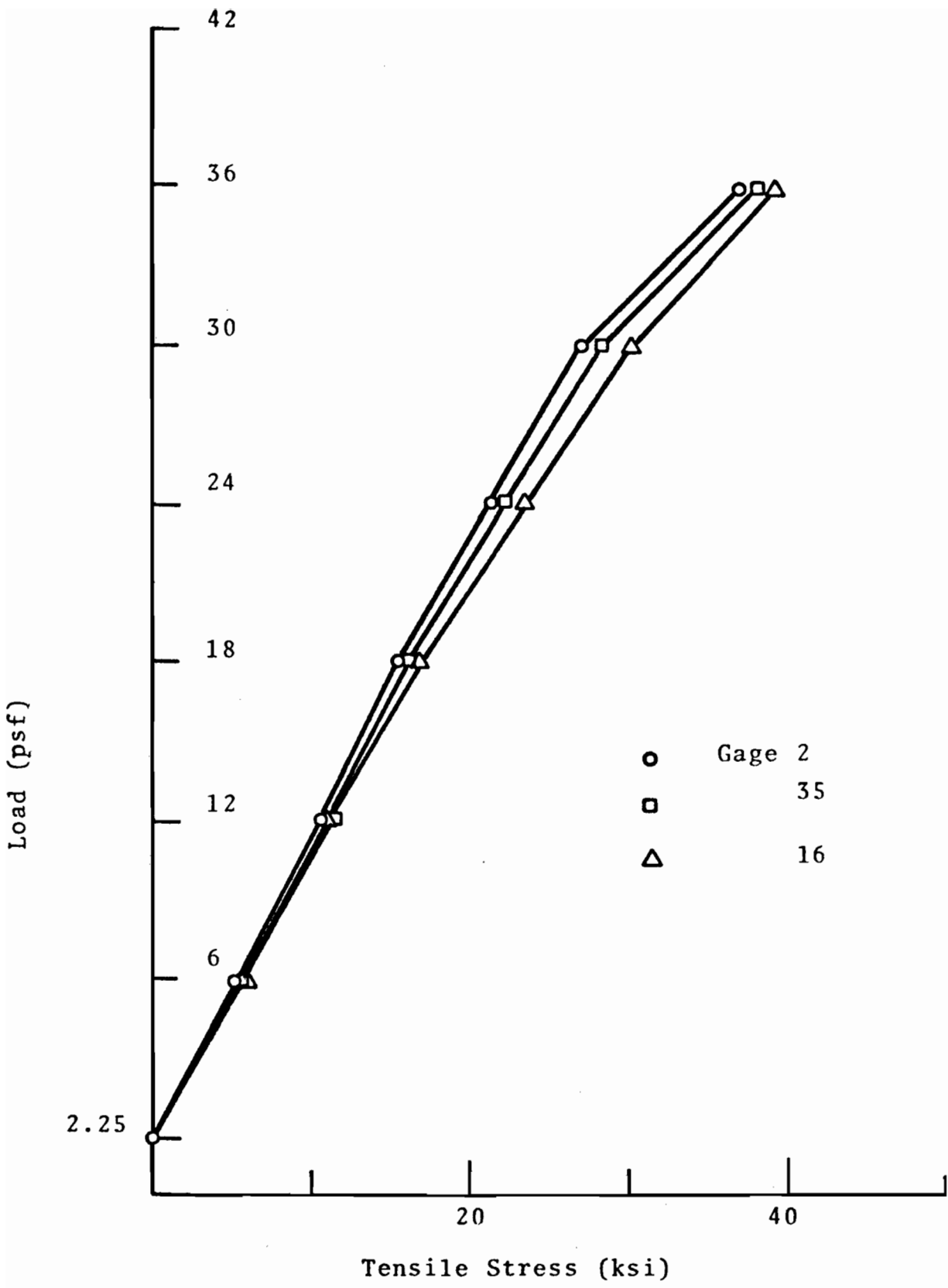


Fig. 16 Stresses at 14 inches from the Interior Support (Just Beyond the Nested Portion), End Spans - First Z-Section Purlin Test

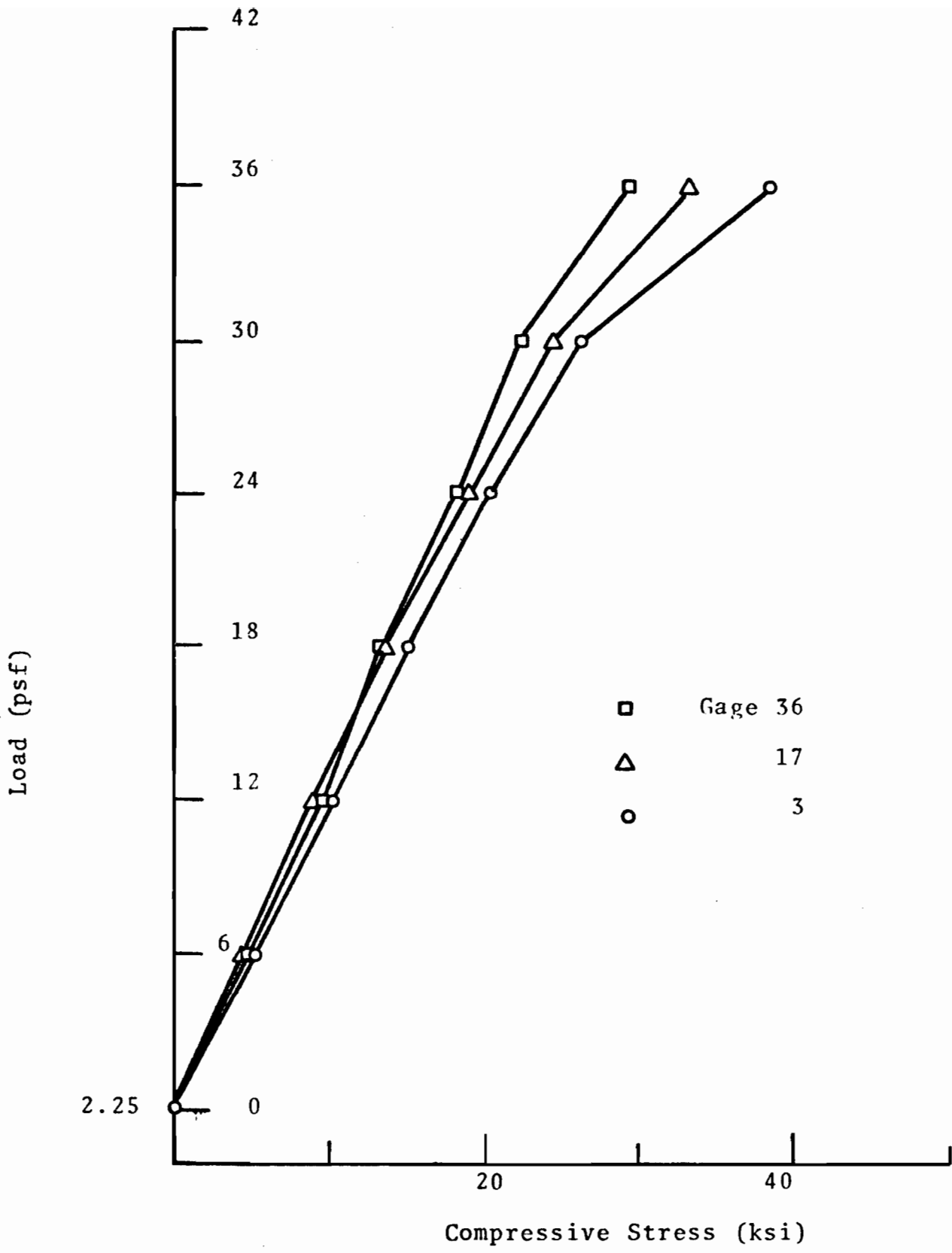


Fig. 17 Stresses at 14 inches from the Interior Support (Just Beyond the Nested Portion), End Spans - First Z-Section Purlin Test

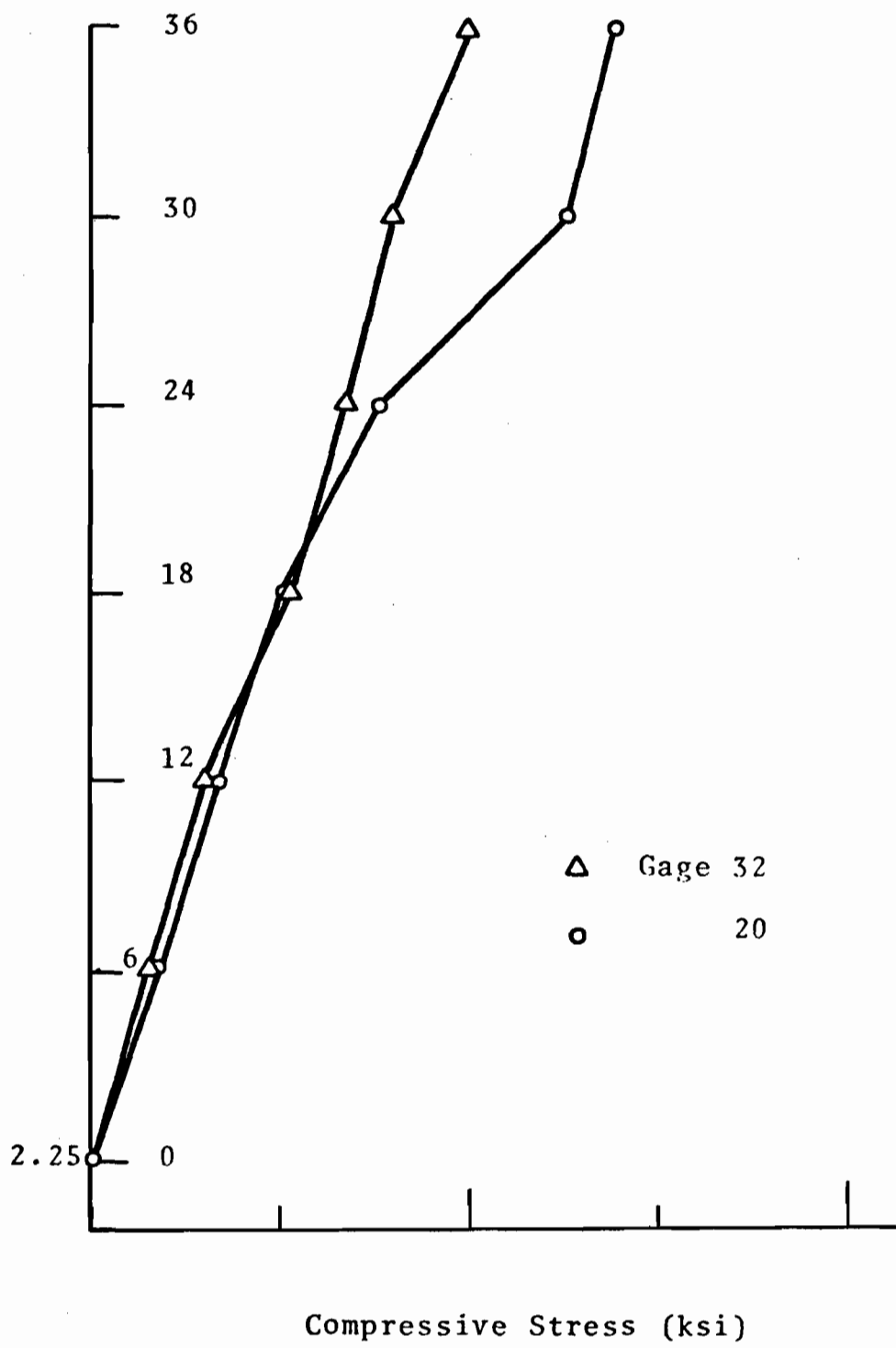


Fig. 18 Stresses at Interior Supports - First Z-Section Purlin Test

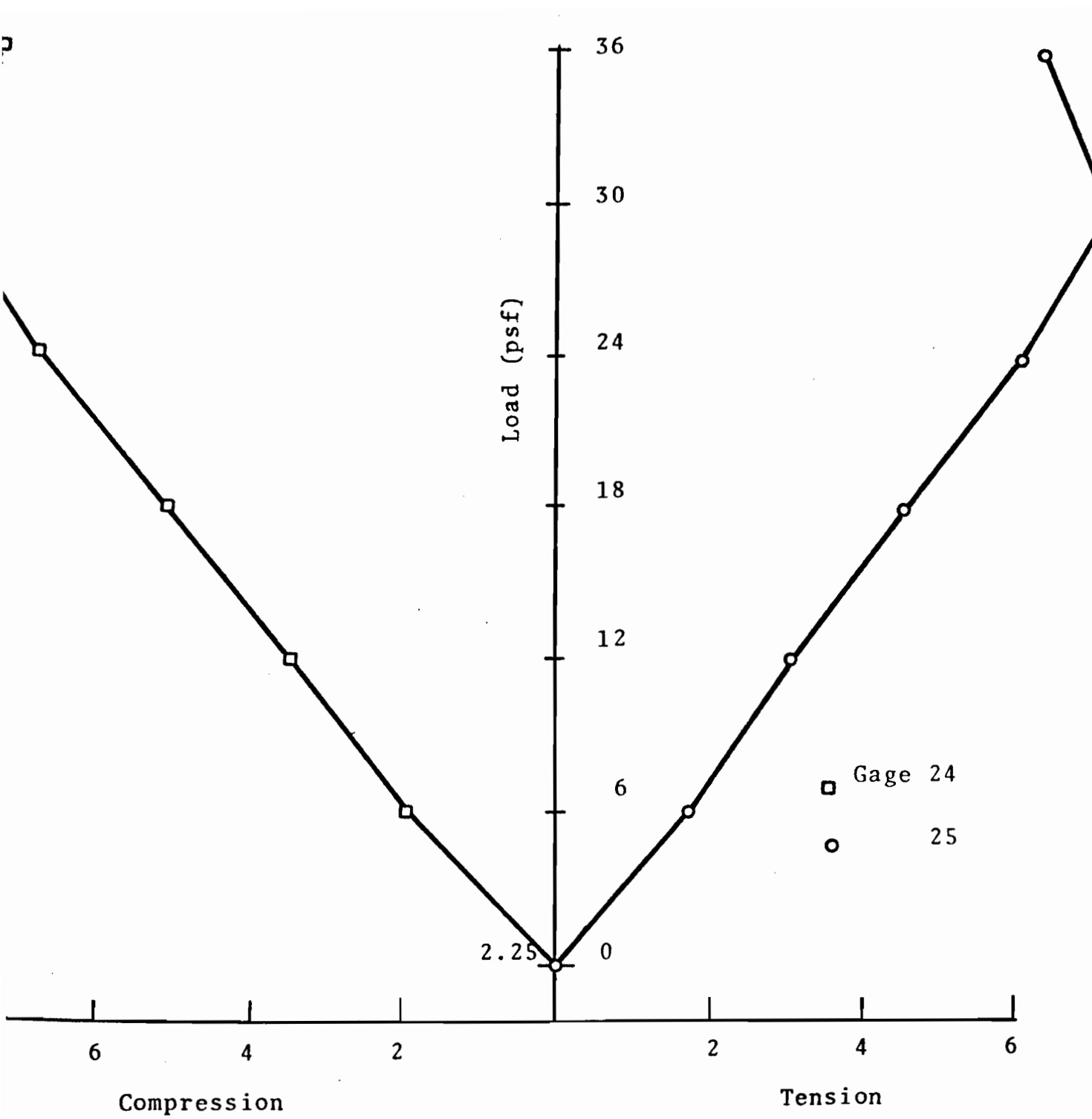


Fig. 19 Stresses at Mid Span, Center Spans -
First Z-Section Purlin Test

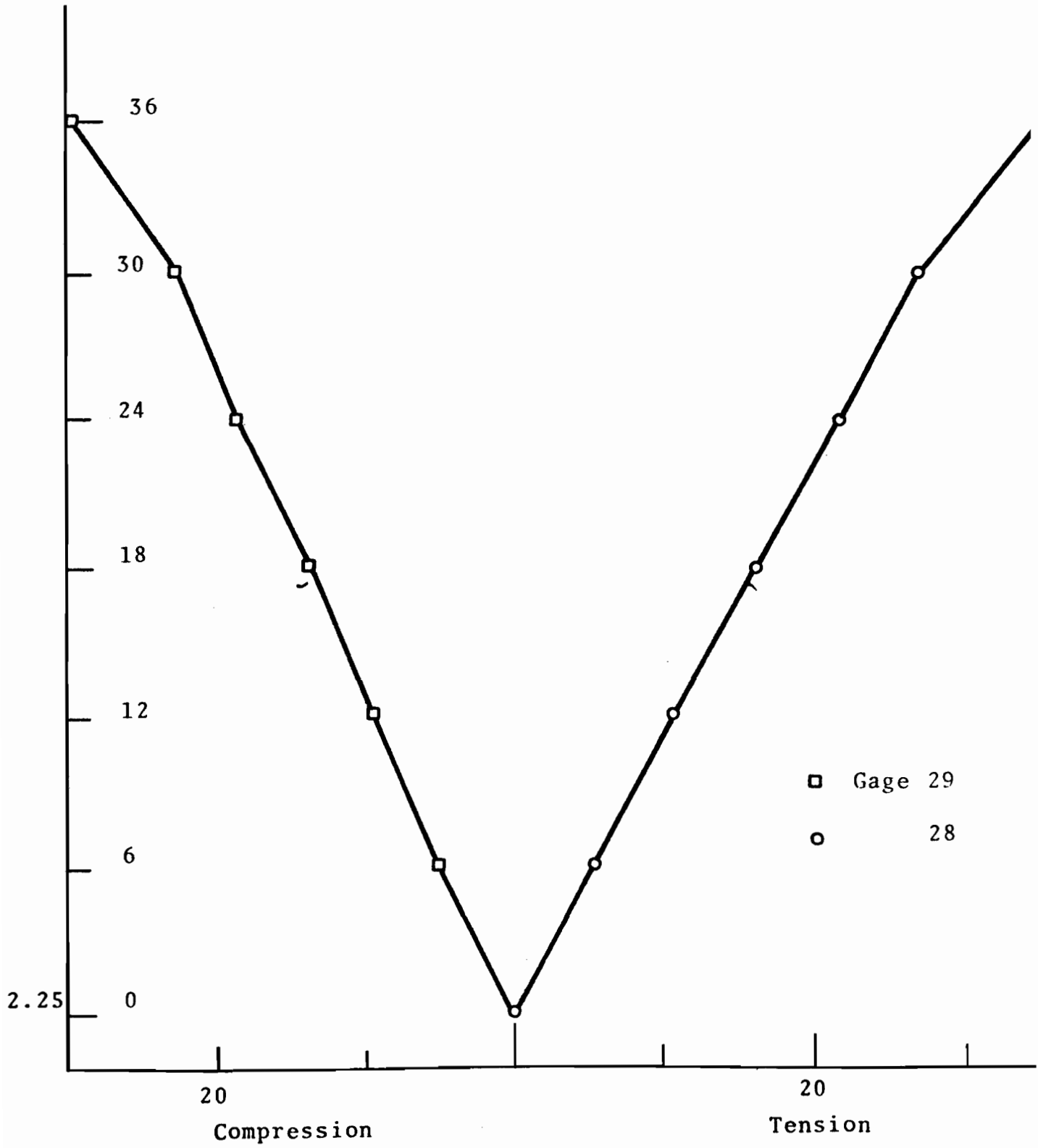


Fig. 20 Stresses at 14.5 inches from the Interior Support (Just Beyond the Nested Portion), Center Spans - First Z-Section Purlin Test

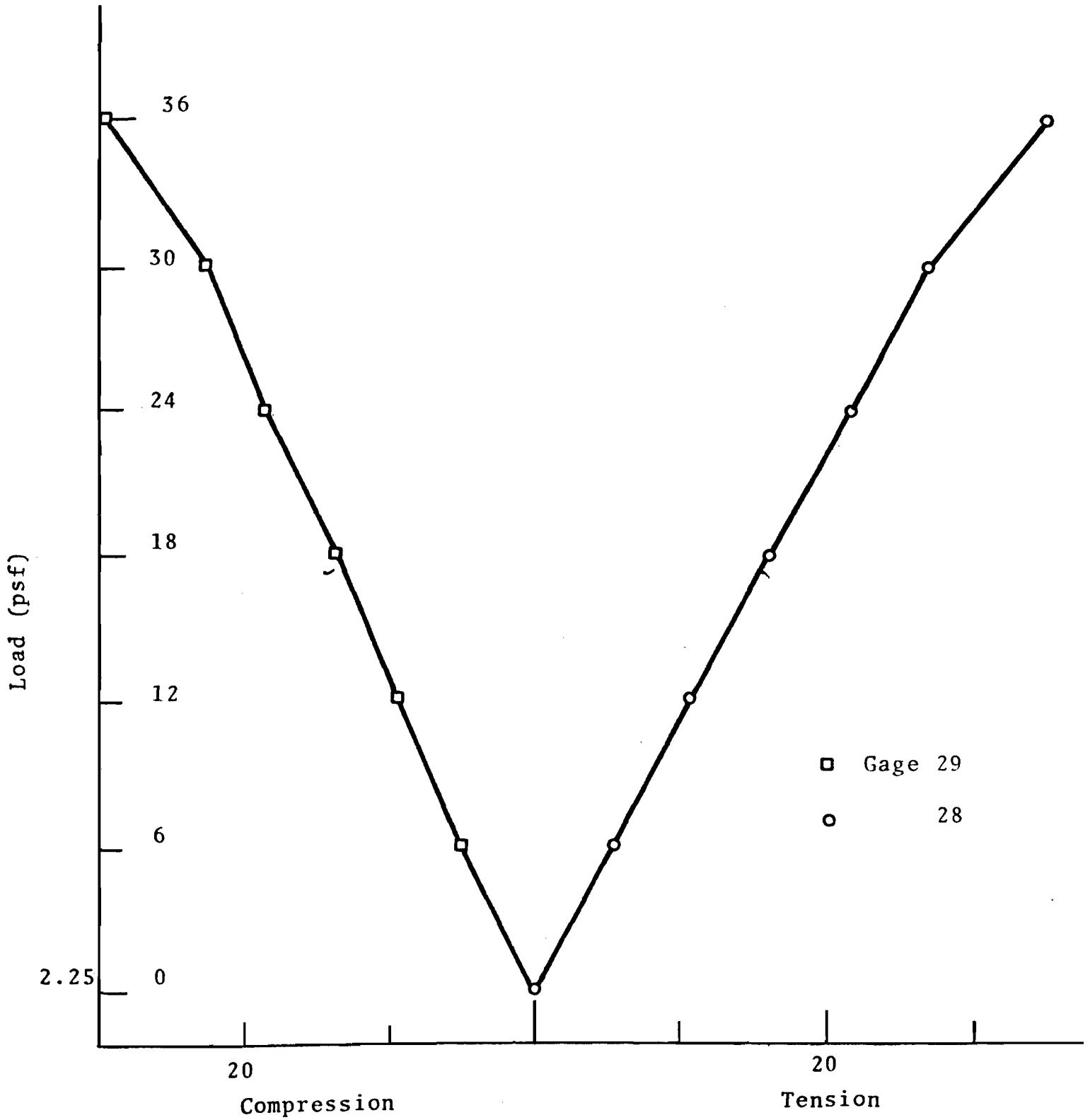


Fig. 20 Stresses at 14.5 inches from the Interior Support (Just Beyond the Nested Portion), Center Spans - First Z-Section Purlin Test

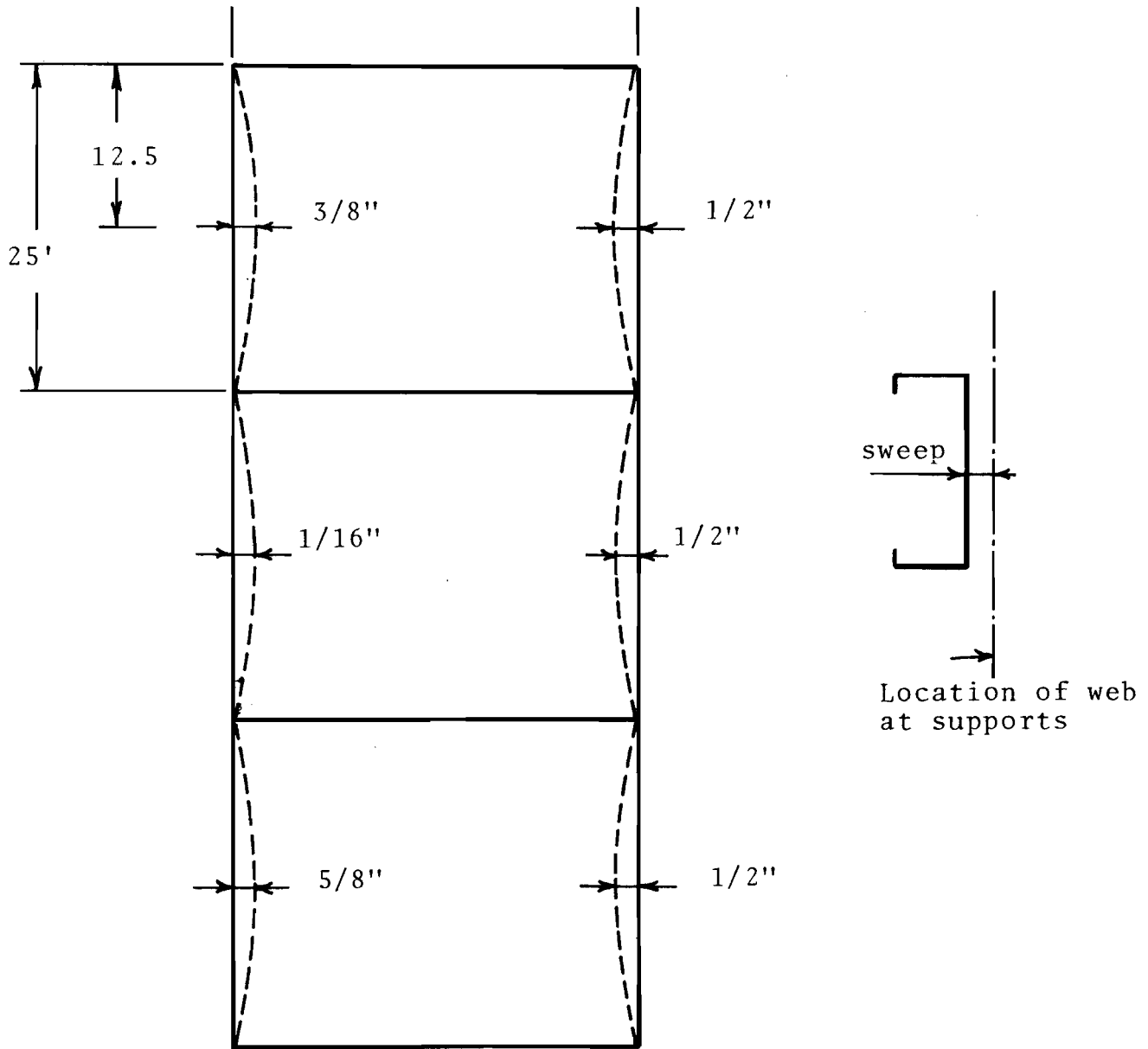


Fig. 21 Initial Sweep of C-Section Purlins

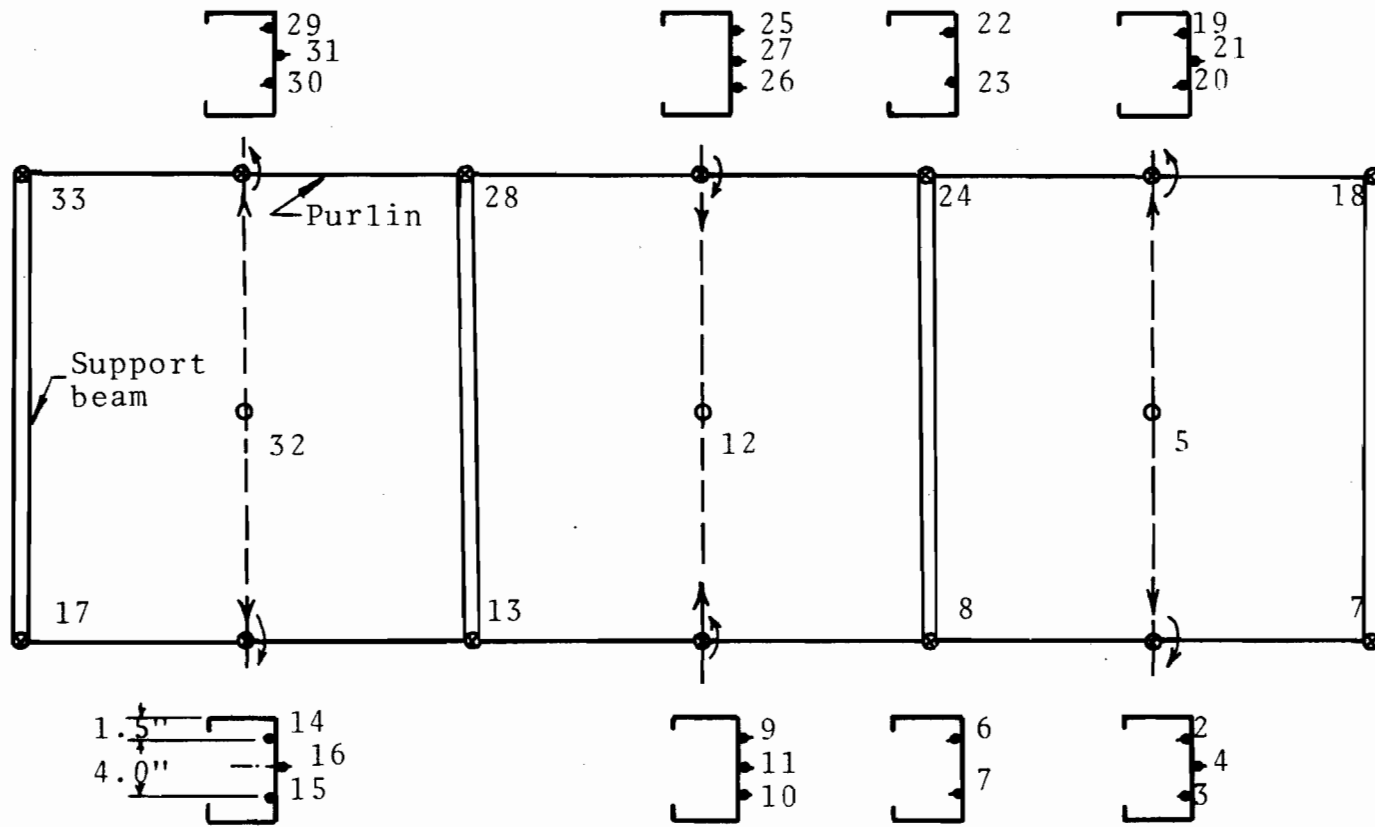


Fig. 22 Dial Gage Locations - C-Section Purlin Test

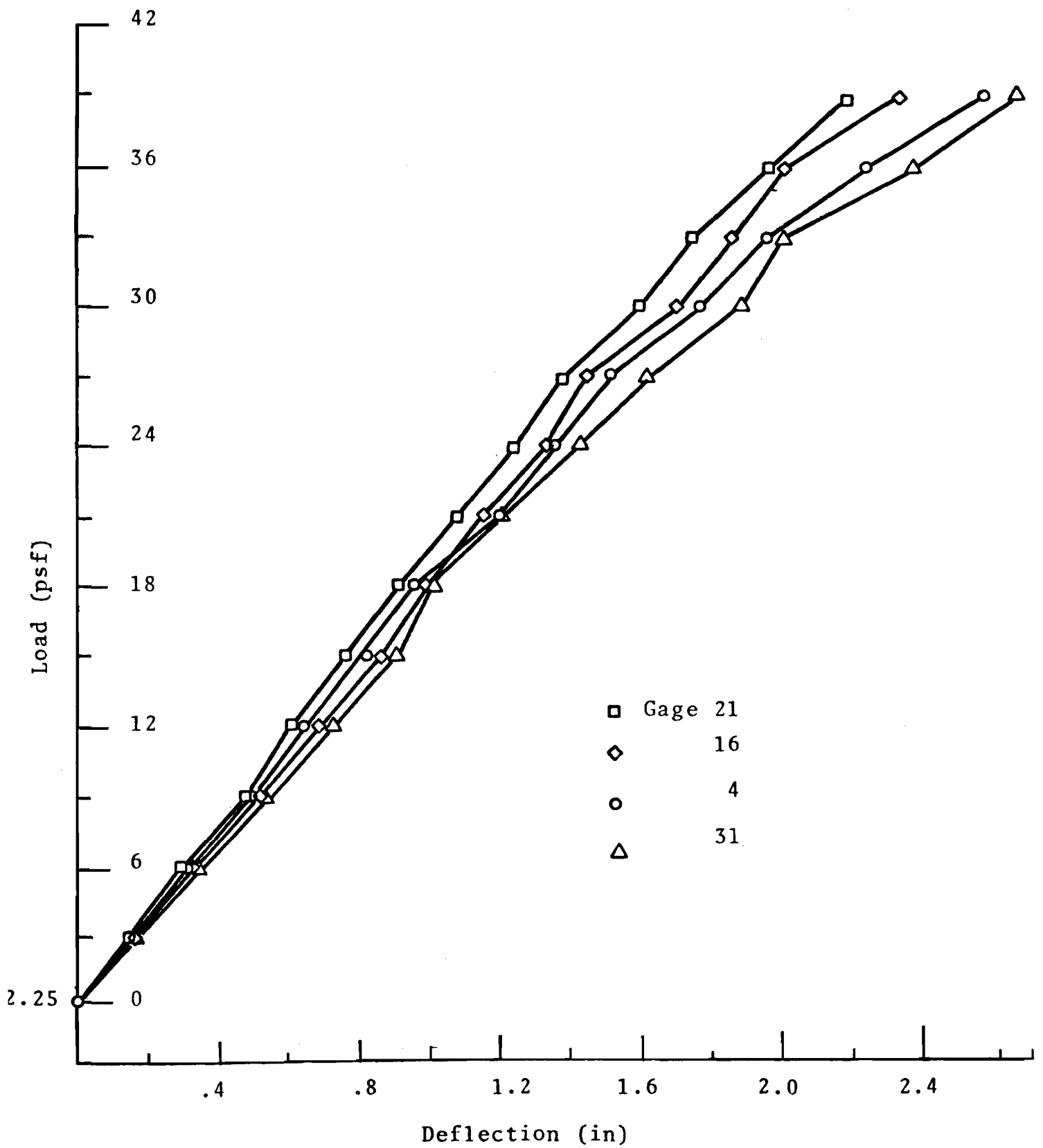


Fig. 23 Vertical Deflection, Midspan of End Spans - C-Section Purlin Test

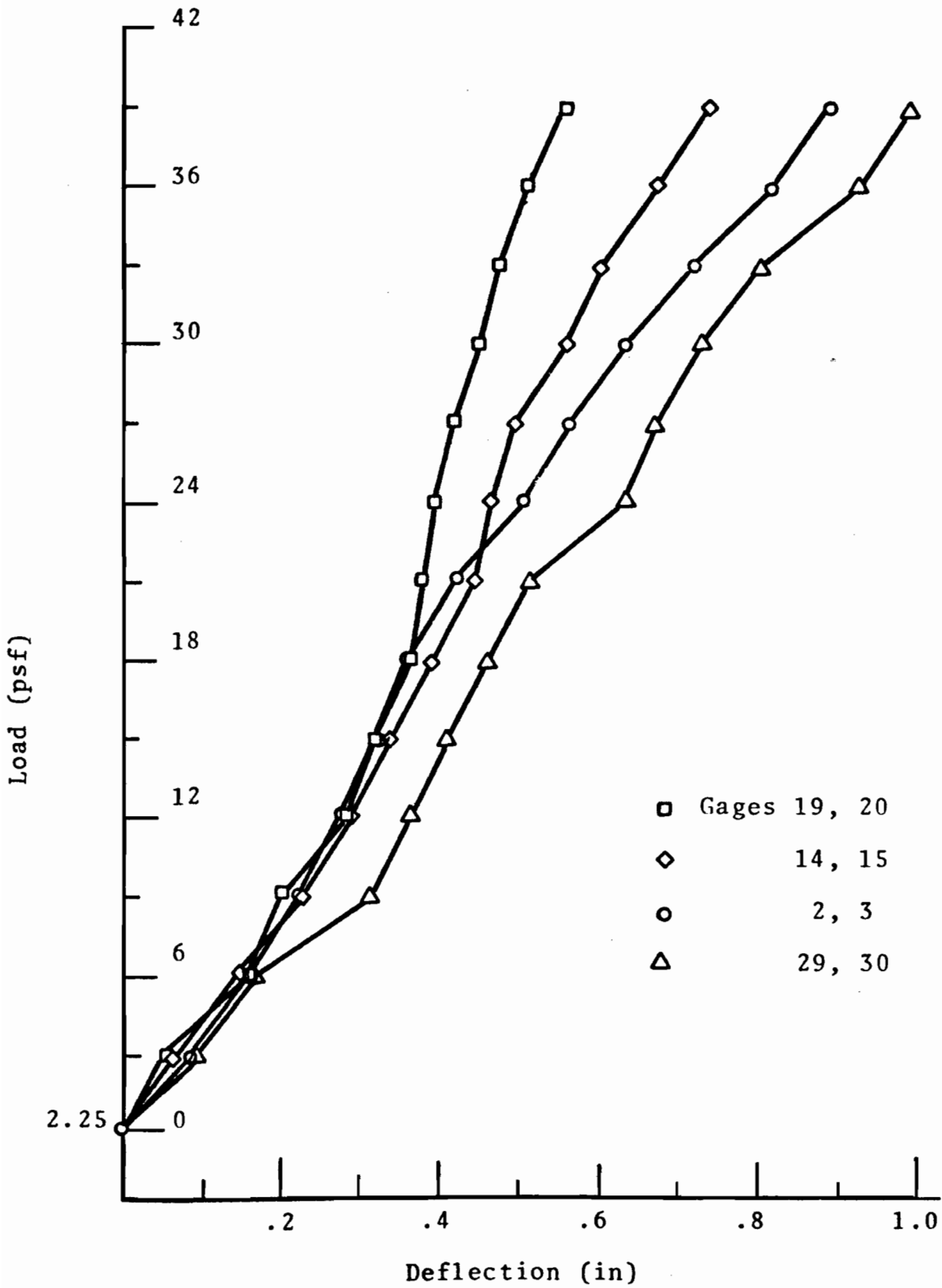


Fig. 24 Horizontal Deflection, Midspan of Eng Spans - C-Section Purlin Test

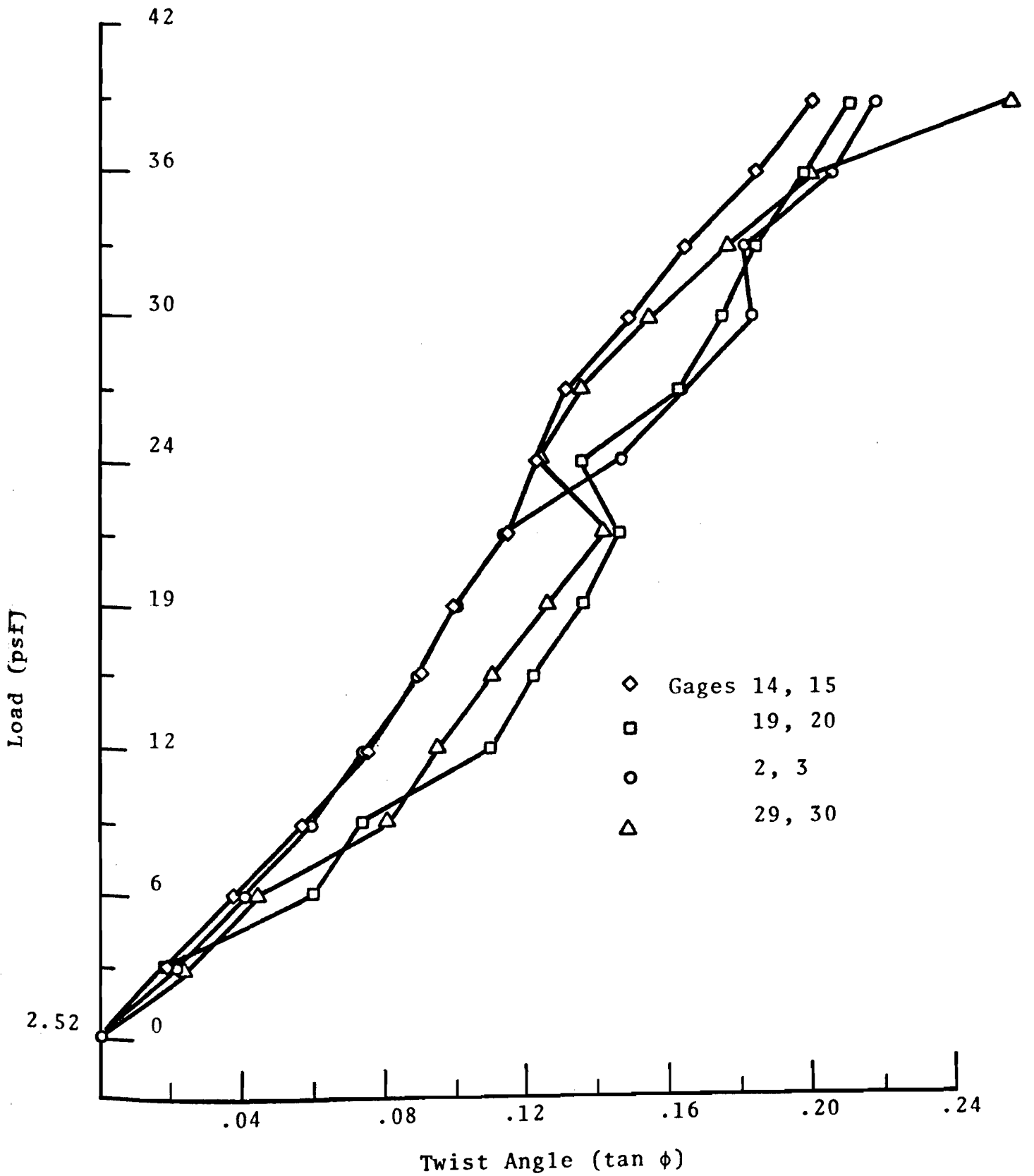


Fig. 25 Twist Angle, Midspan of End Spans - C-Section Purlin Test

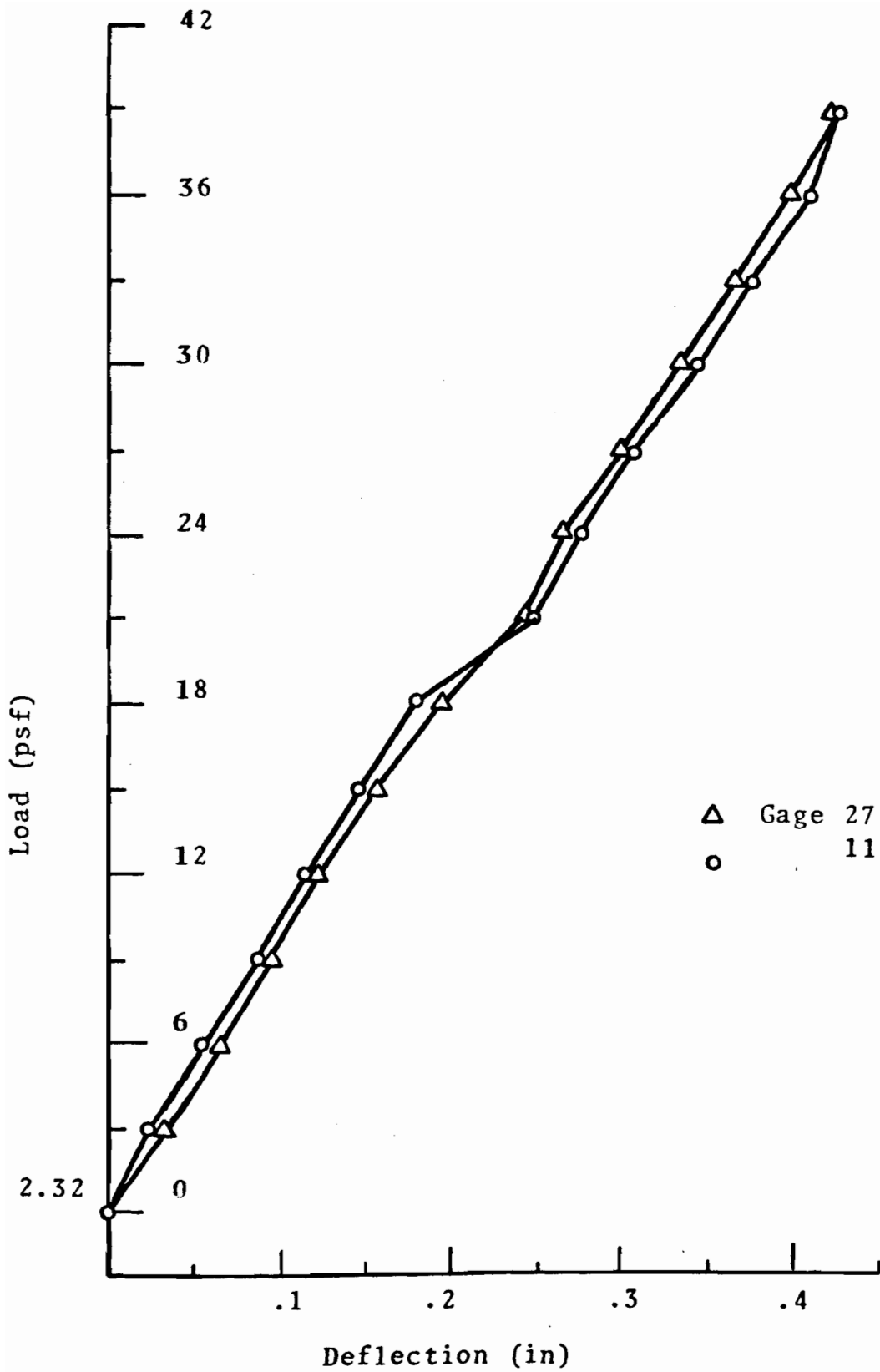


Fig. 26 Vertical Deflection, Midspan of Center Spans - C-Section Purlin Test

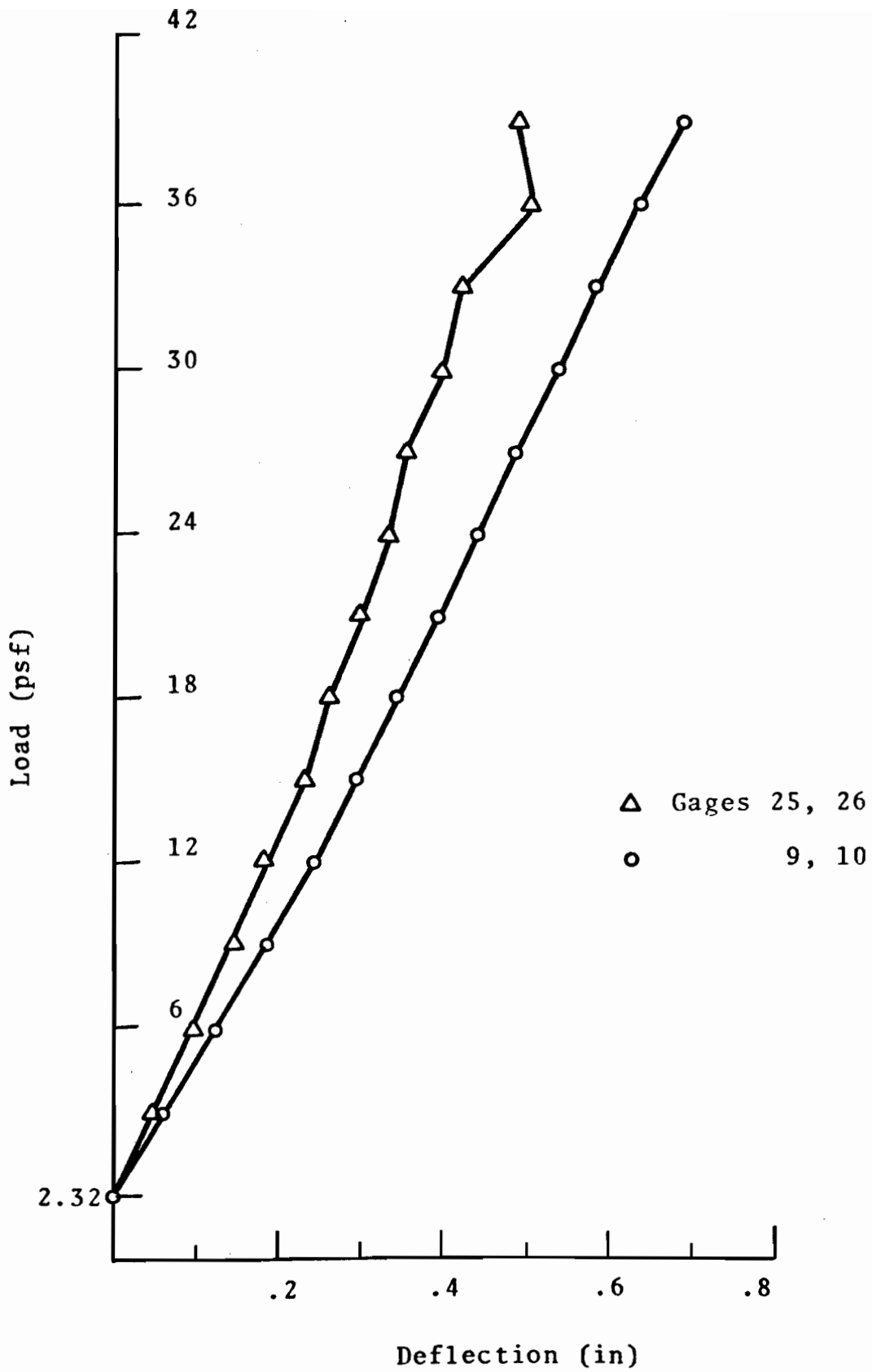


Fig. 27 Horizontal Deflection, Midspan of Center Spans - C-Section Purlin Test

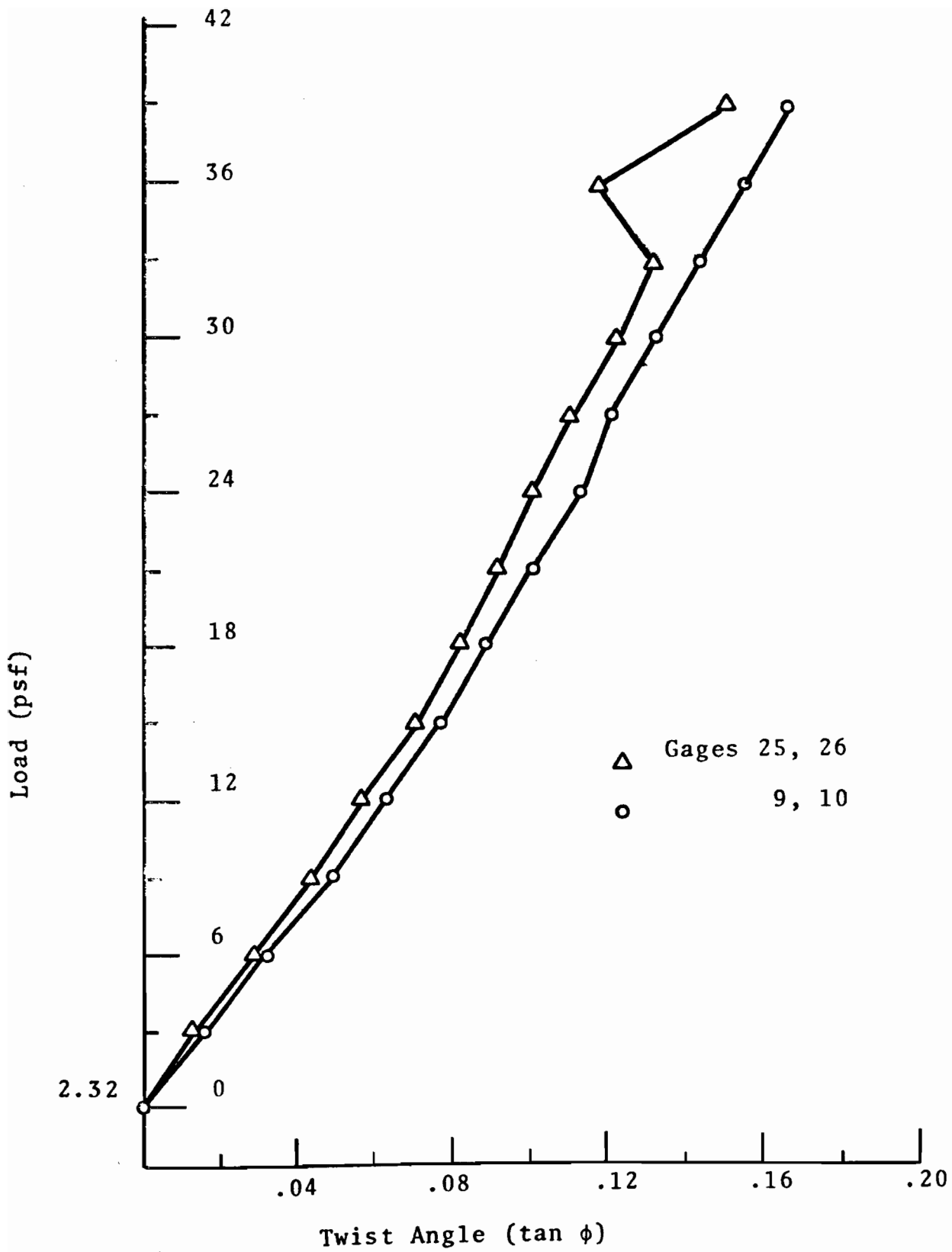


Fig. 28 Twist Angle, Midspan of Center Spans - C-Section Purlin Test

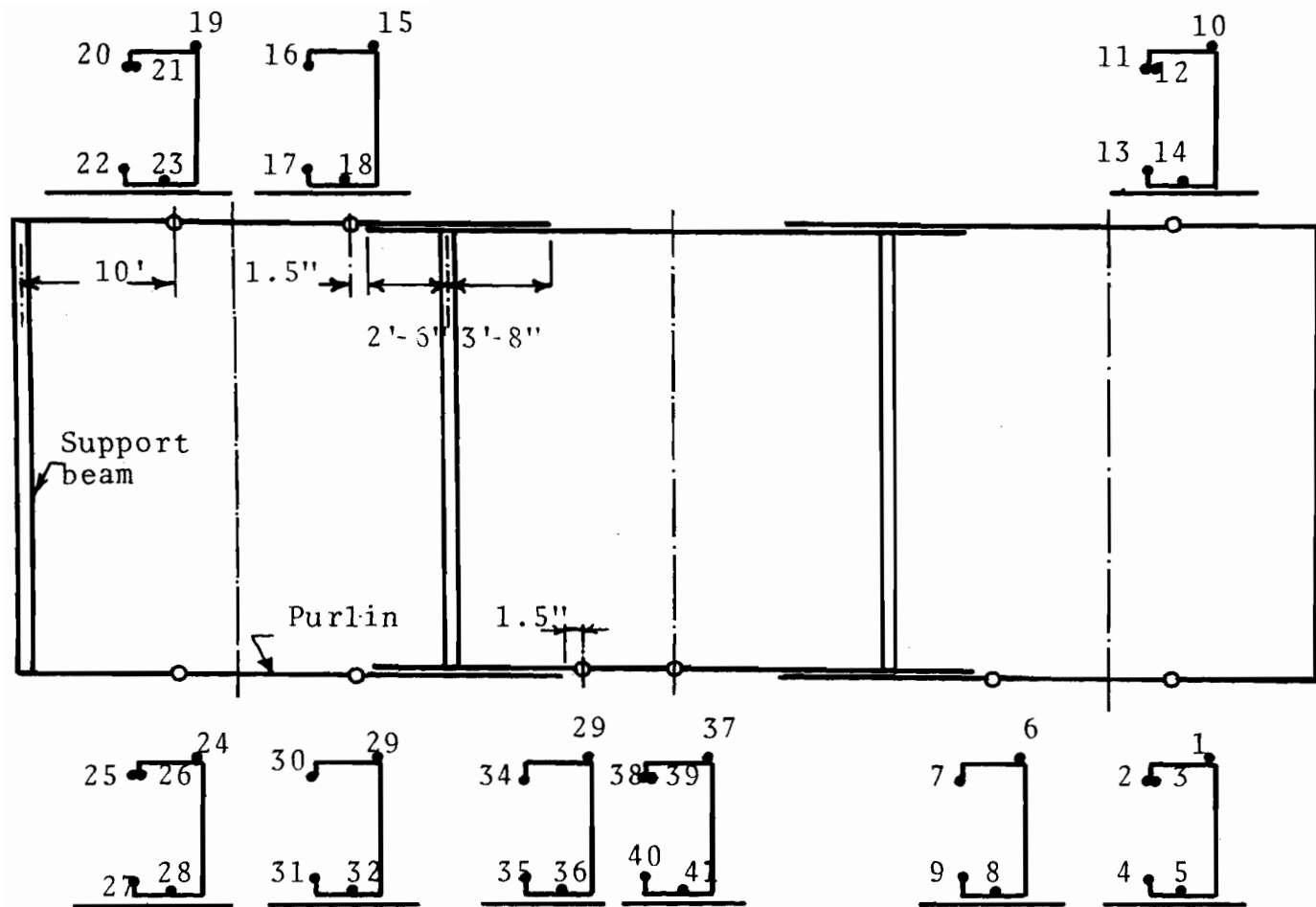


Fig. 29 Strain Gage Locations - C-Section
Purlin Test

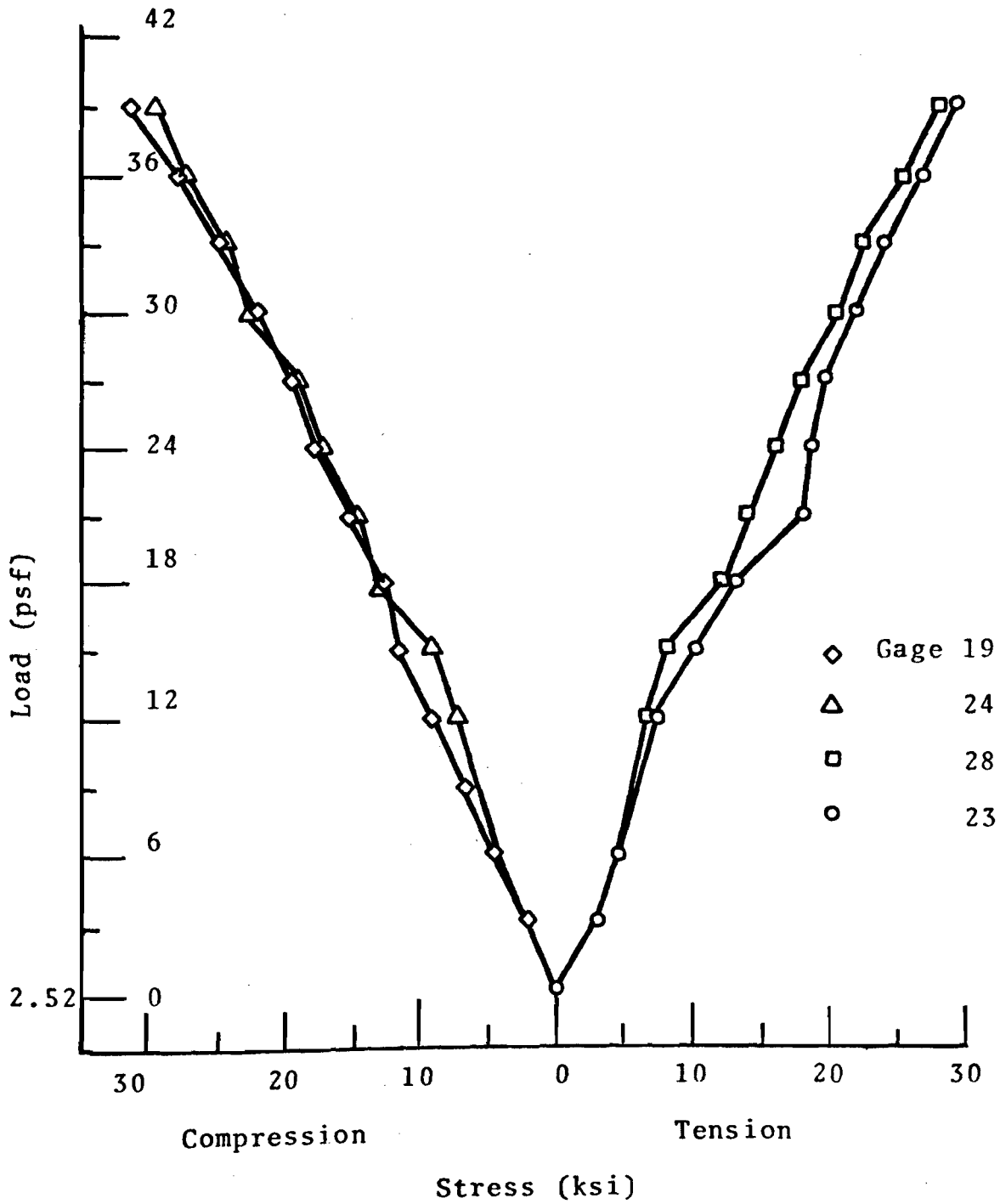


Fig. 30 Stresses at 10 ft. From Outside Supports, End Spans - C-Section Purlin Test

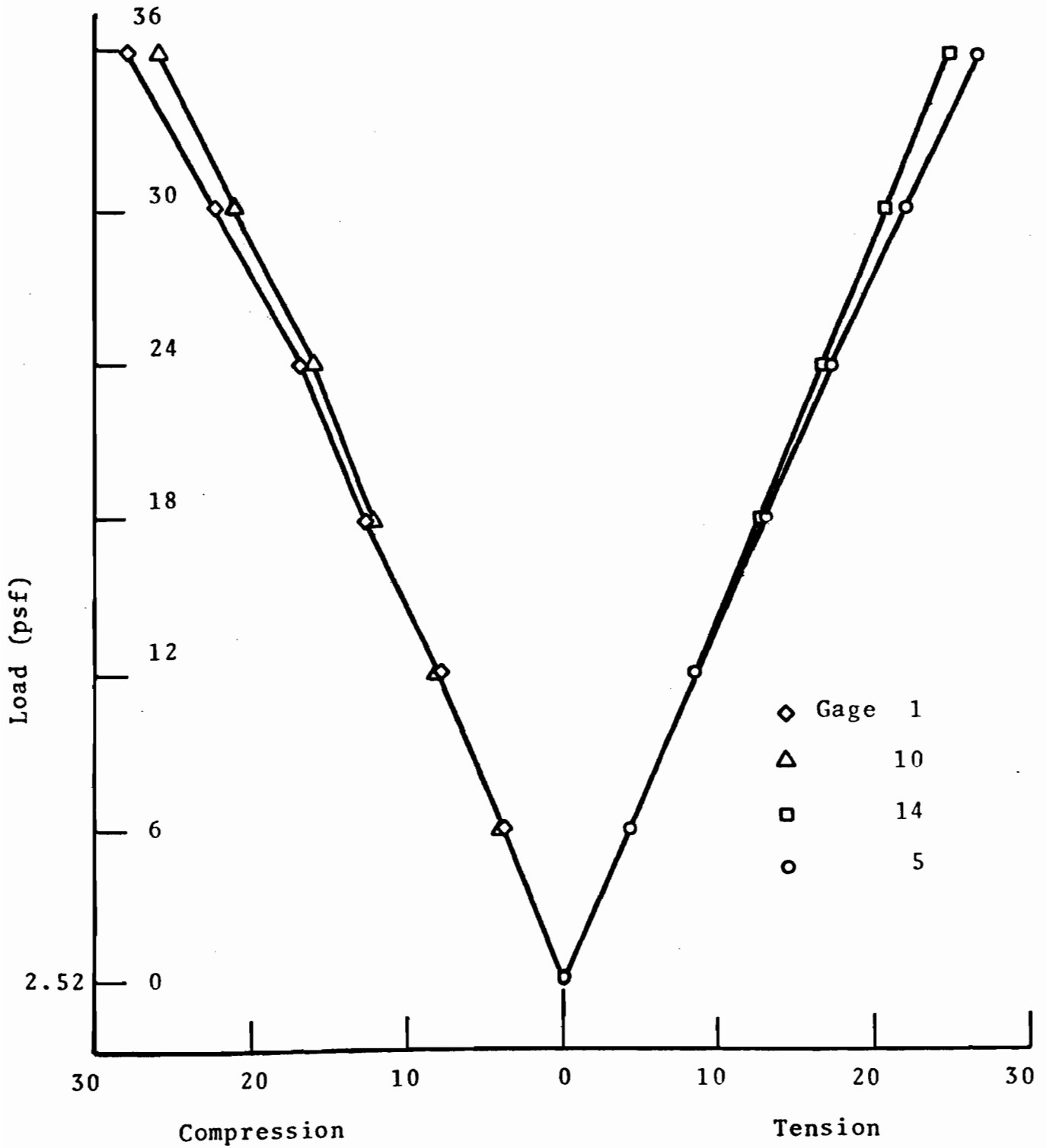


Fig. 31 Stresses at 10 ft. From Outside Supports, End Spans -C-Section Purlin Test

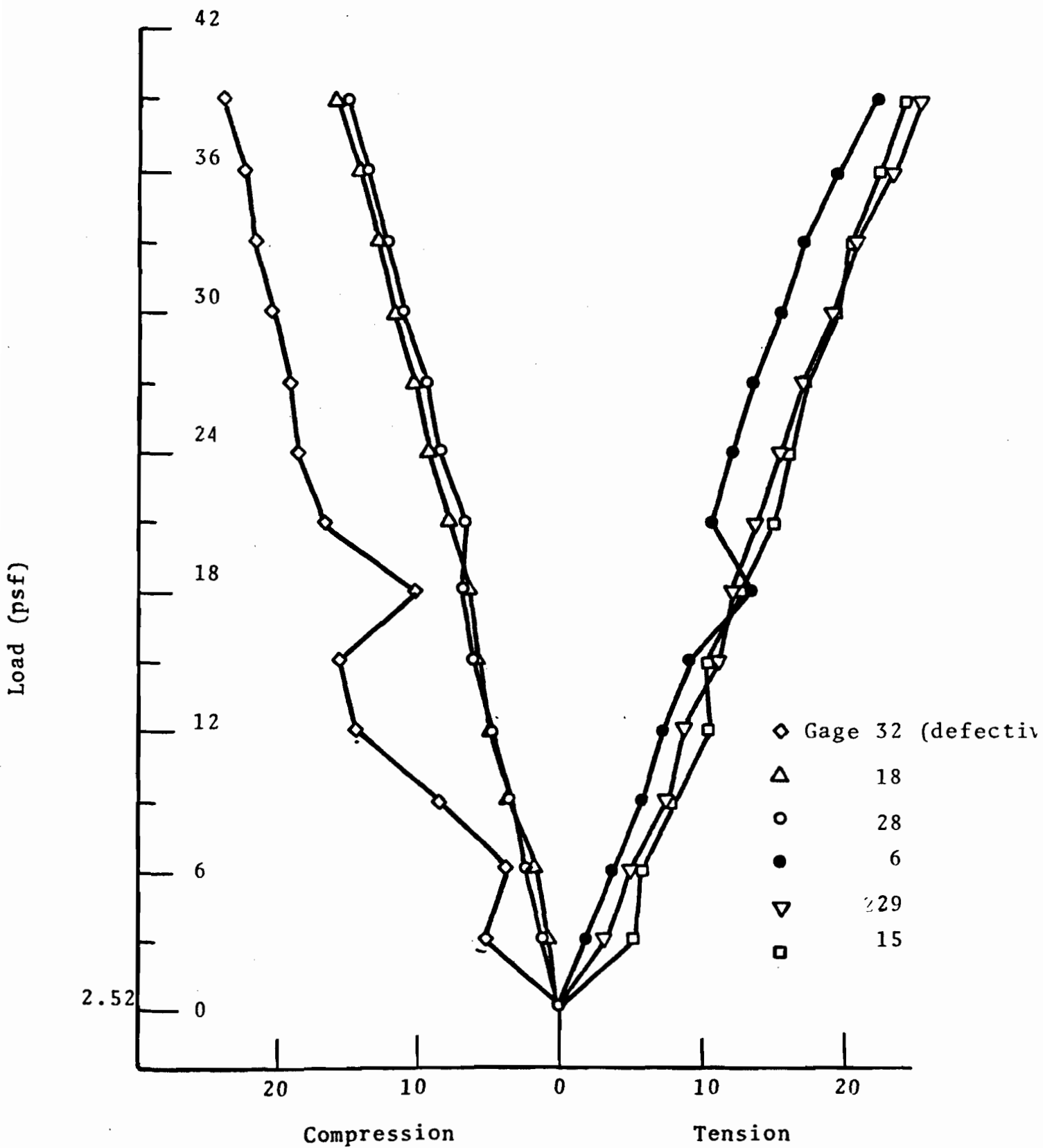


Fig. 32 Stresses at 1.5 inches Away From the Overlap Over the Interior Support, End Spans - C-Section Purlin Test

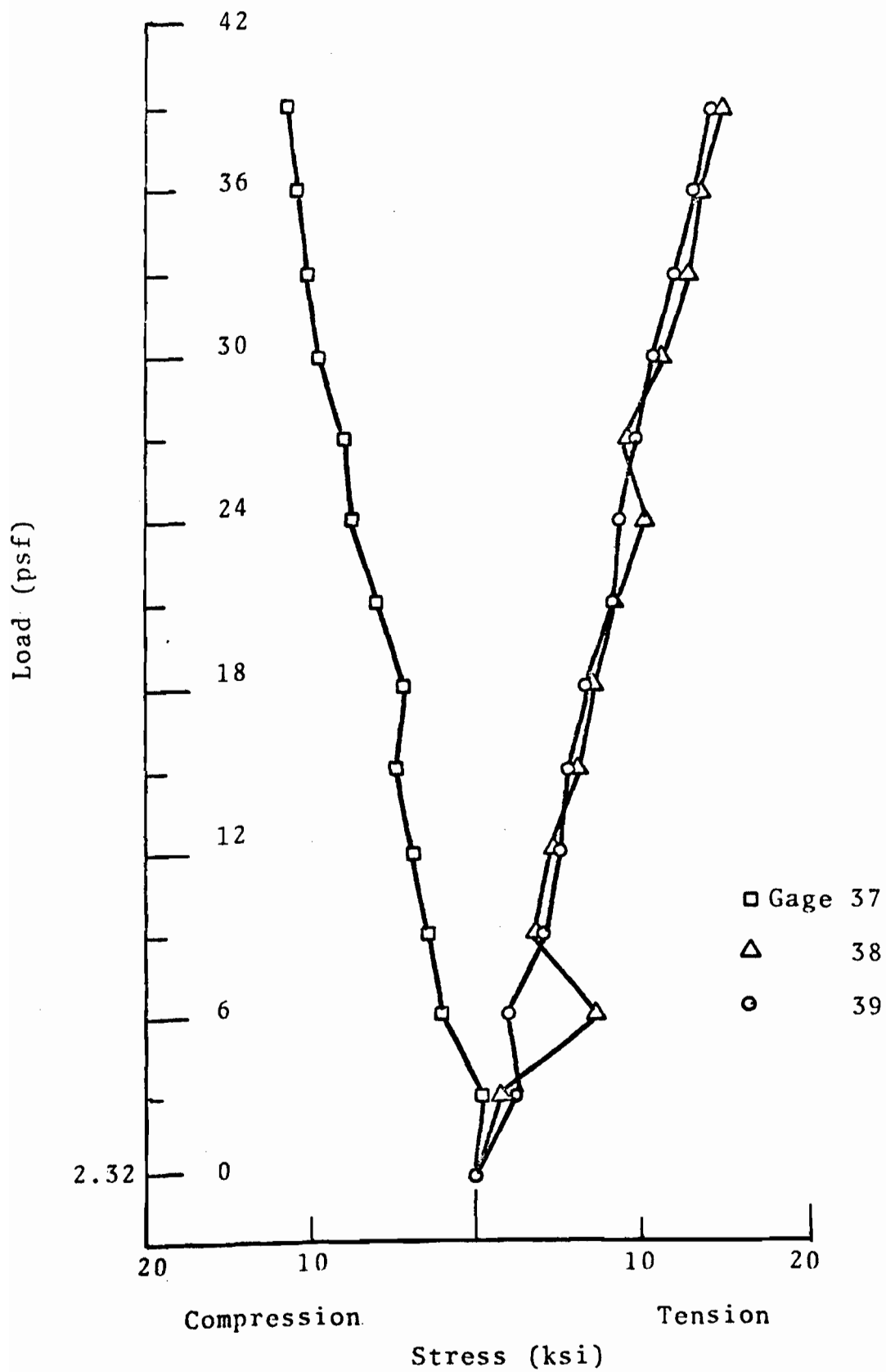


Fig. 33 Stresses at Midspan, Center Spans - C-Section Purlin Test

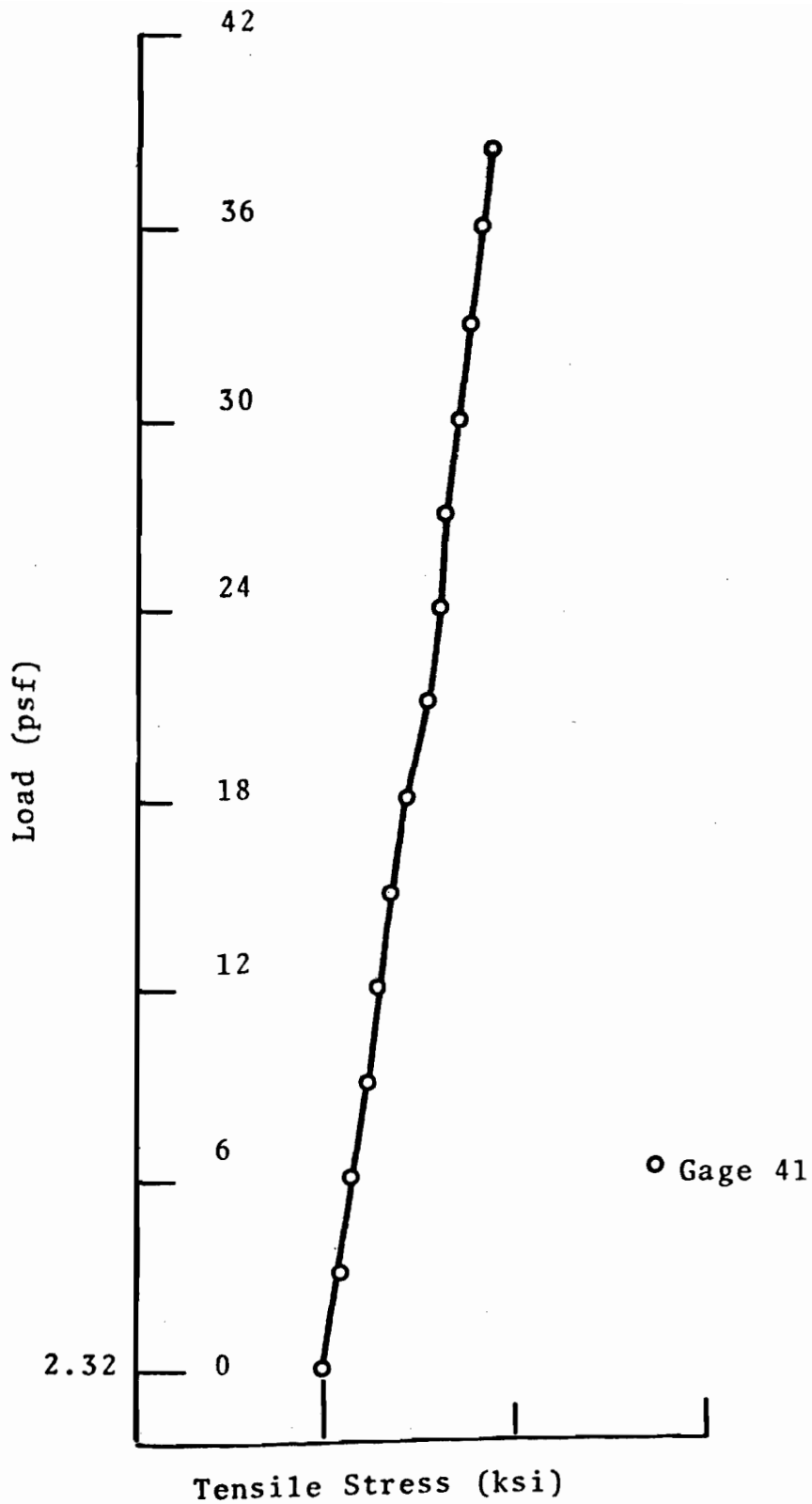


Fig. 33a Stresses at Midspan, Center Spans - C-Section Purlin Test

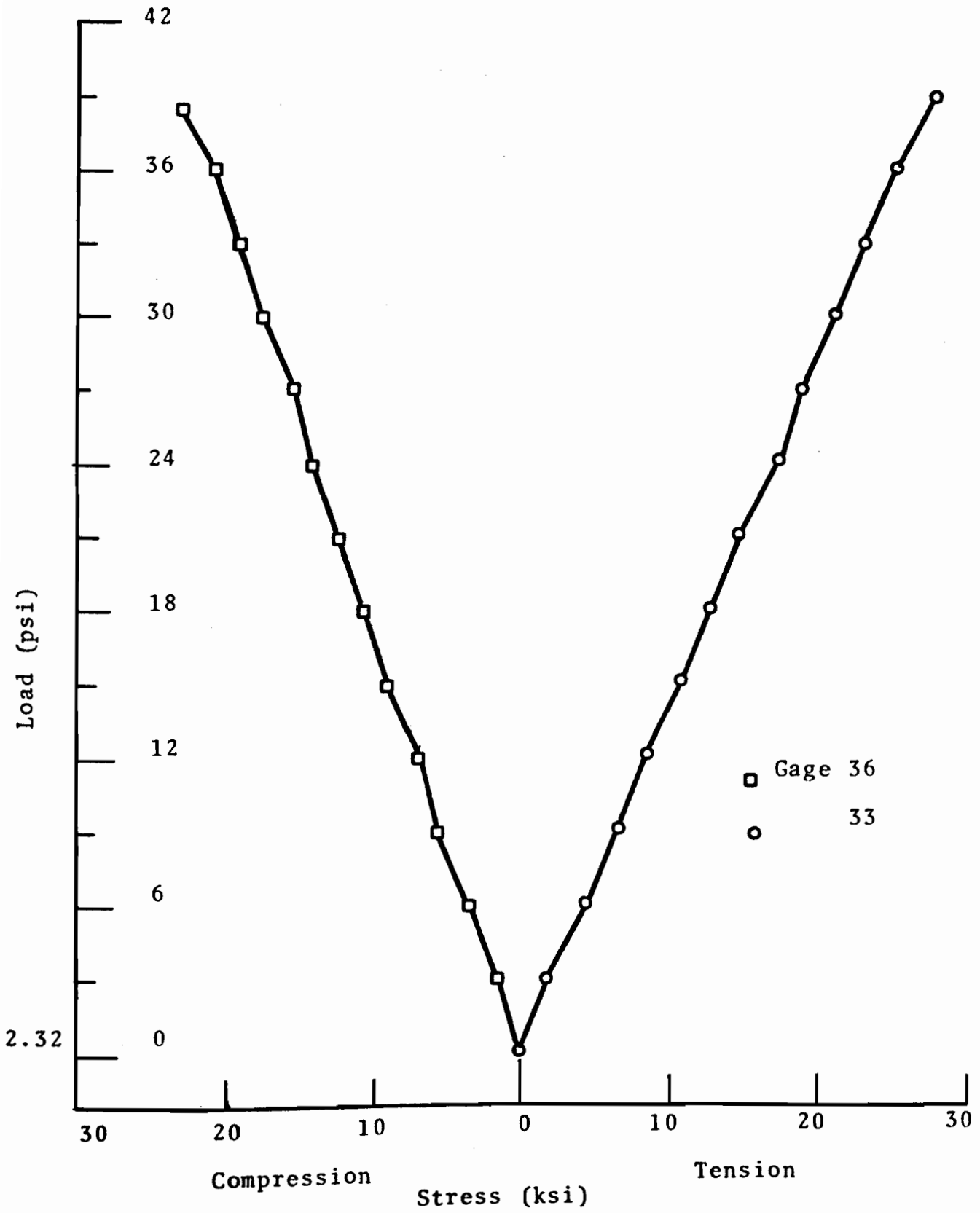


Fig. 34 Stresses at 1.5 inches Away From the Overlap Over the Interior Support, Center Span - C-Section Purlin Test

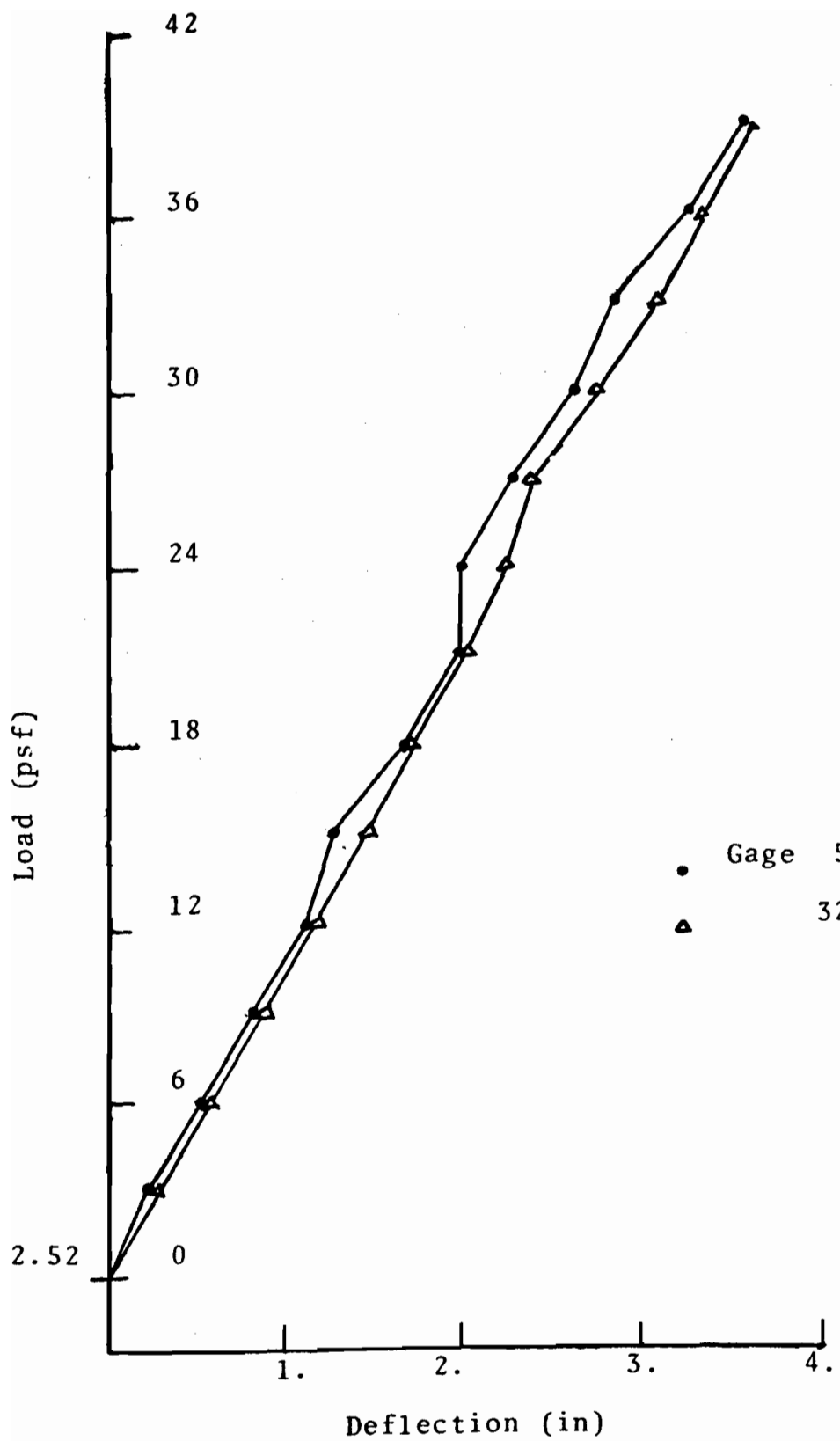


Fig. 35 Vertical Deflection of Roof Deck at Mid Point of the End Spans - C-Section Purlin Test

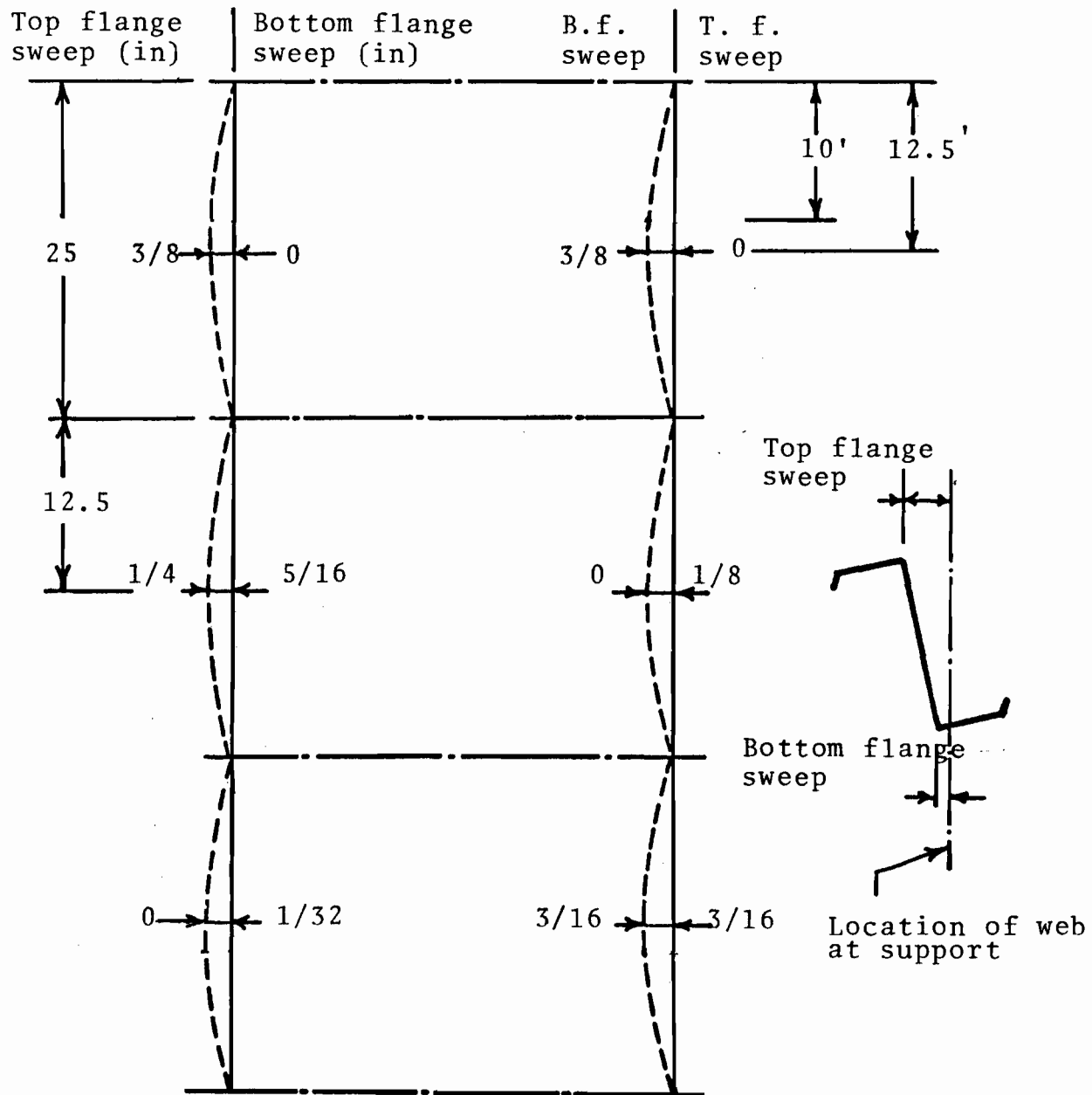


Fig. 36 Initial Sweep of Z-Section Purlin Assembly - Second Test

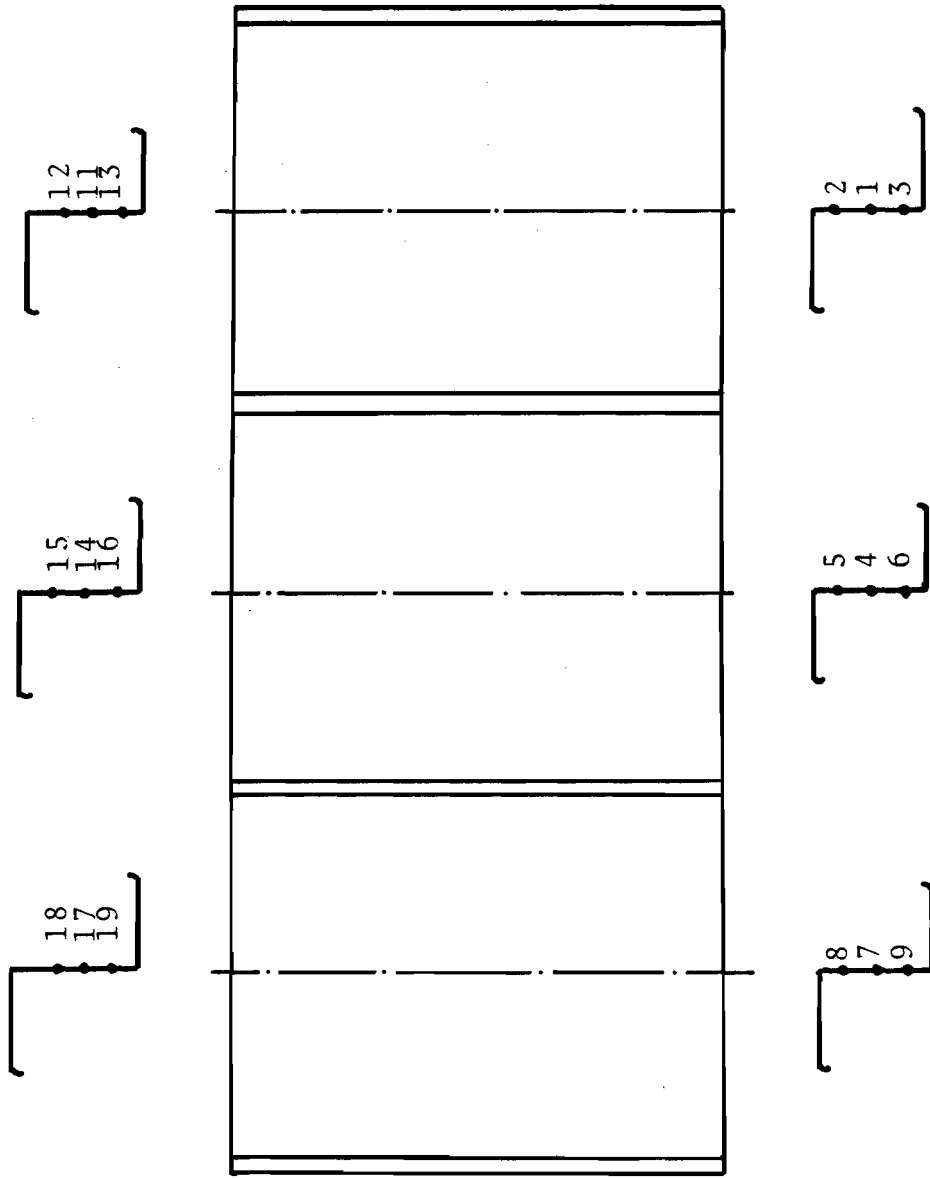


Fig. 37 Dial Gage Locations - Second Z-Section Purlin Test

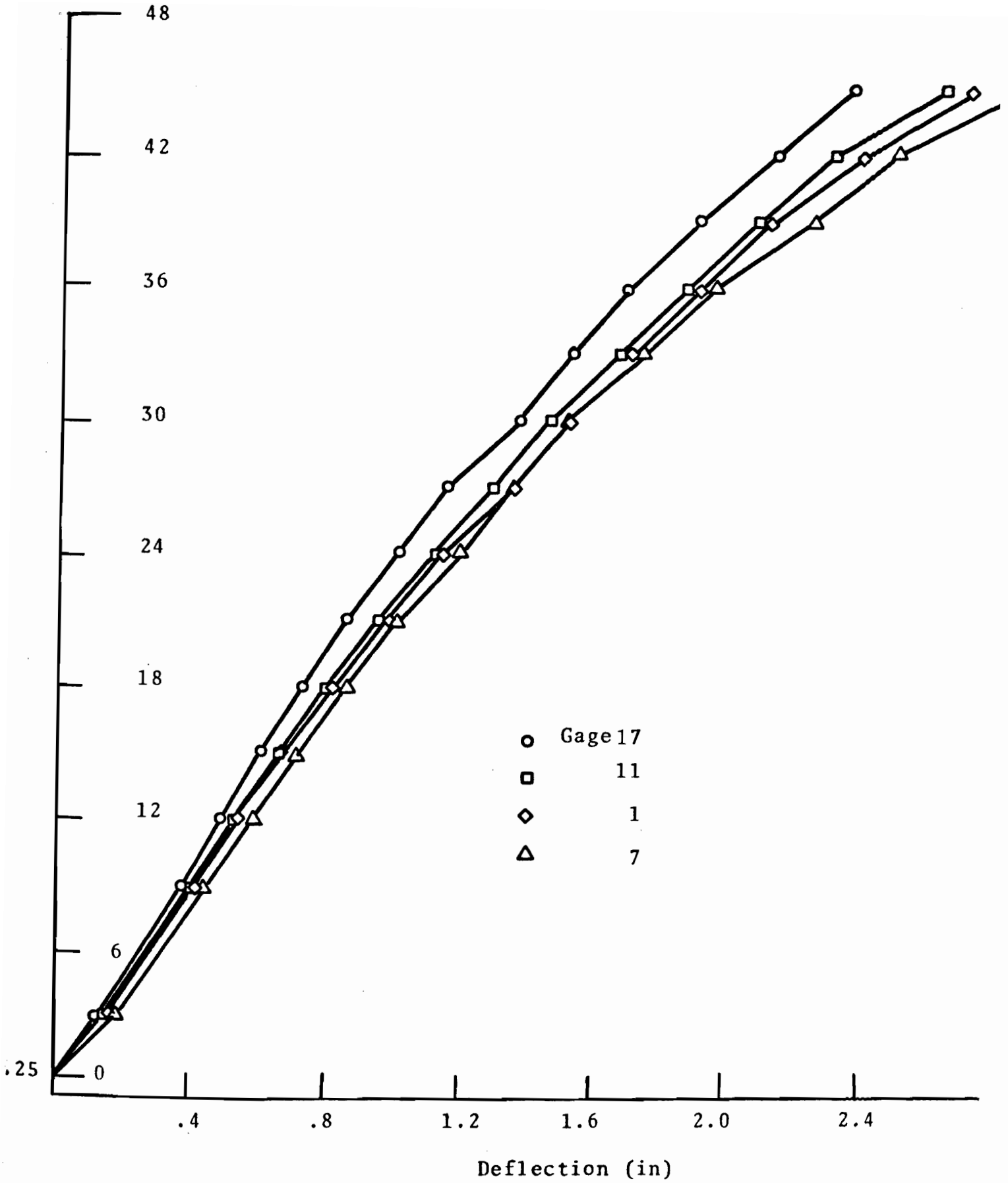


Fig. 38 Vertical Deflection, Midspan of End Spans - Second Z-Section Purlin Test

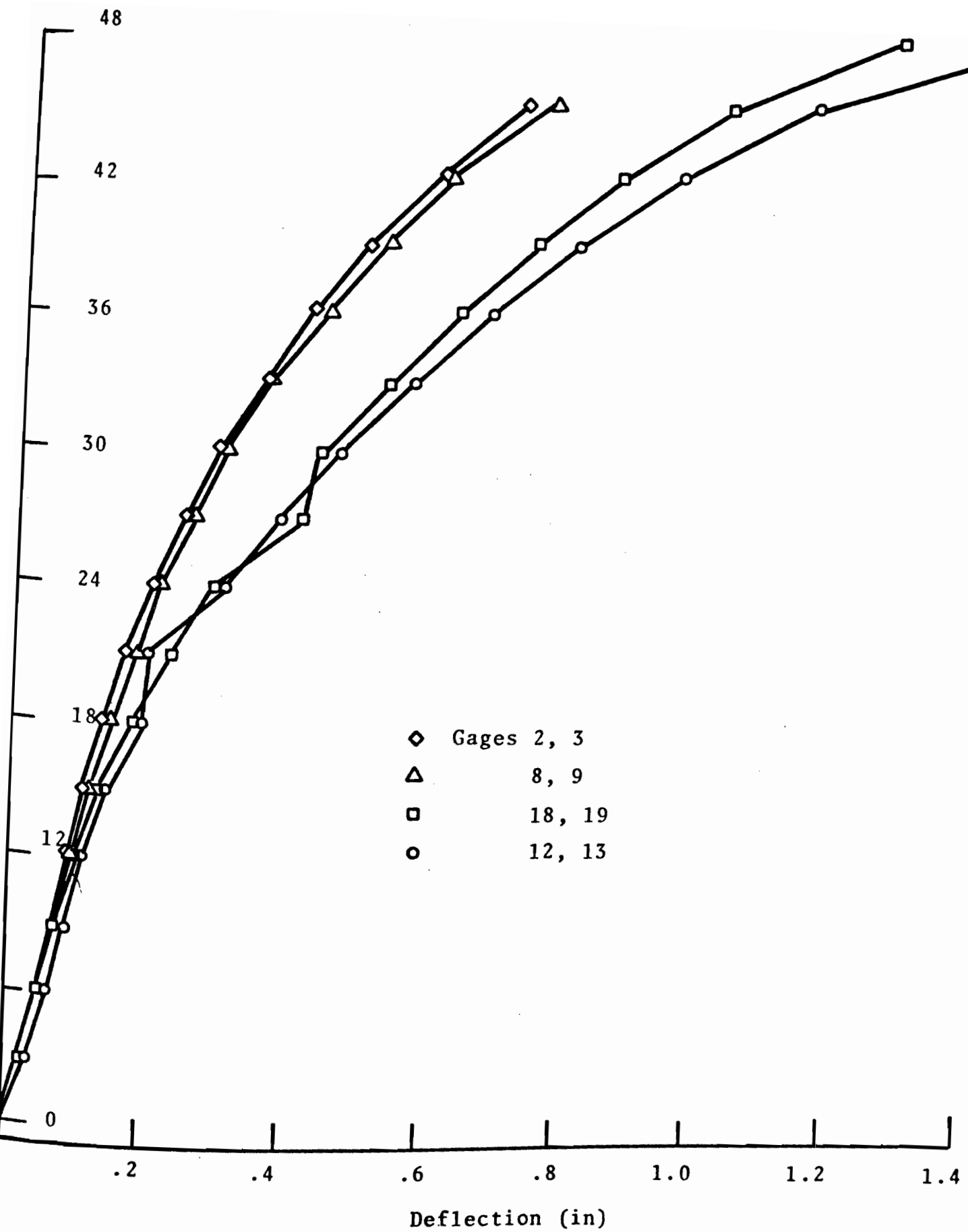


Fig. 39 Horizontal Deflection, Midspan of End Spans - Second Z-Section Purlin Test

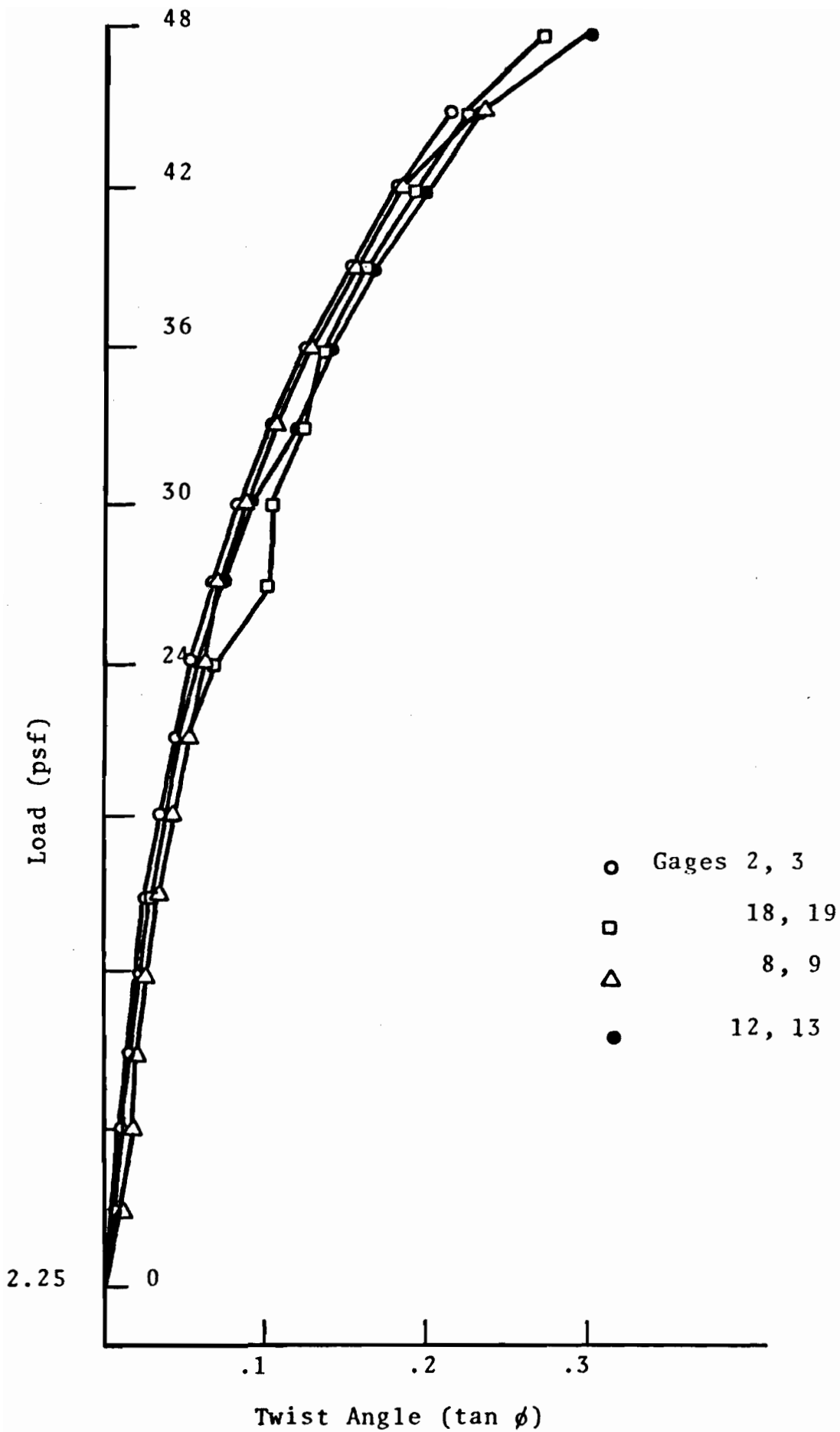


Fig. 40 Twist Angle, Midspan of End Spans - Second Z-Section Purlin Test

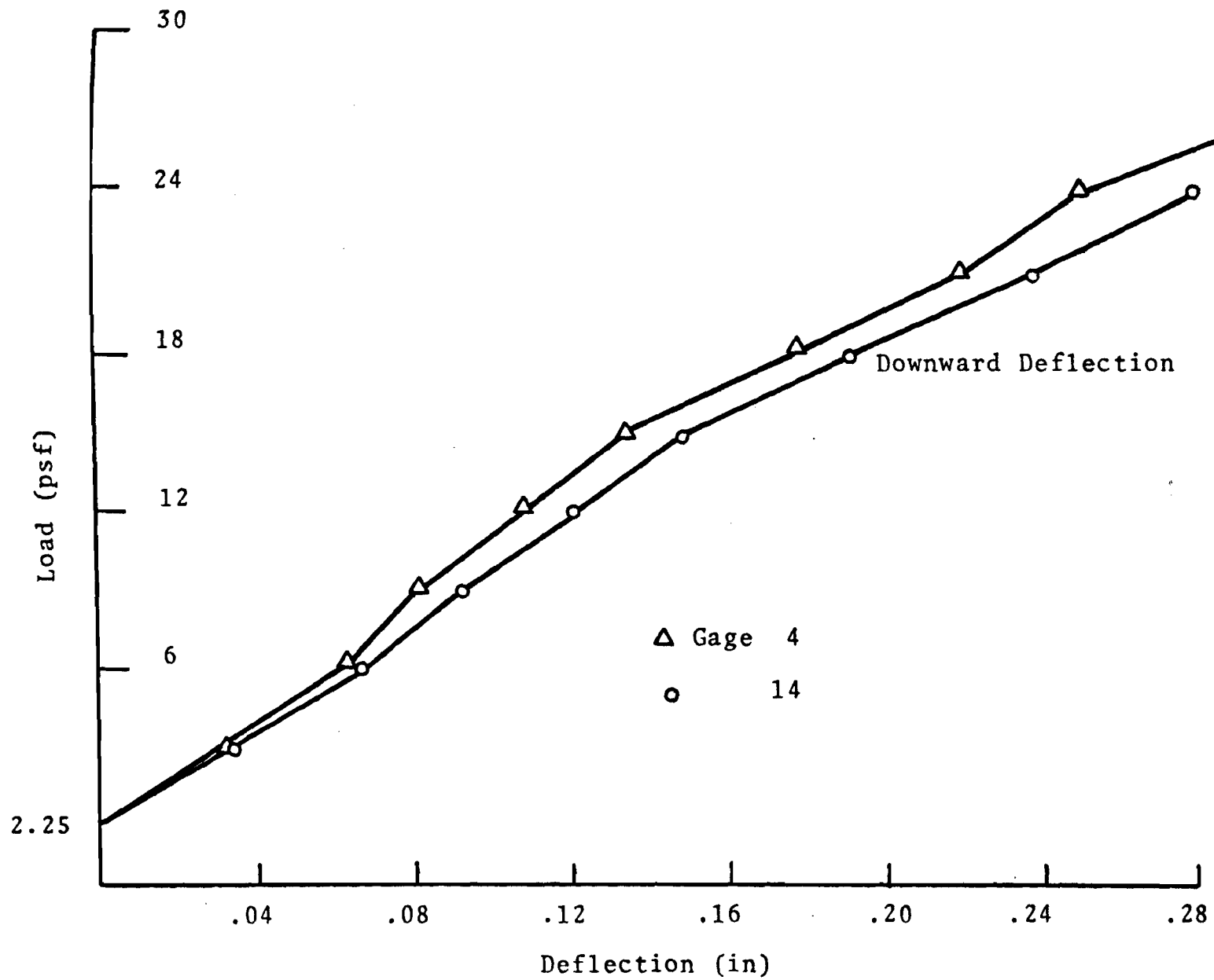


Fig. 41 Vertical Deflection, Midspan of Center Spans -
Second Z-Section Purlin Test

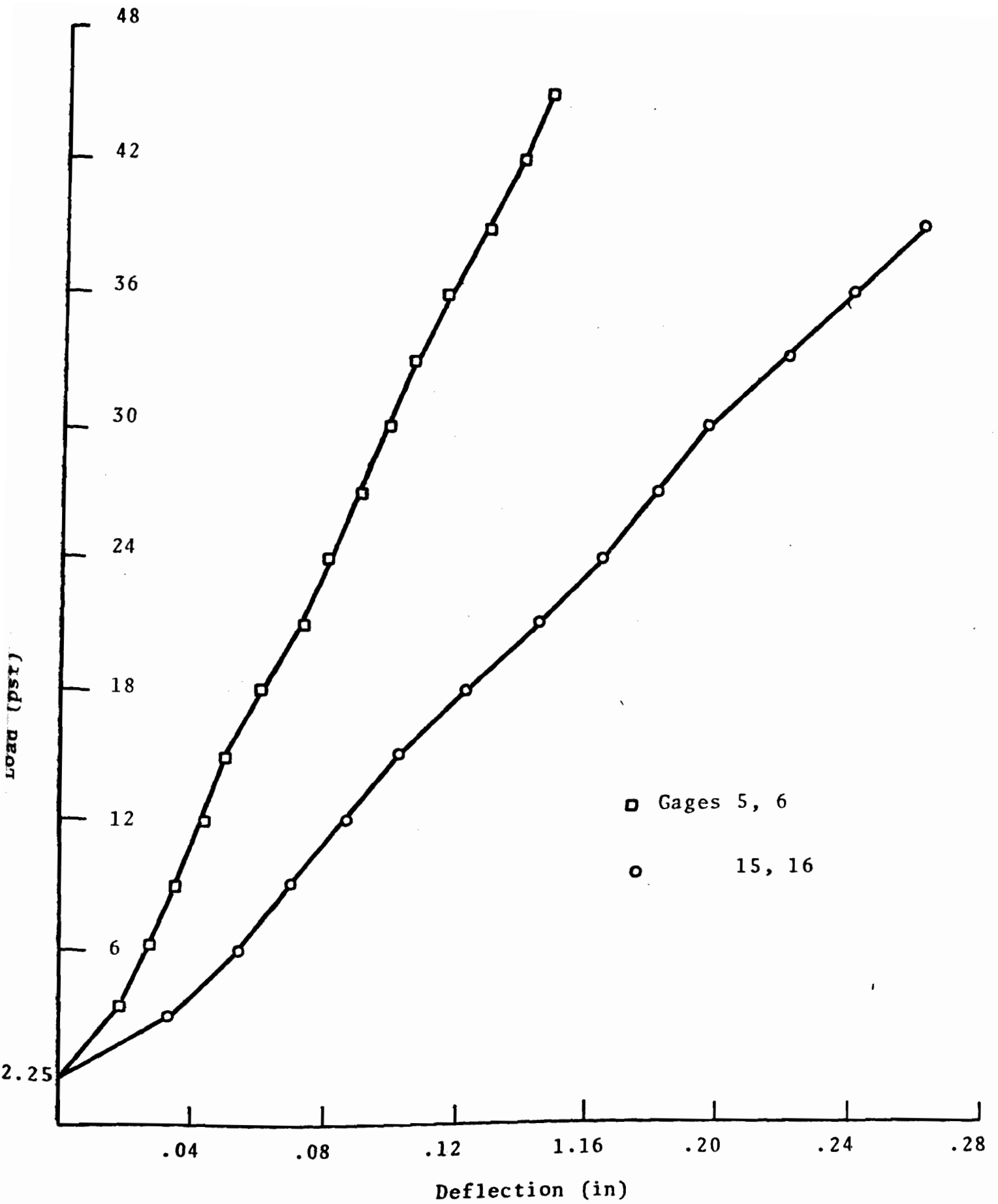


Fig. 42 Horizontal Deflection, Midspan of Center Spans - Second Z-Section Purlin Test

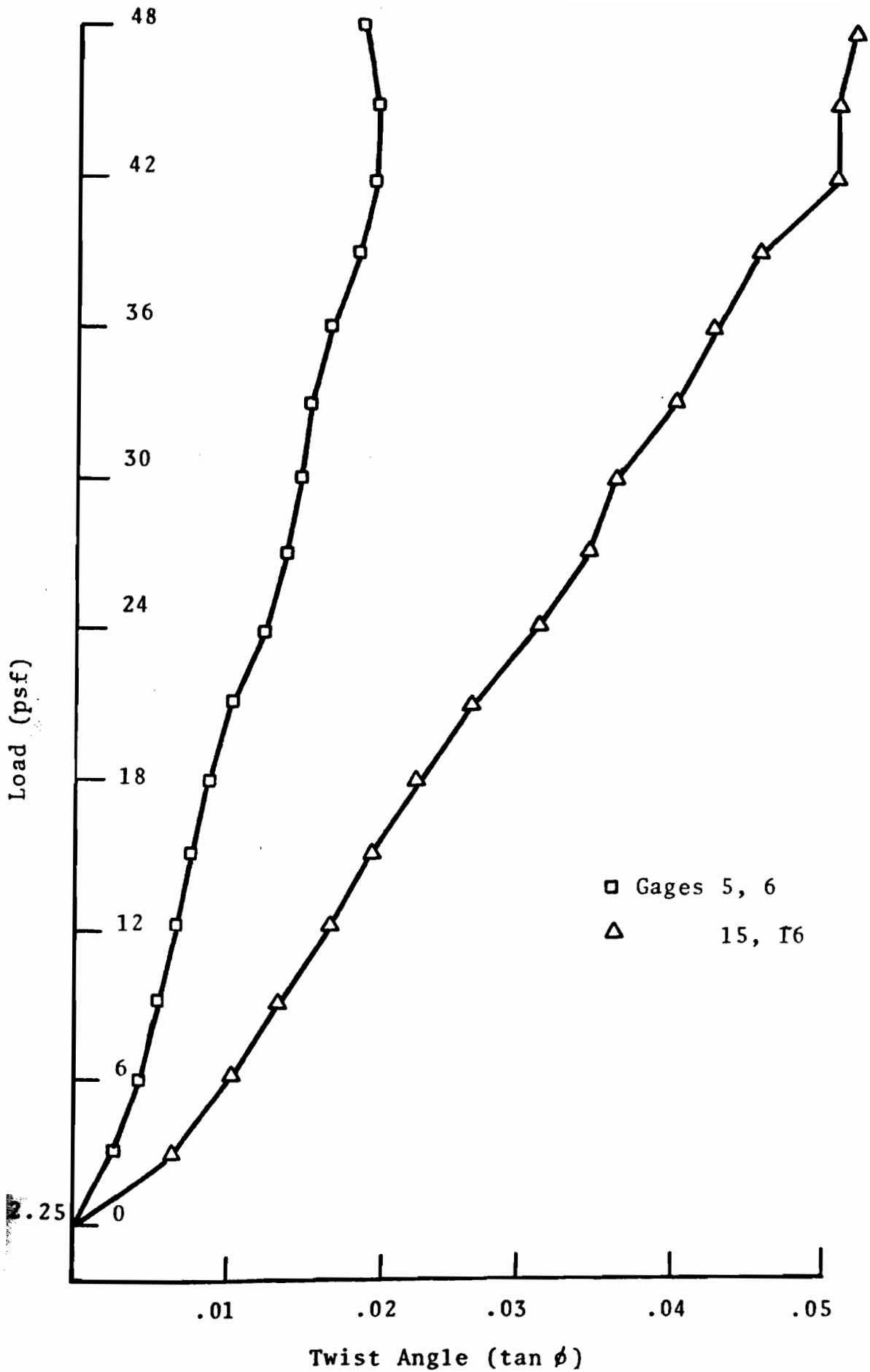


Fig. 43 Twist Angle, Midspan of Center Spans - Second Z-Section Purlin Test

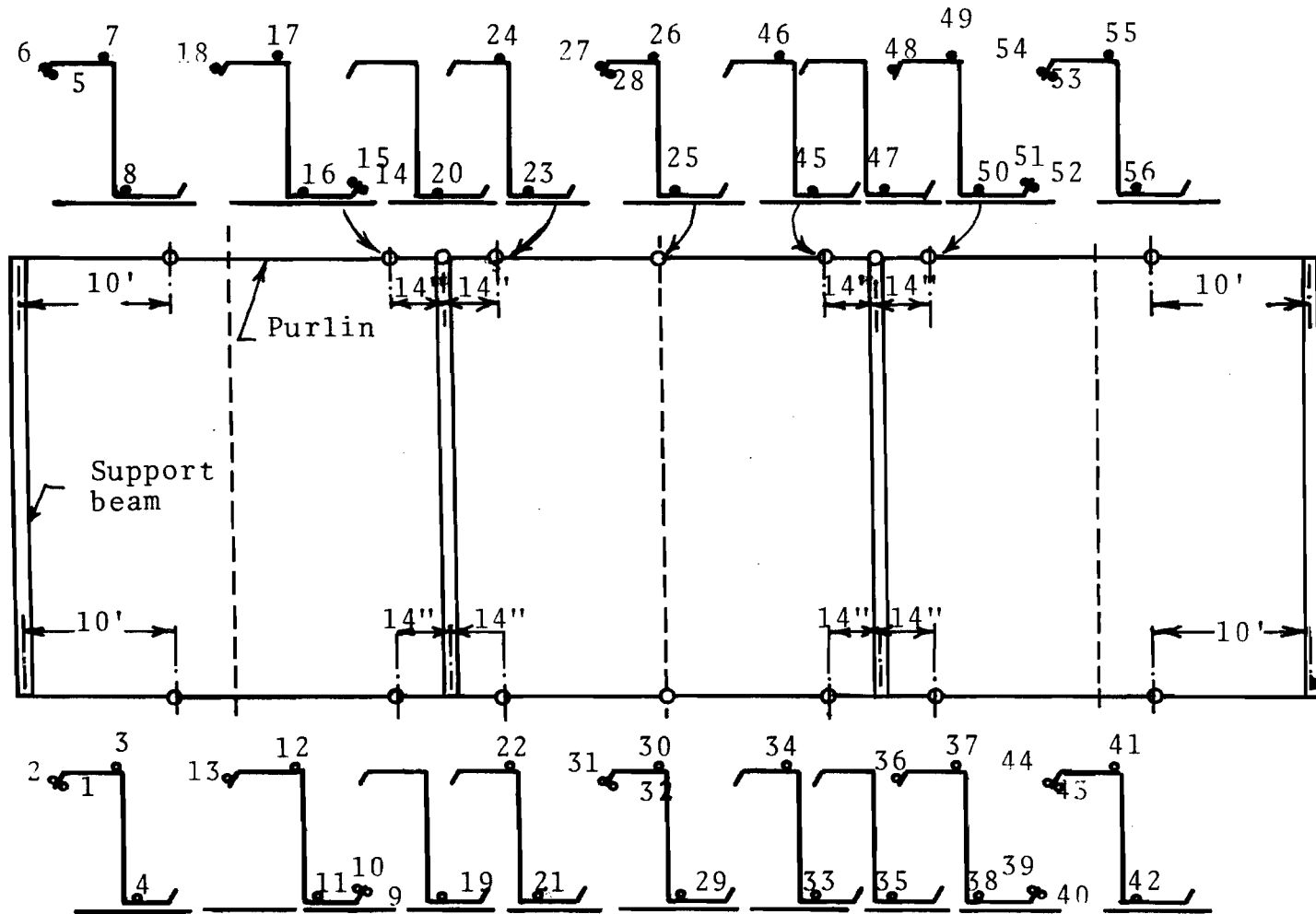


Fig. 44 Strain Gage Locations - Second Z-Section Purlin Test

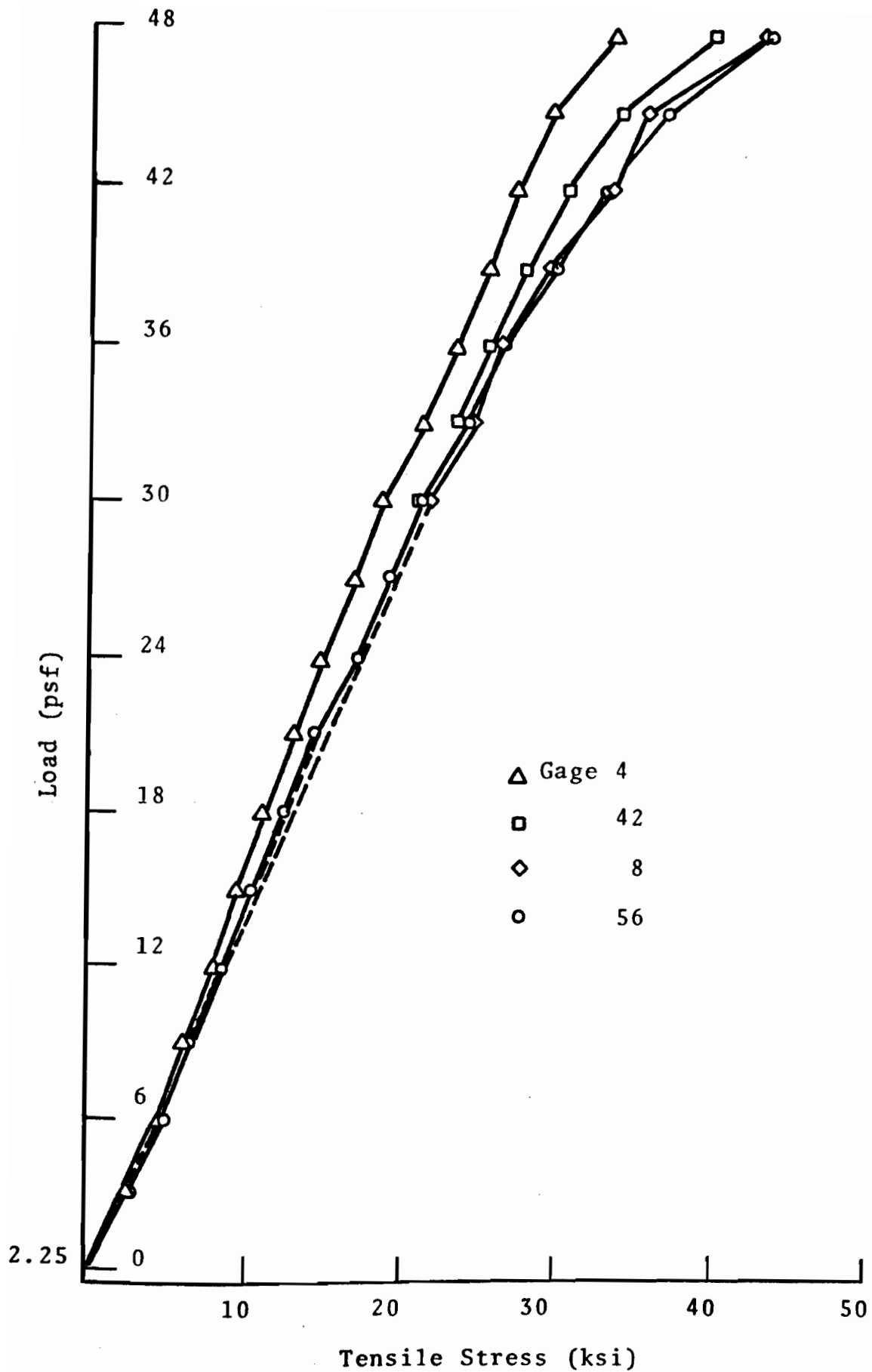


Fig. 45 Stresses at 10 ft. From Outside Supports, End Spans - Second Z-Section Purlin Test

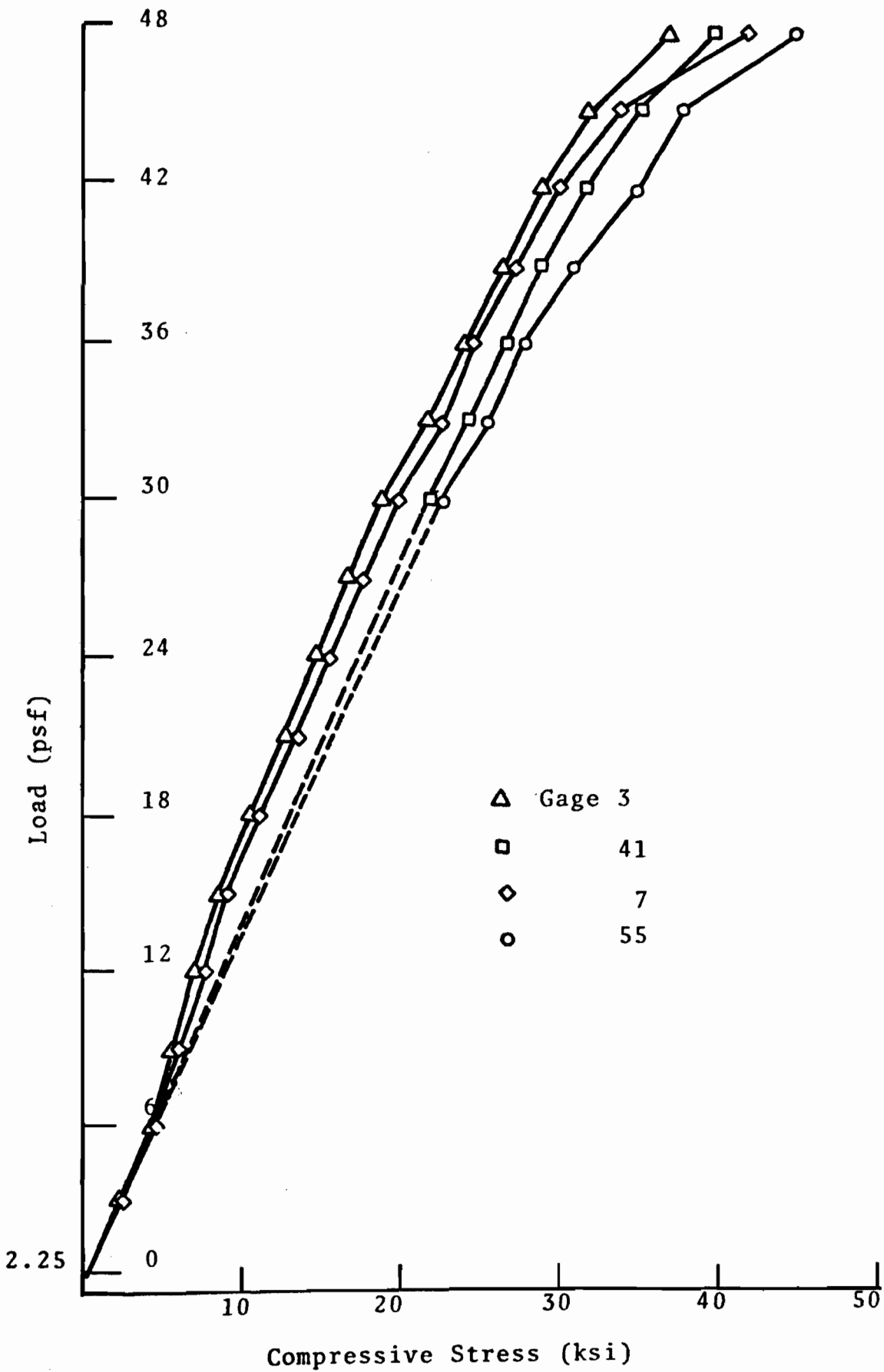


Fig. 46 Stresses at 10 ft. From Outside Supports, End Spans - Second Z-Section Purlin Test

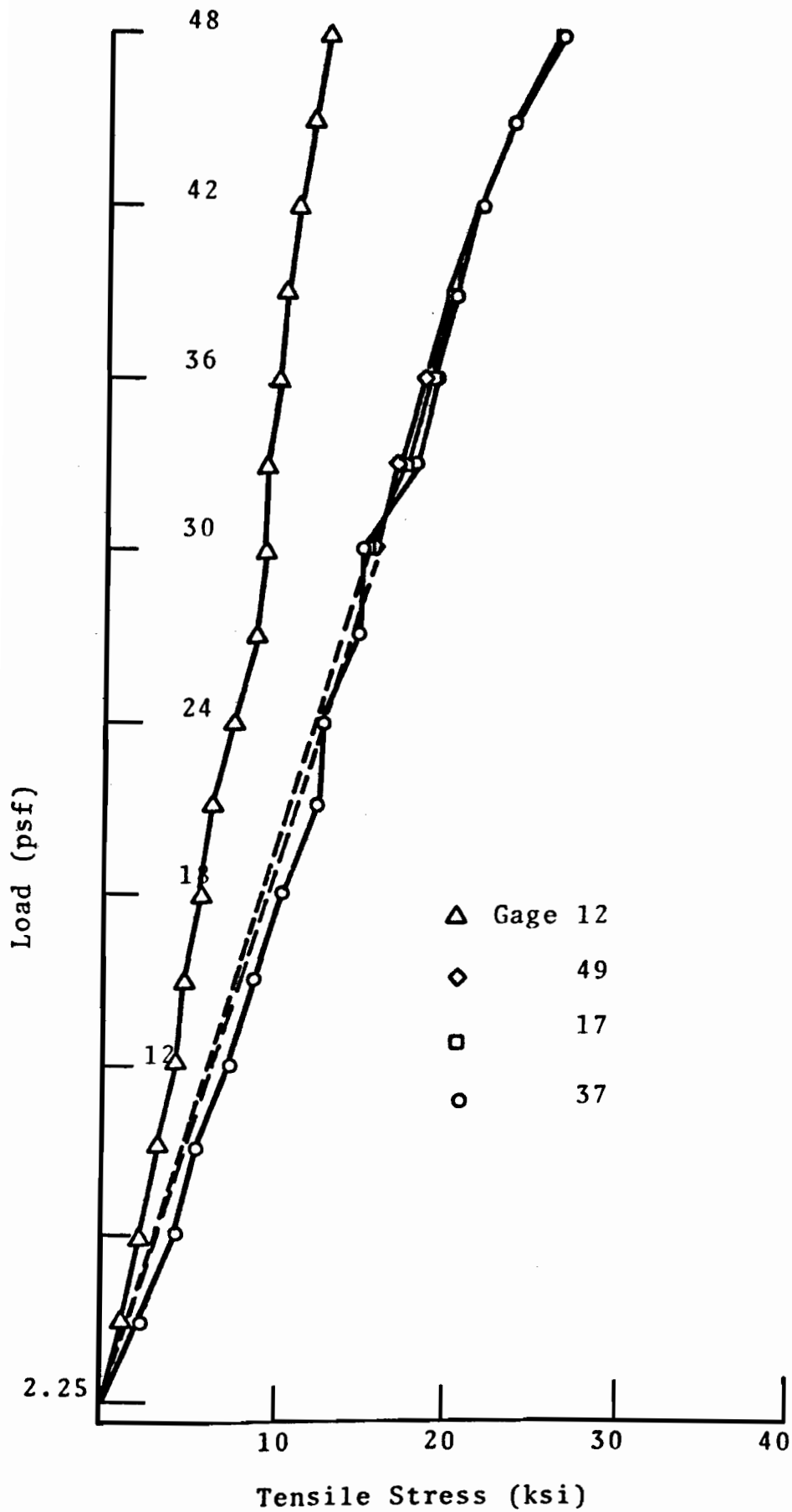


Fig. 47 Stresses at 14 inches from the Interior Support (Just Beyond the Nested Portion), End Spans - Second Z-Section Purlin Test

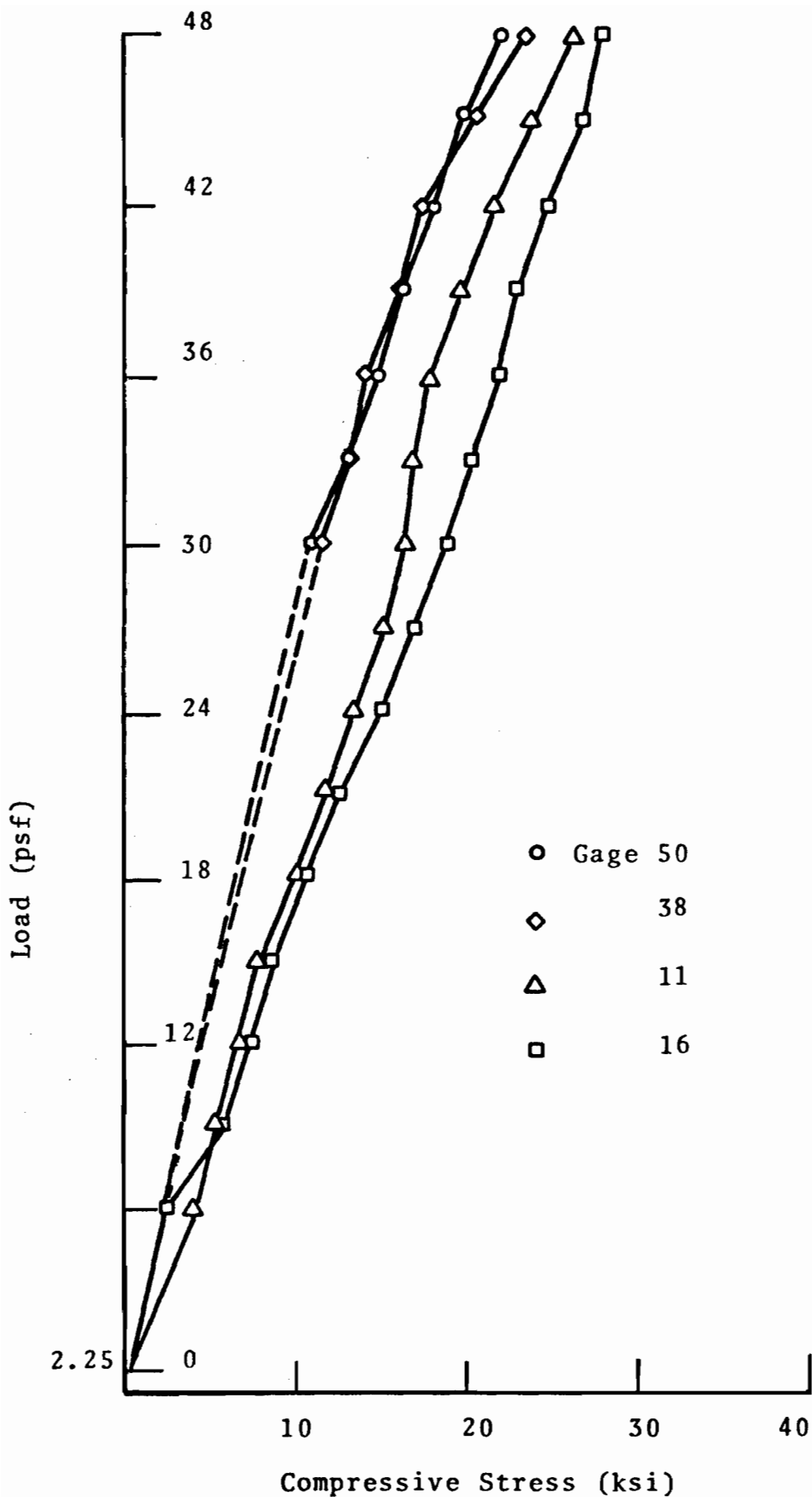


Fig. 48 Stresses at 14 inches from the Interior Support (Just Beyond the Nested Portion), End Spans - Second Z-Section Purlin Test

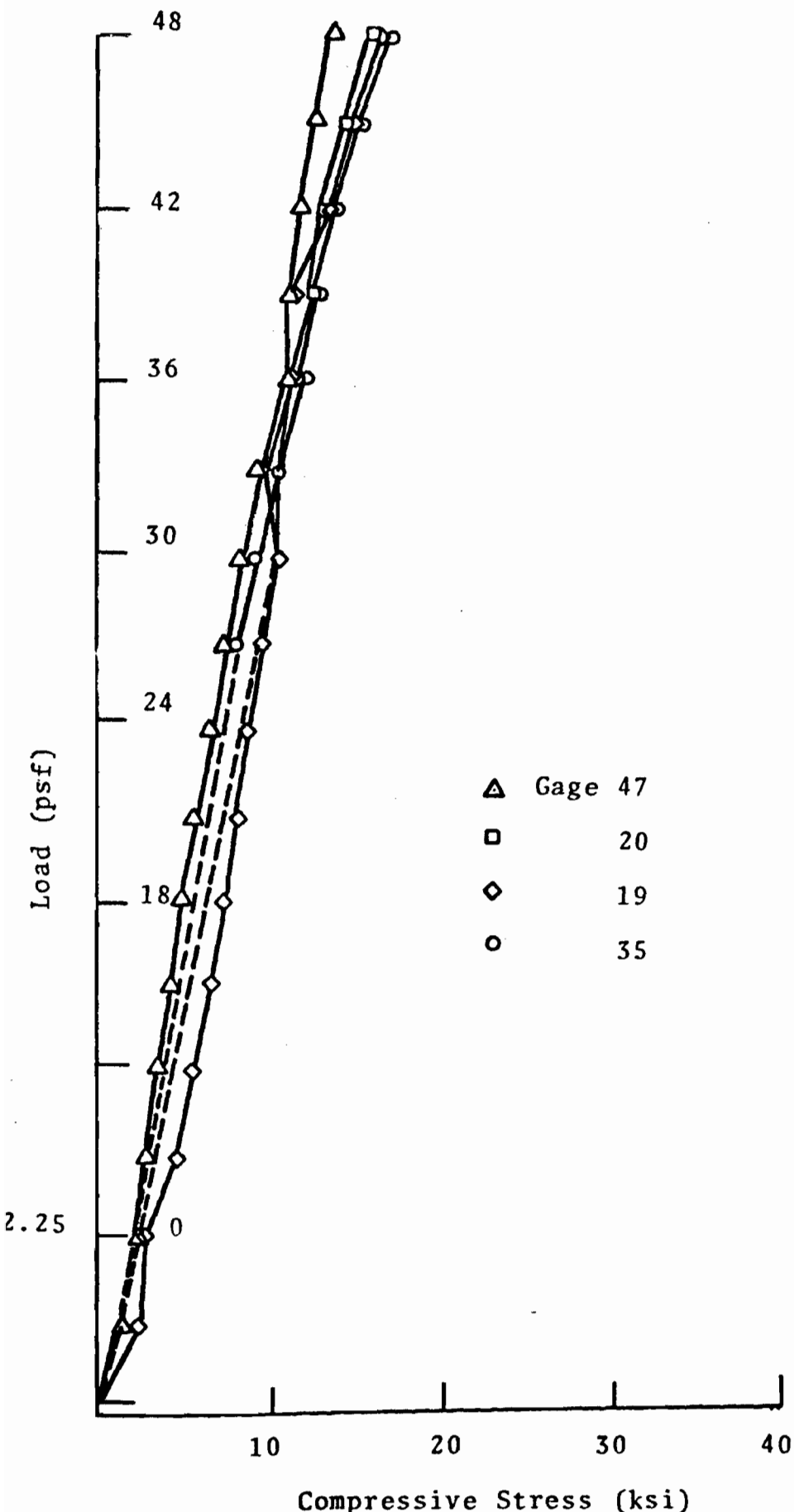


Fig. 49 Stresses at Interior Supports - Second Z-Section Purlin Test

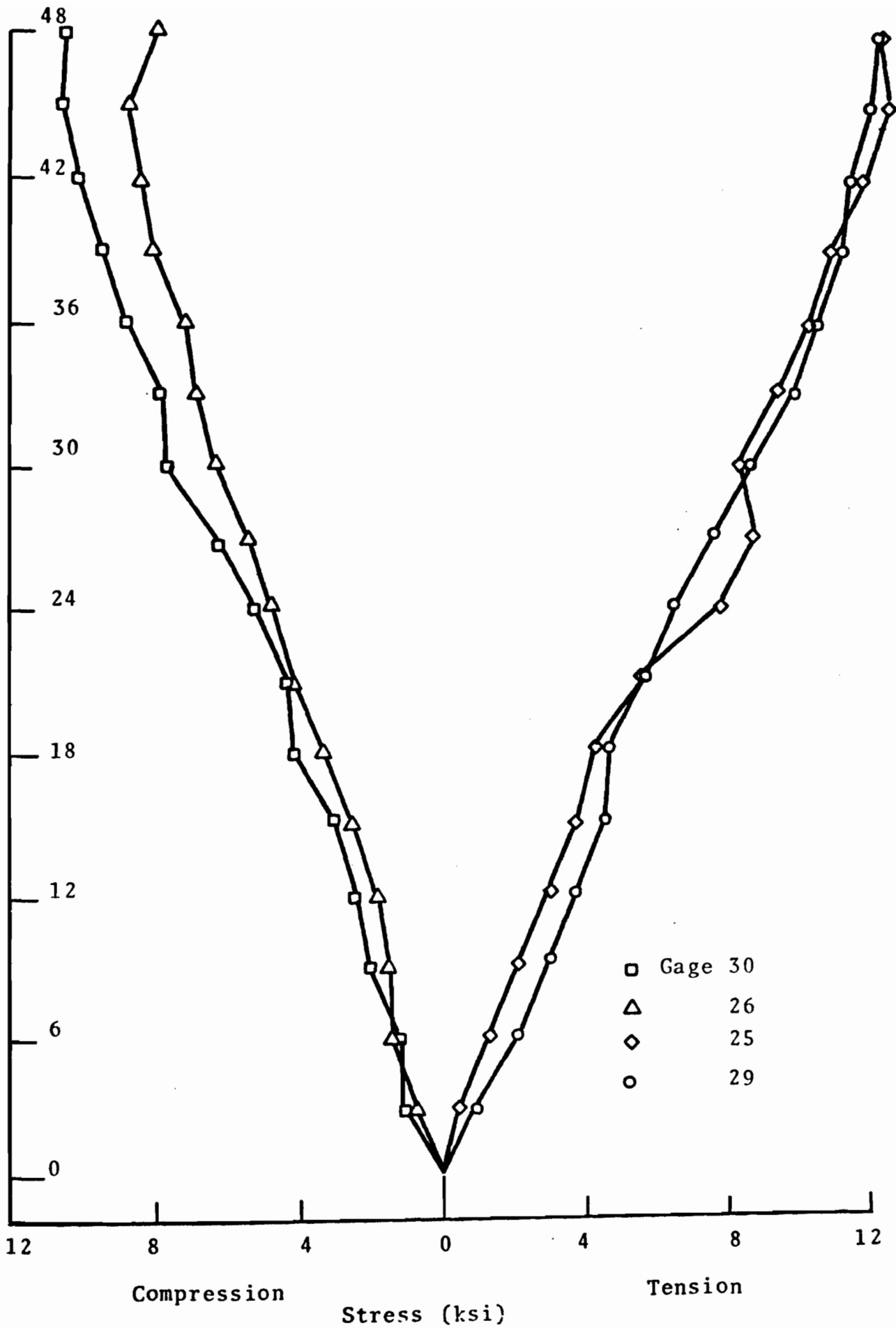


Fig. 50 Stresses at Midspan, Center spans - Second Z-Section Purlin Test

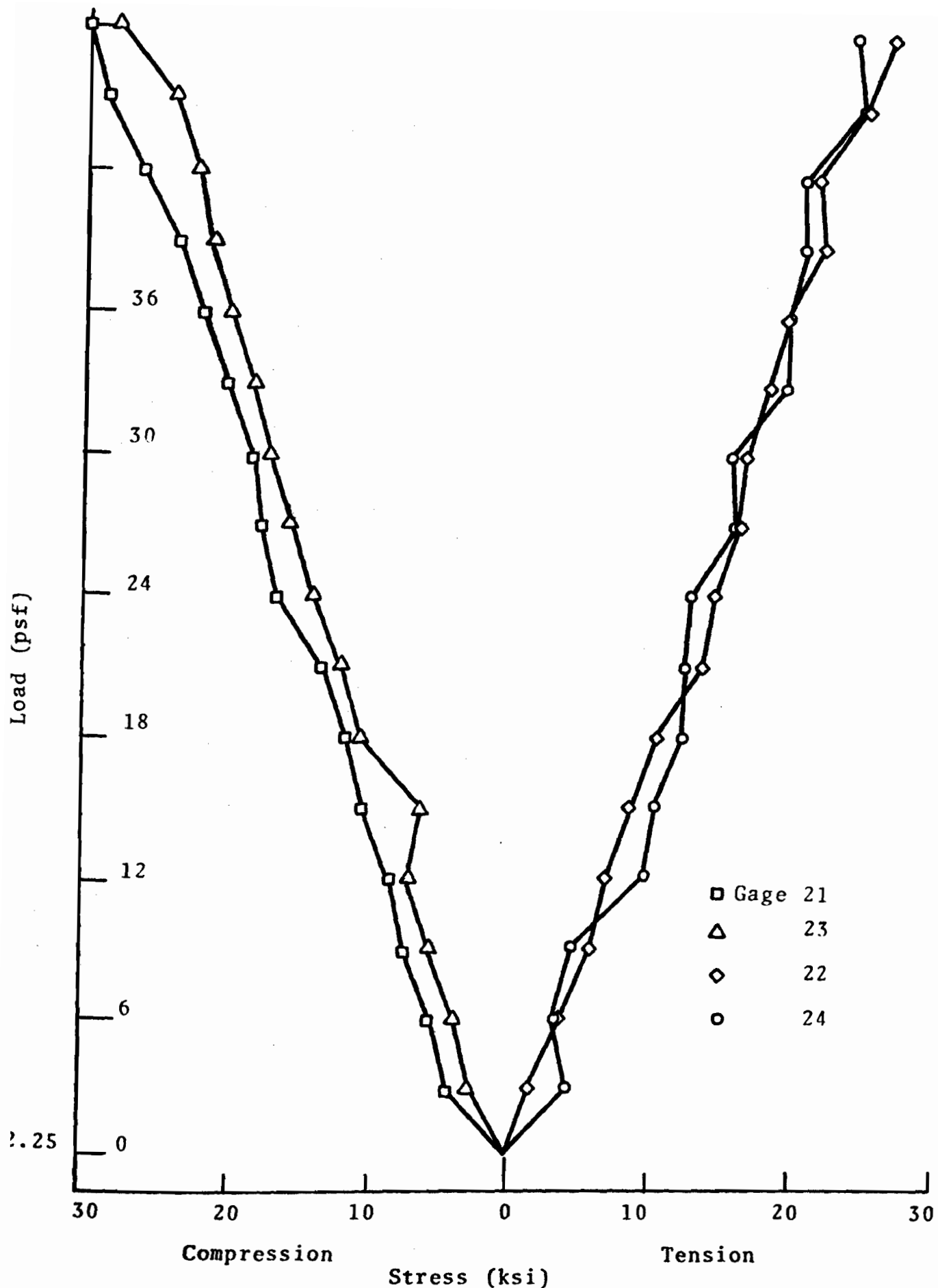


Fig. 51 Stresses at 14.5 inches from the Interior Support (Just Beyond the Nested Portion), Center Spans - Second Z-Section Purlin Test

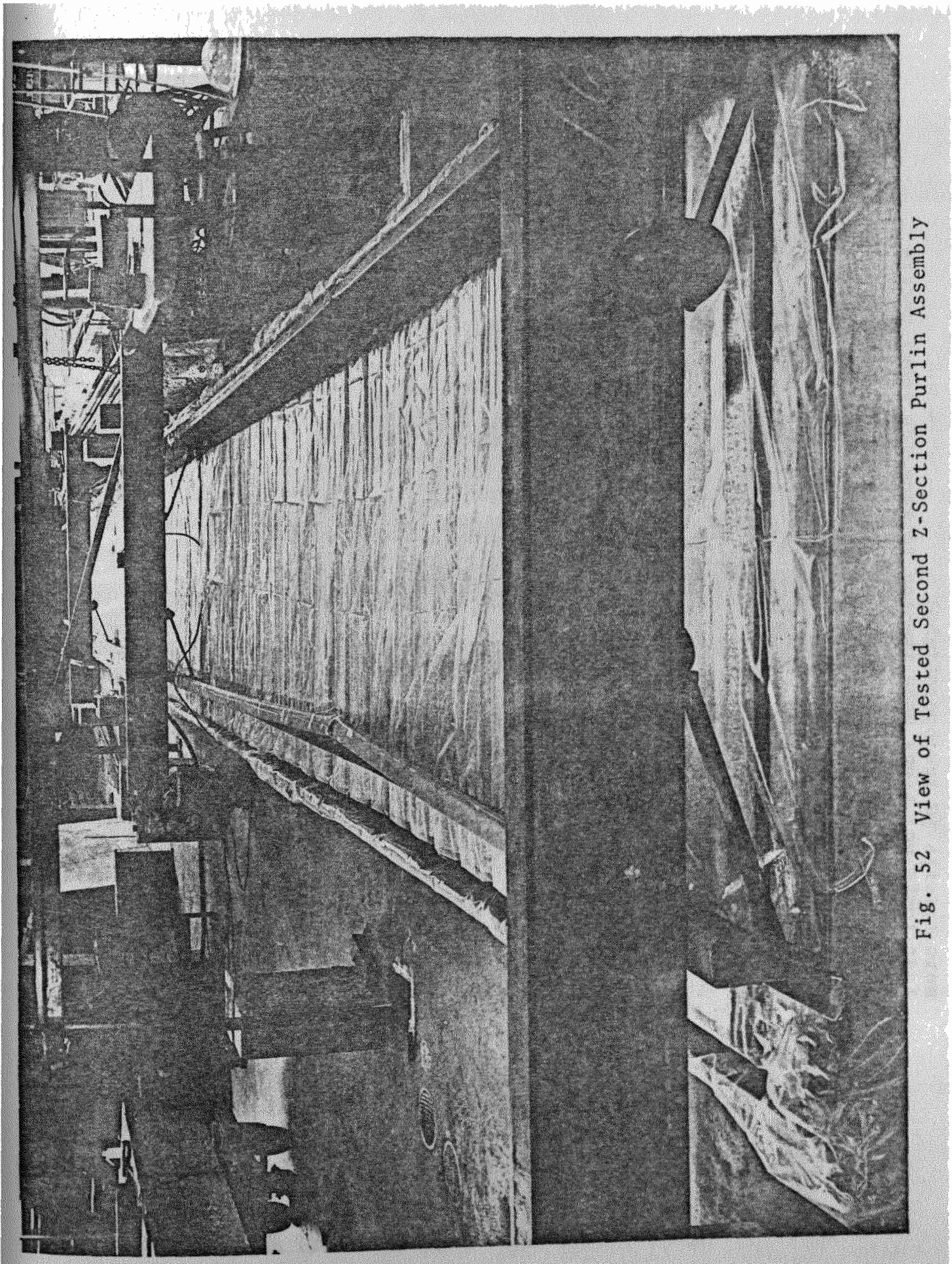


Fig. 52 View of Tested Second Z-Section Purlin Assembly

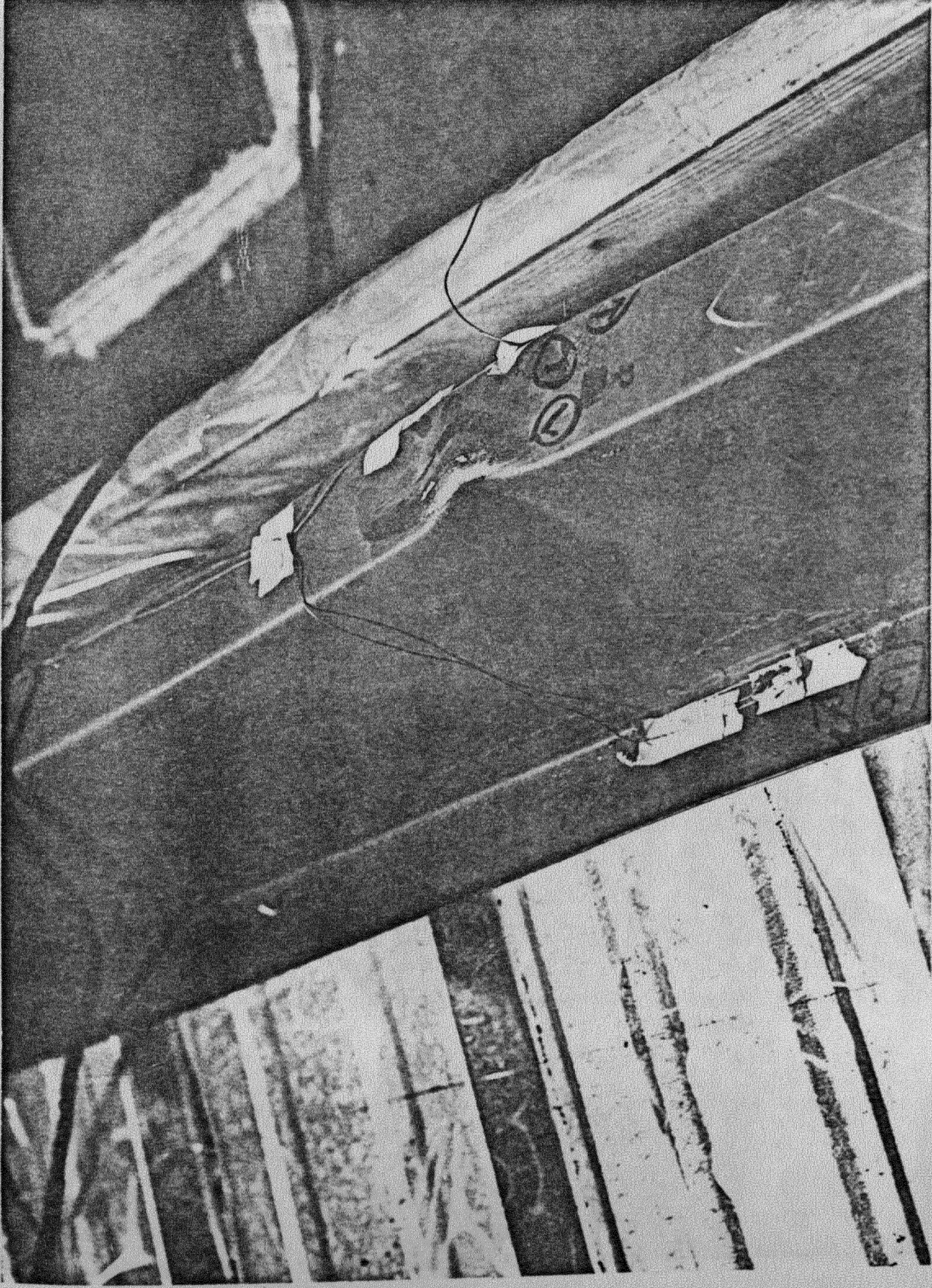


Fig. 53 View of Local Buckle in the Second Z-Section Purlin Assembly
Test (Gage No. 7 has been removed to show the local buckle
more clearly in the photograph)

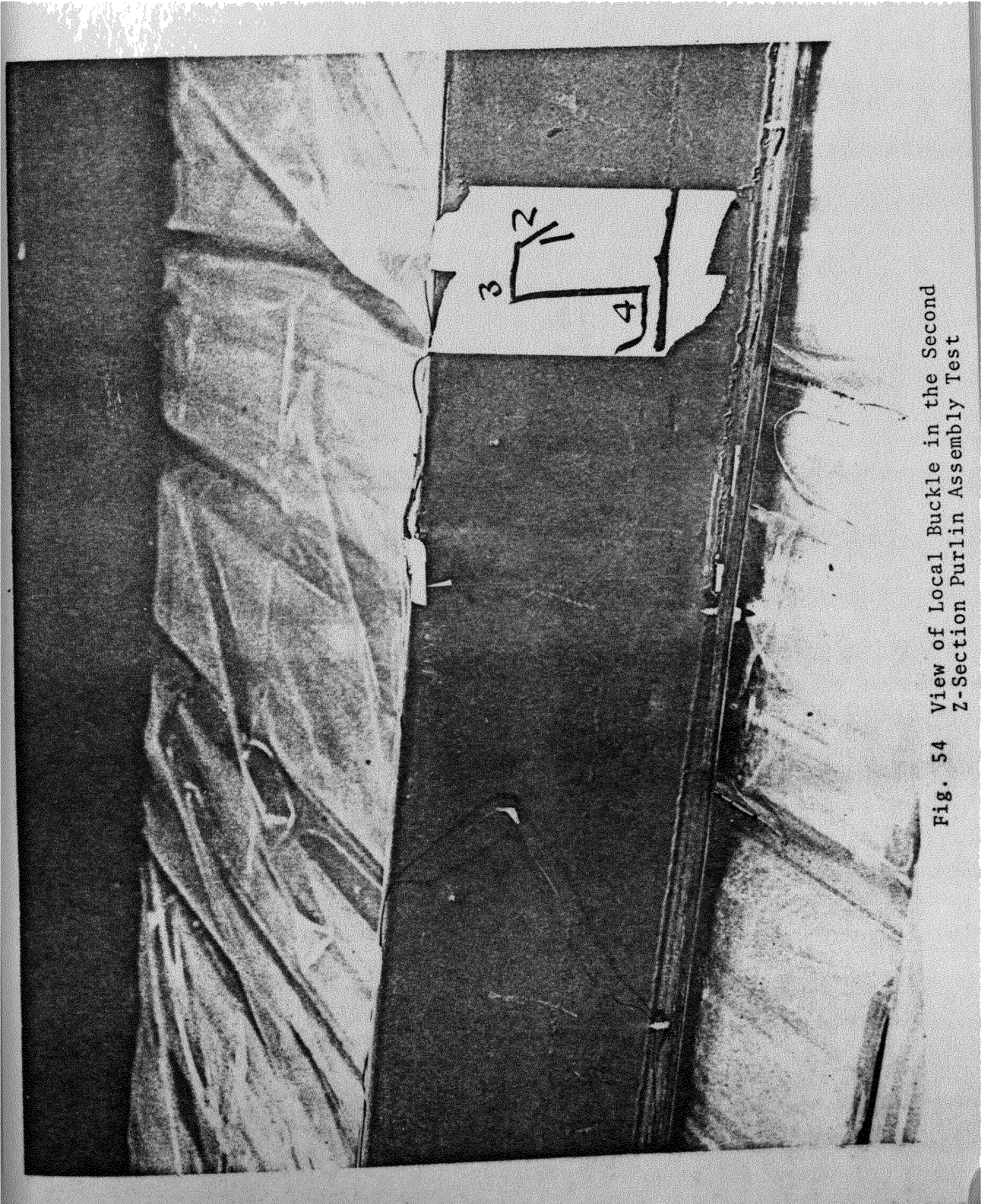


Fig. 54 View of Local Buckle in the Second Z-Section Purlin Assembly Test

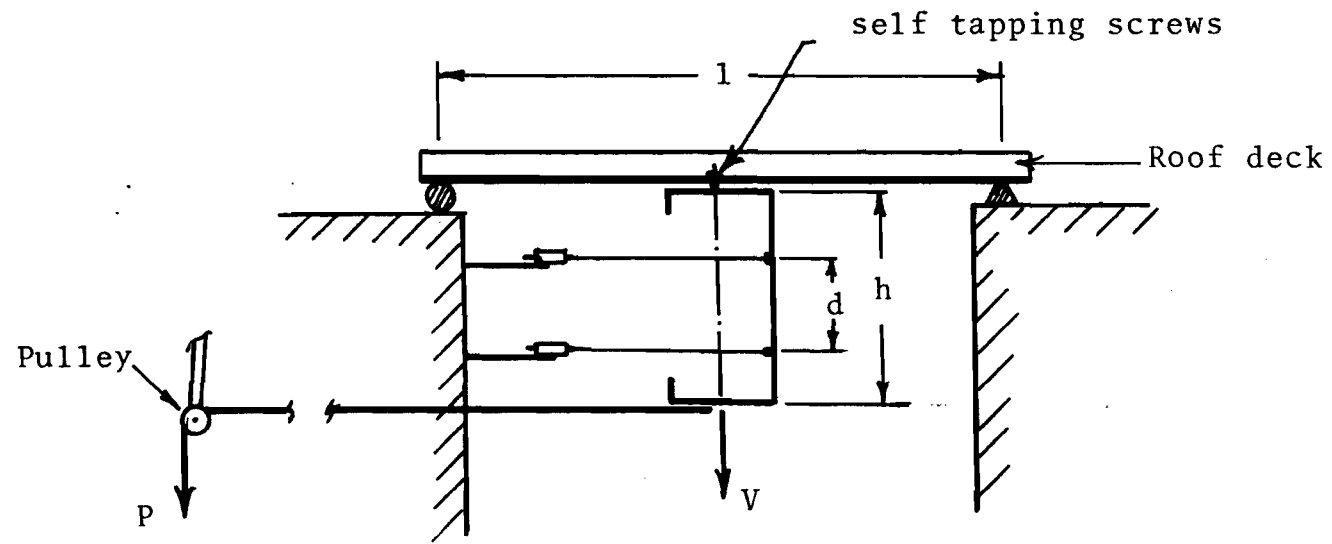


Fig. 55 Test Set-up for the Determination of the Rotational Restraint, F , for a Prototype

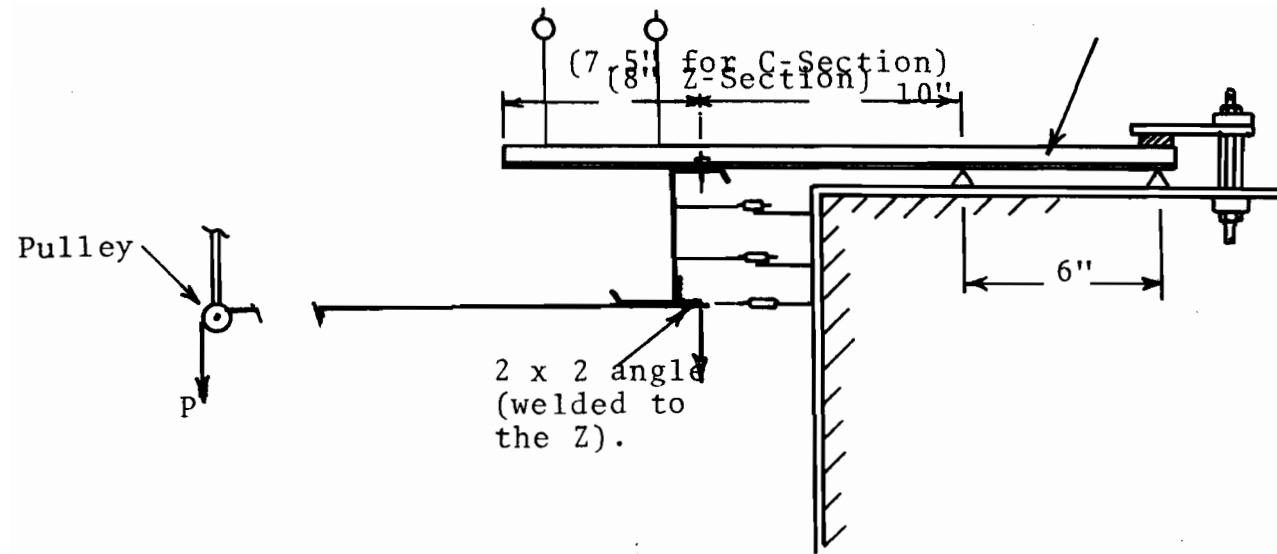


Fig. 56 Test Set-up for the Determination of the
 Rotational Restraint, F, for the Tests
 Conducted

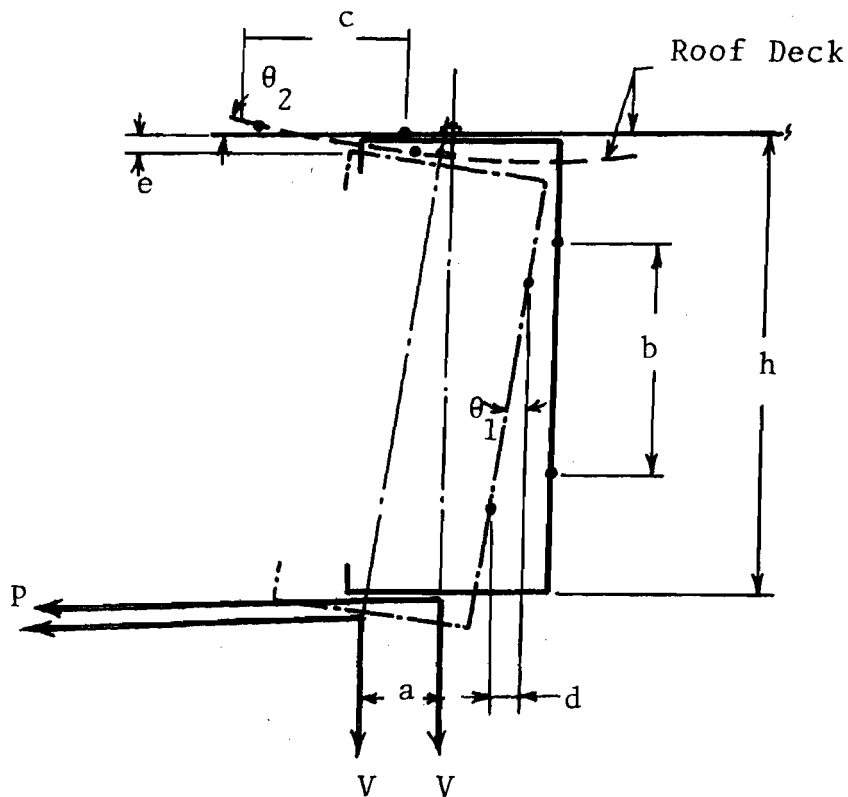


Fig. 57 Determination of Rotational Stiffness, F.

Notation: h = Depth of Purlin ; a = Horizontal displ. of Vertical Load V

b = Distance between dial gages on web of purlin

d = Relative horiz. movement of gages on web of purlin

c = Distance between the dial gages on the roof deck

e = Relative vert. disp. of dial gages on the roof deck

$$M = Ph + Va$$

$$\theta = \theta_1 - \theta_2, \text{ where } \theta_1 = \frac{d}{b} \text{ and } \theta_2 = \frac{a}{e}$$

$$F = \frac{M/w}{\theta}$$

where w = Distance between the screws.

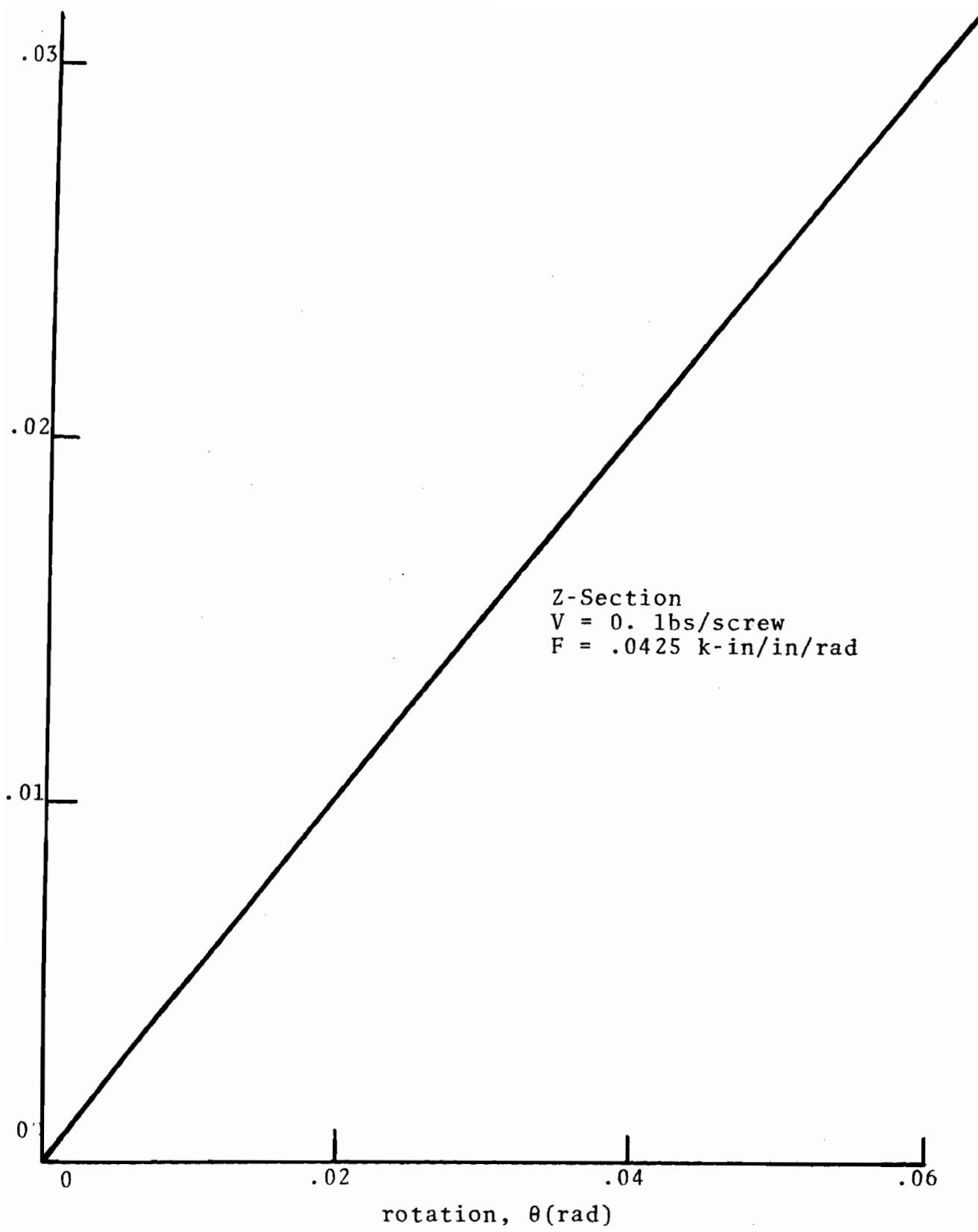


Fig. 58 Plot for Determining Rotational Restraint, F

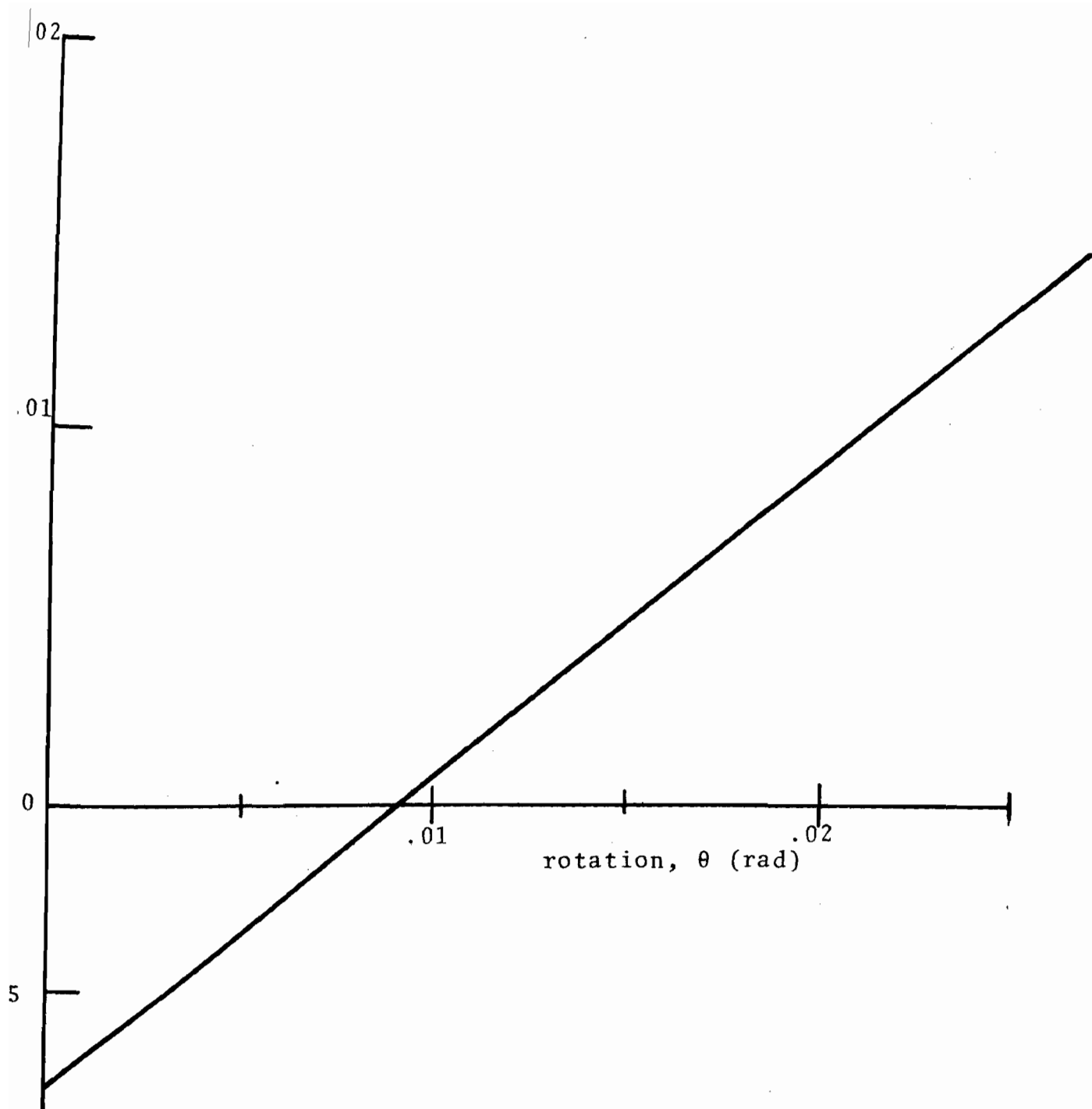


Fig. 59 Plot for Determining Rotational Restraint, F

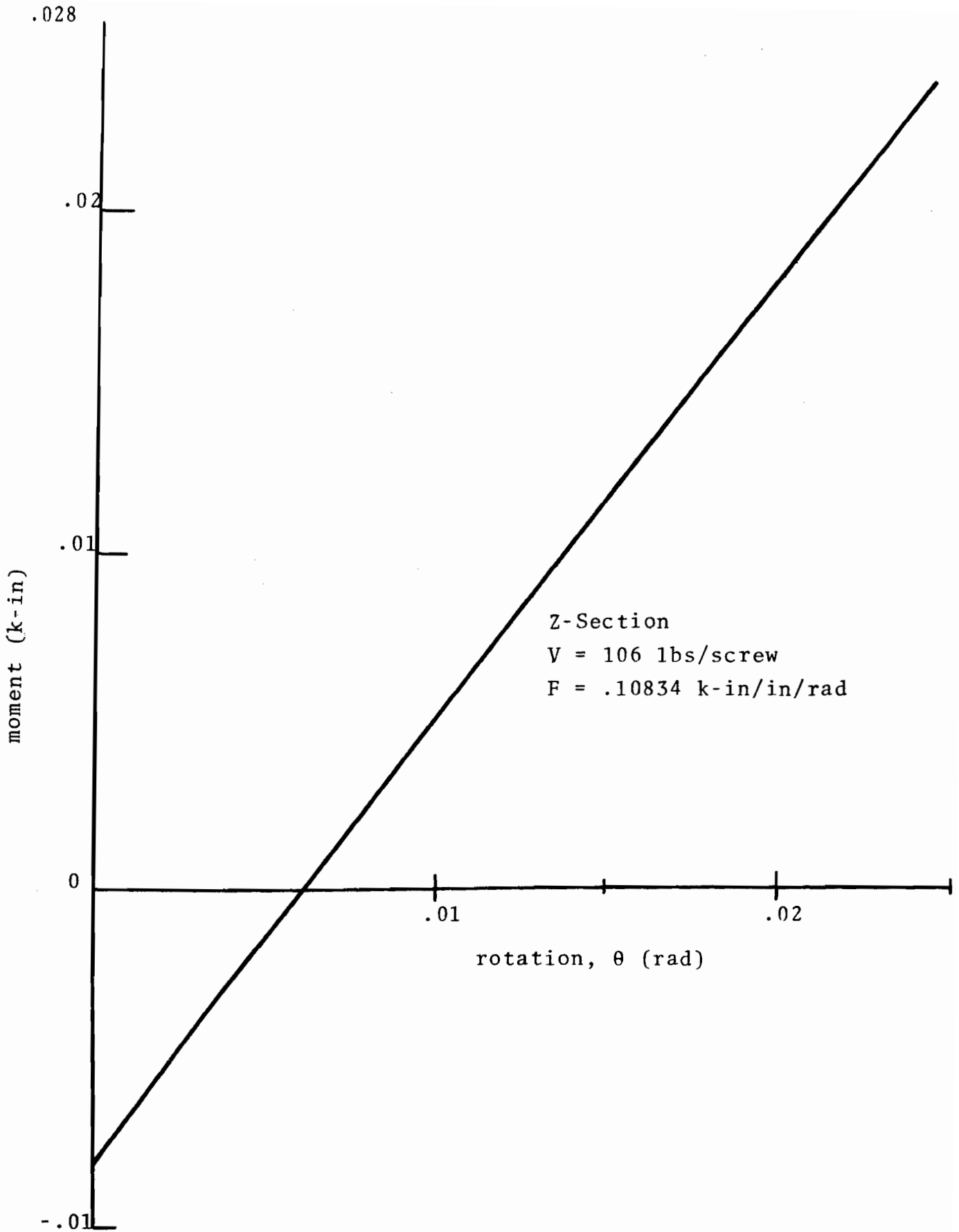


Fig. 60 Plot for Determining Rotational Restraint F

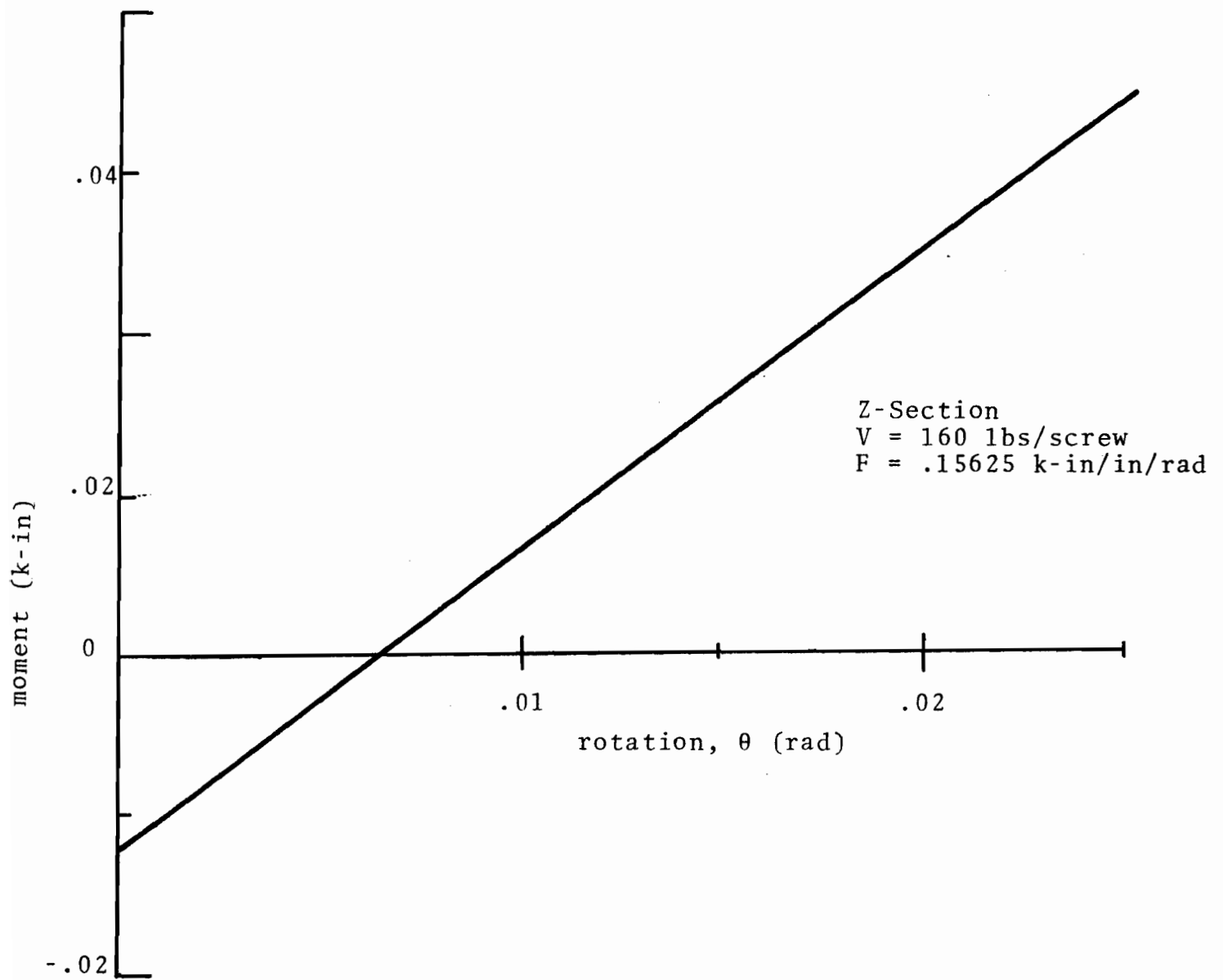


Fig. 61 Plot for Determining Rotational Restraint F

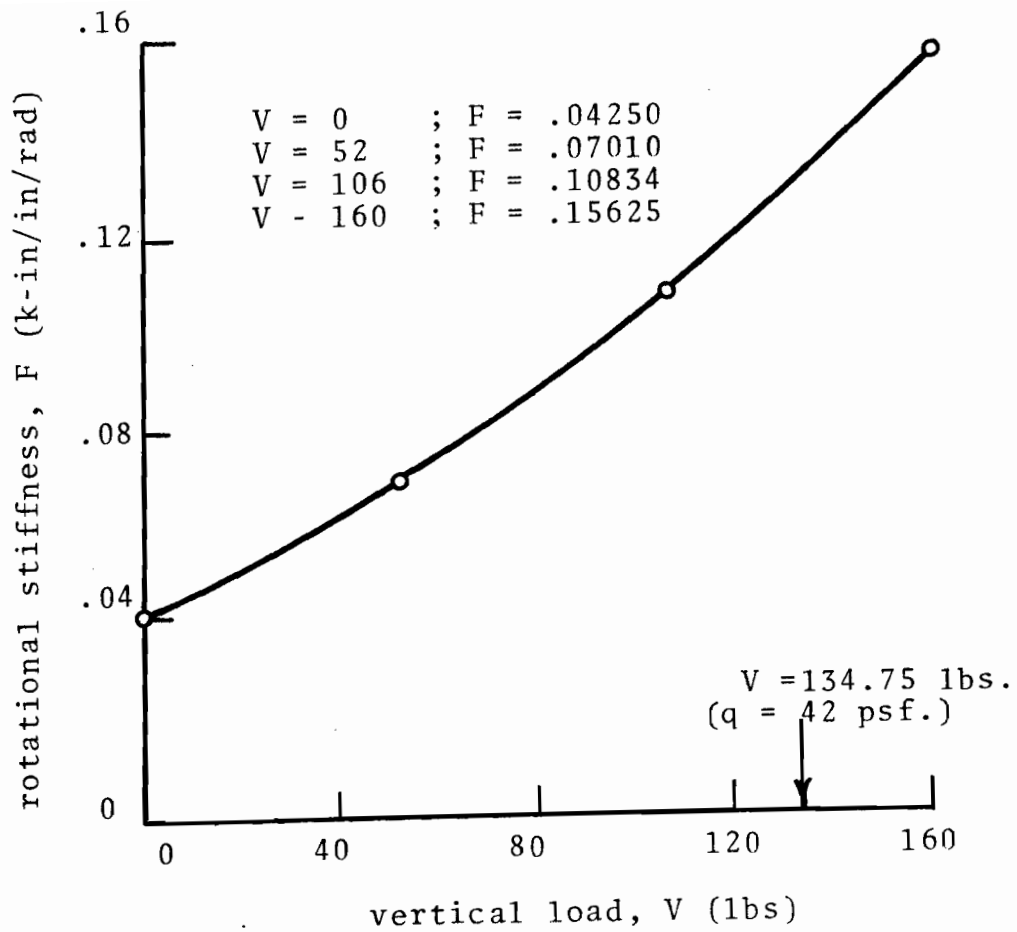


Fig. 62 F versus V

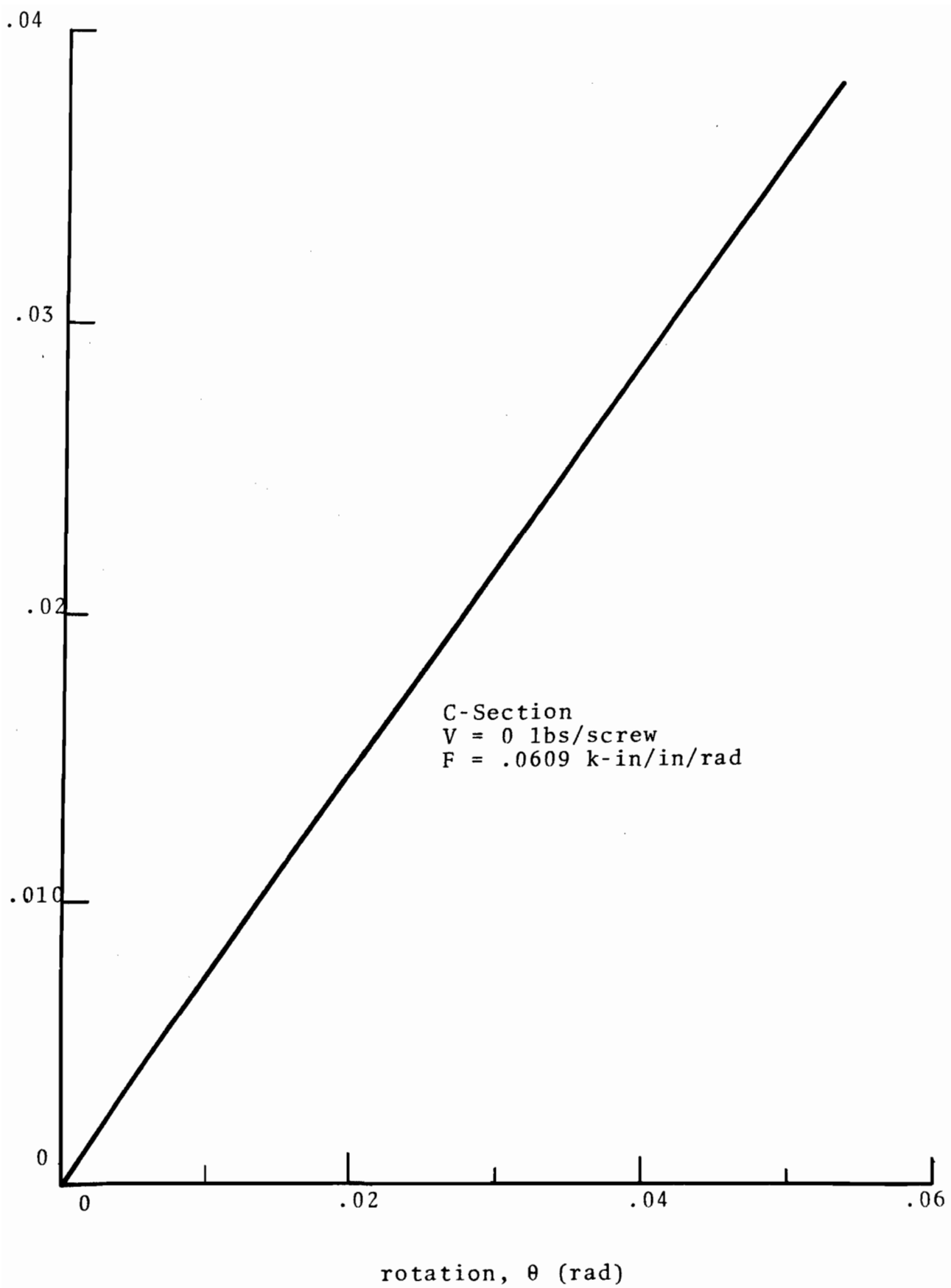


Fig. 63 Plot for Determining Rotational Restraint F

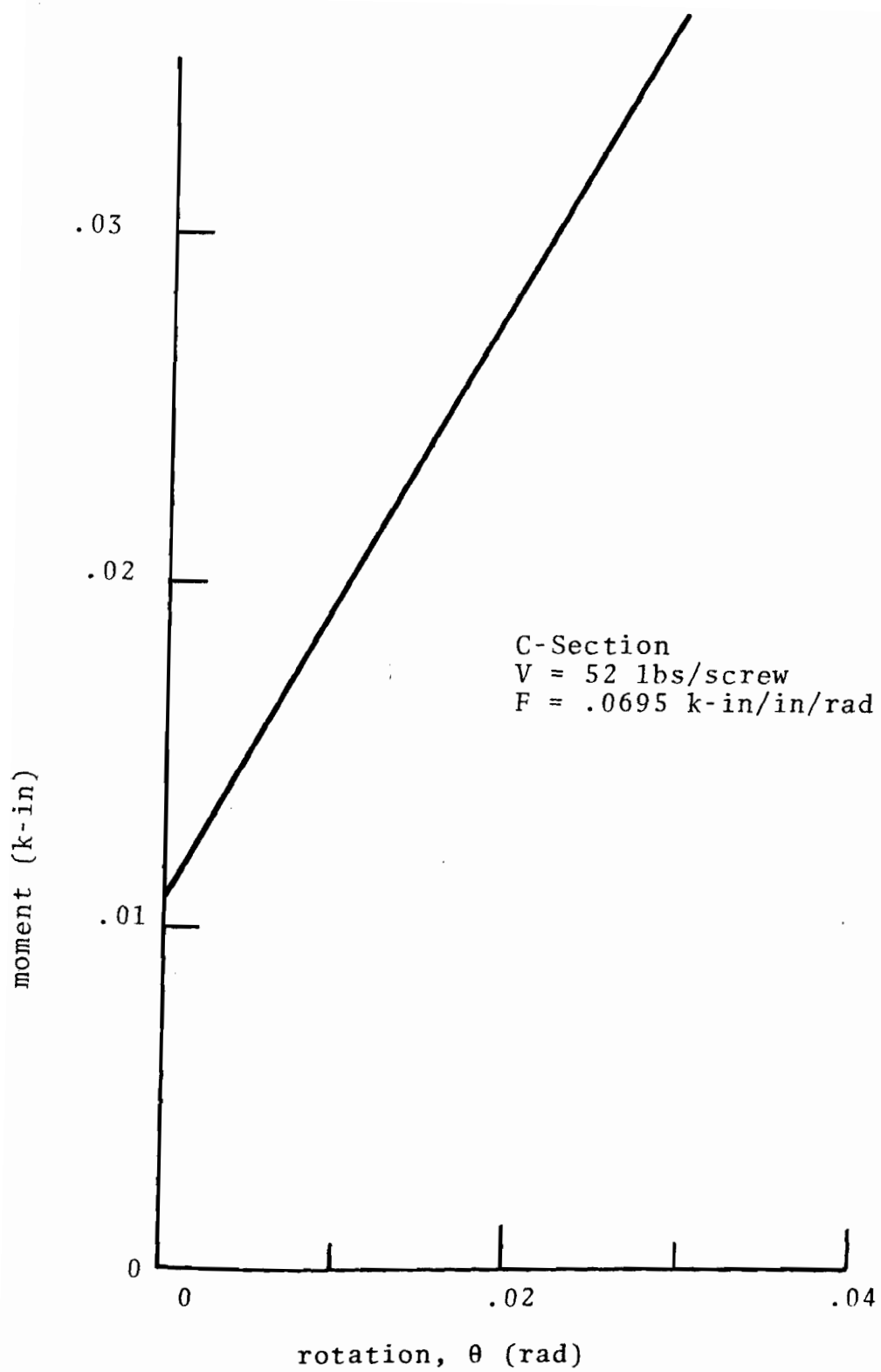


Fig. 64 Plot for Determining Rotational Restraint F

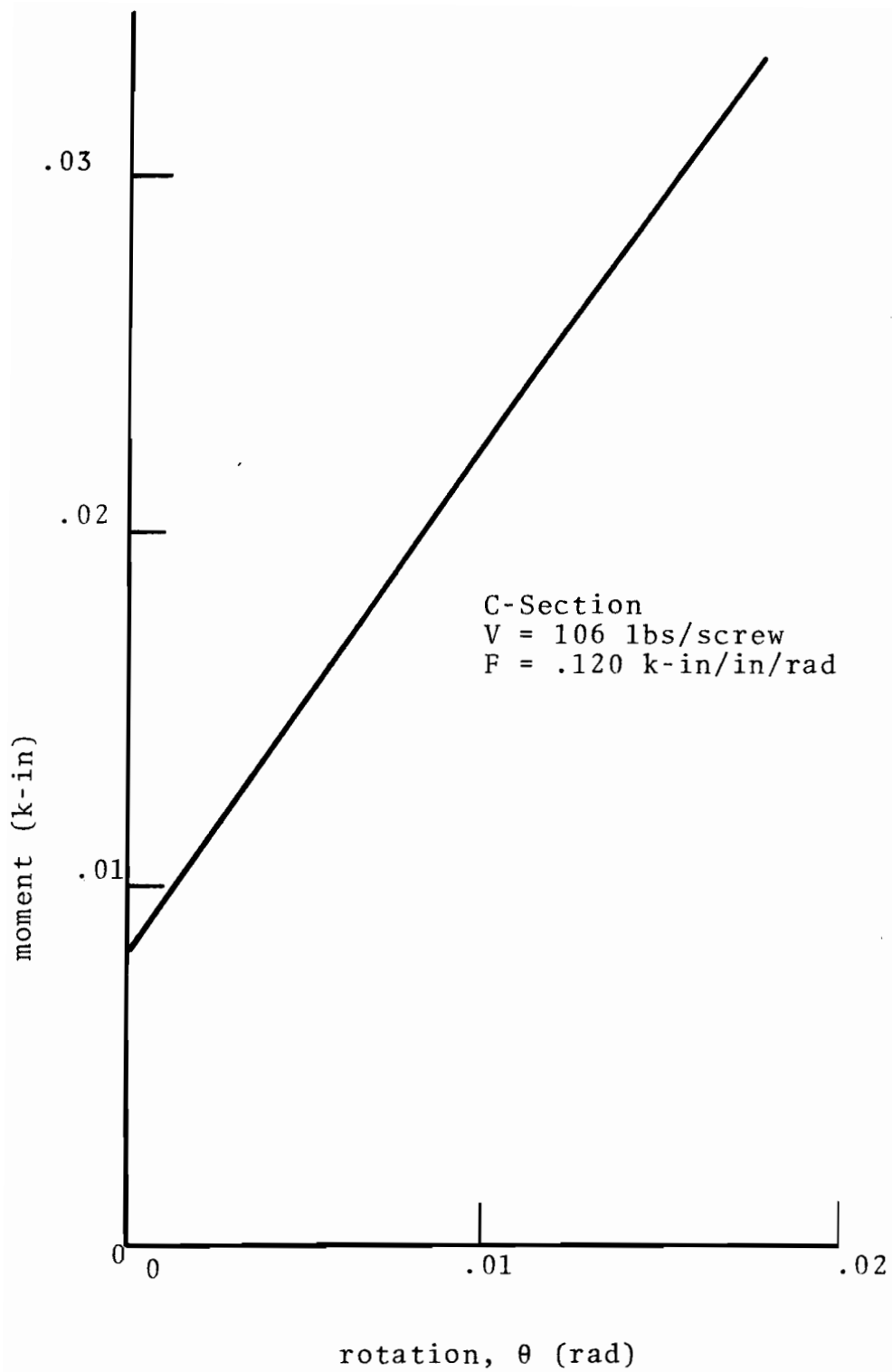


Fig. 65 Plot for Determining Rotational Restraint F

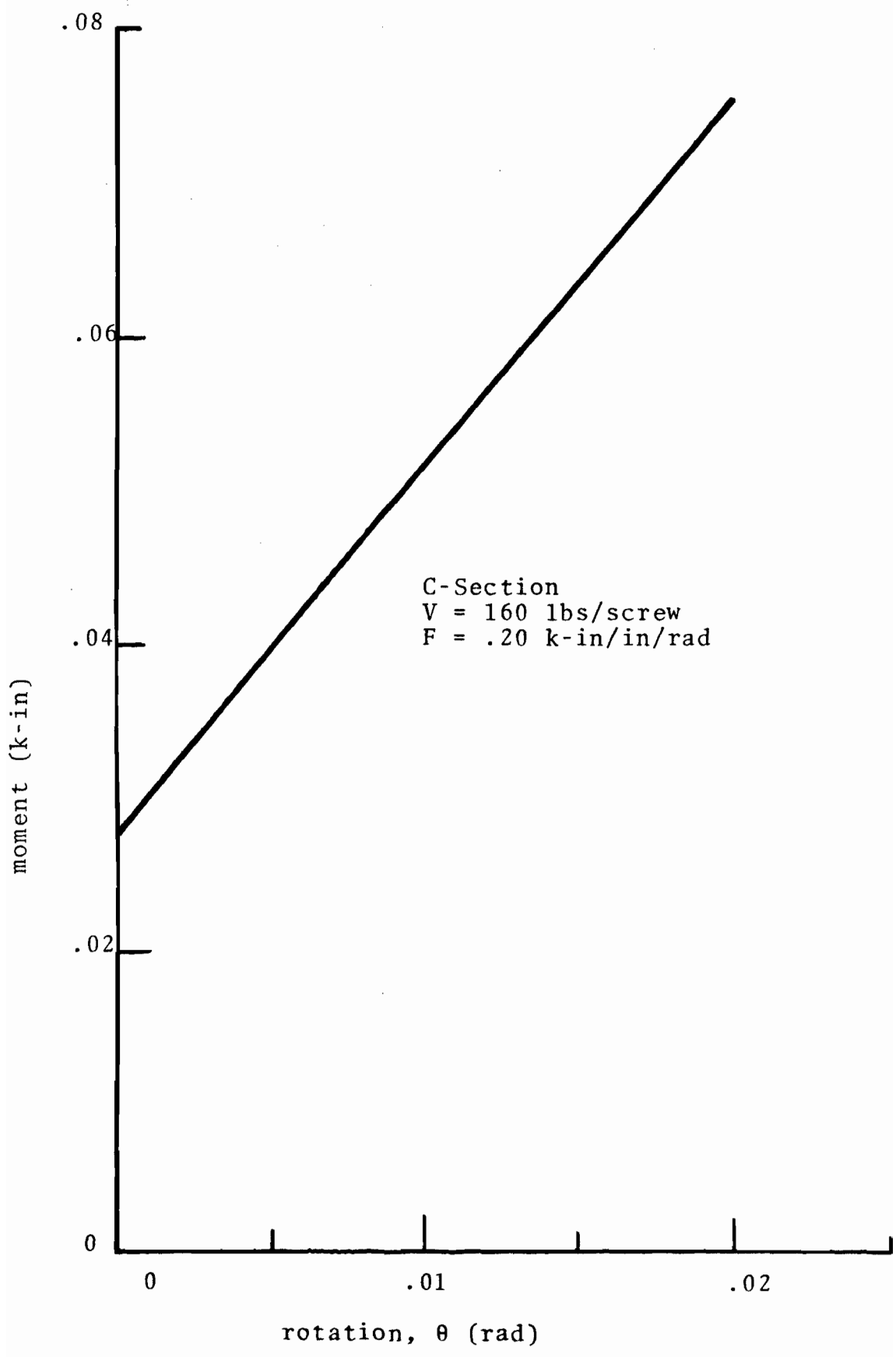


Fig. 66 Plot for Determining Rotational Restraint F

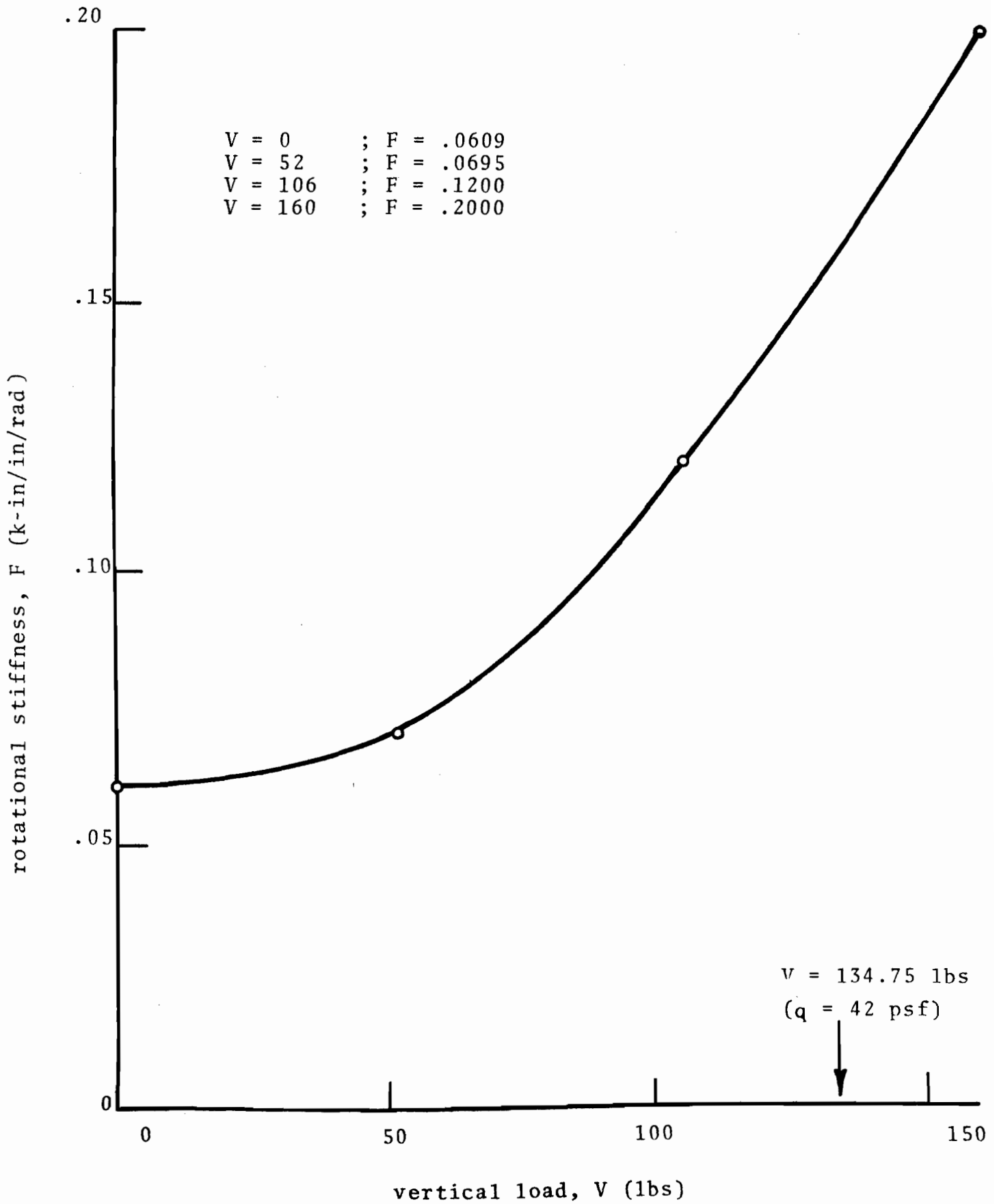
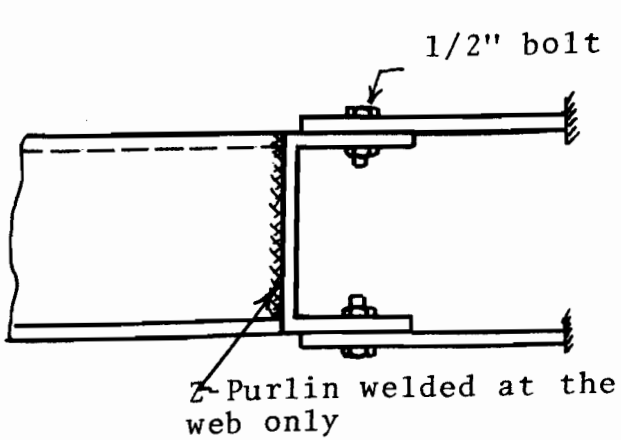
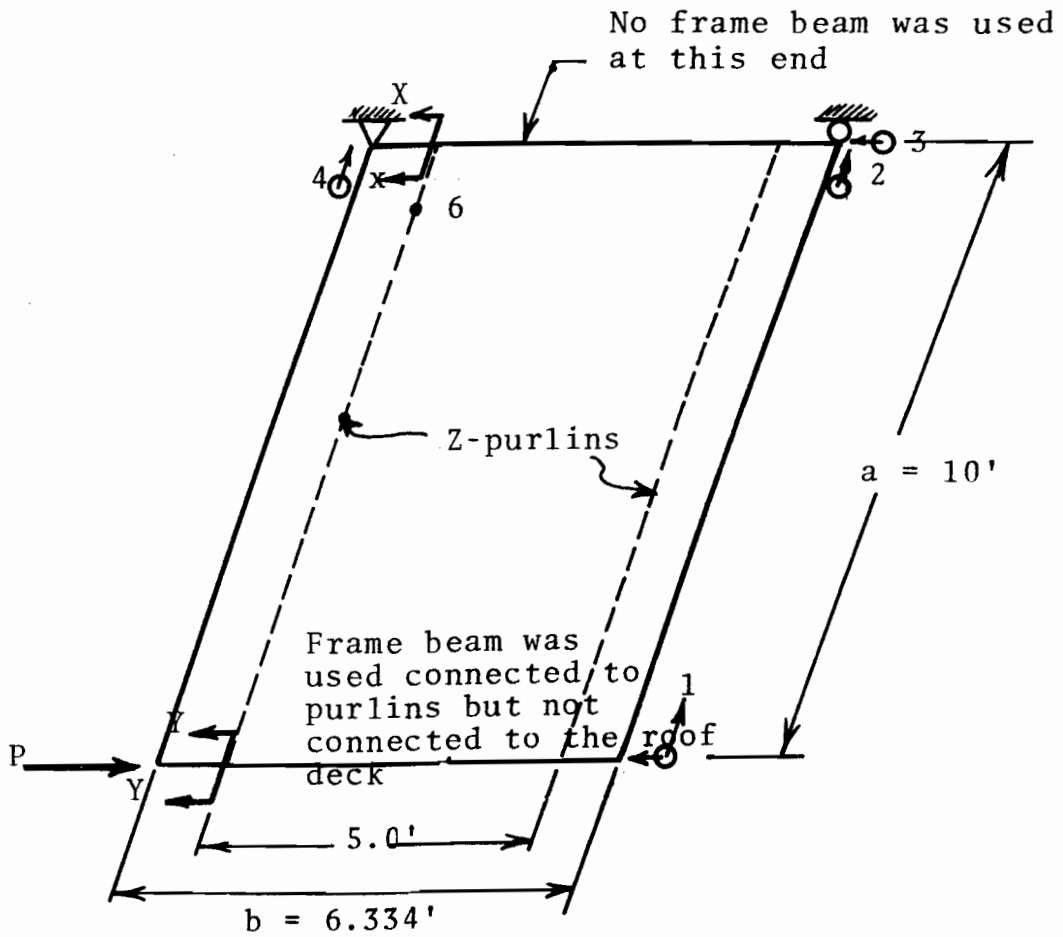
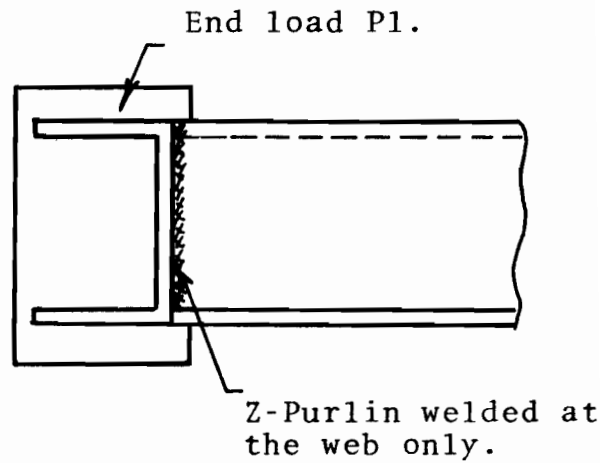


Fig. 67 F Versus V

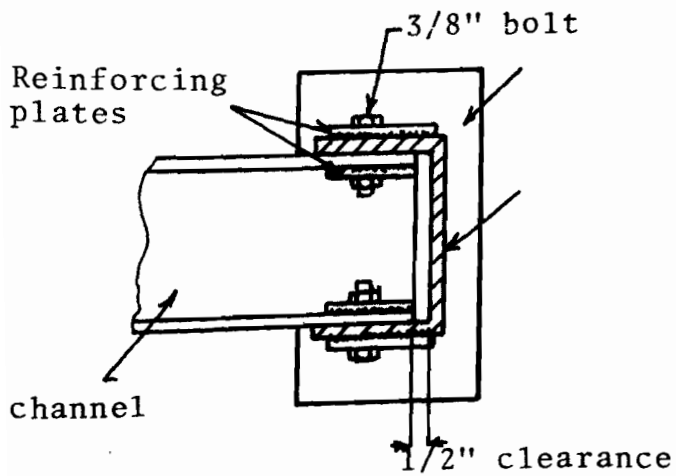
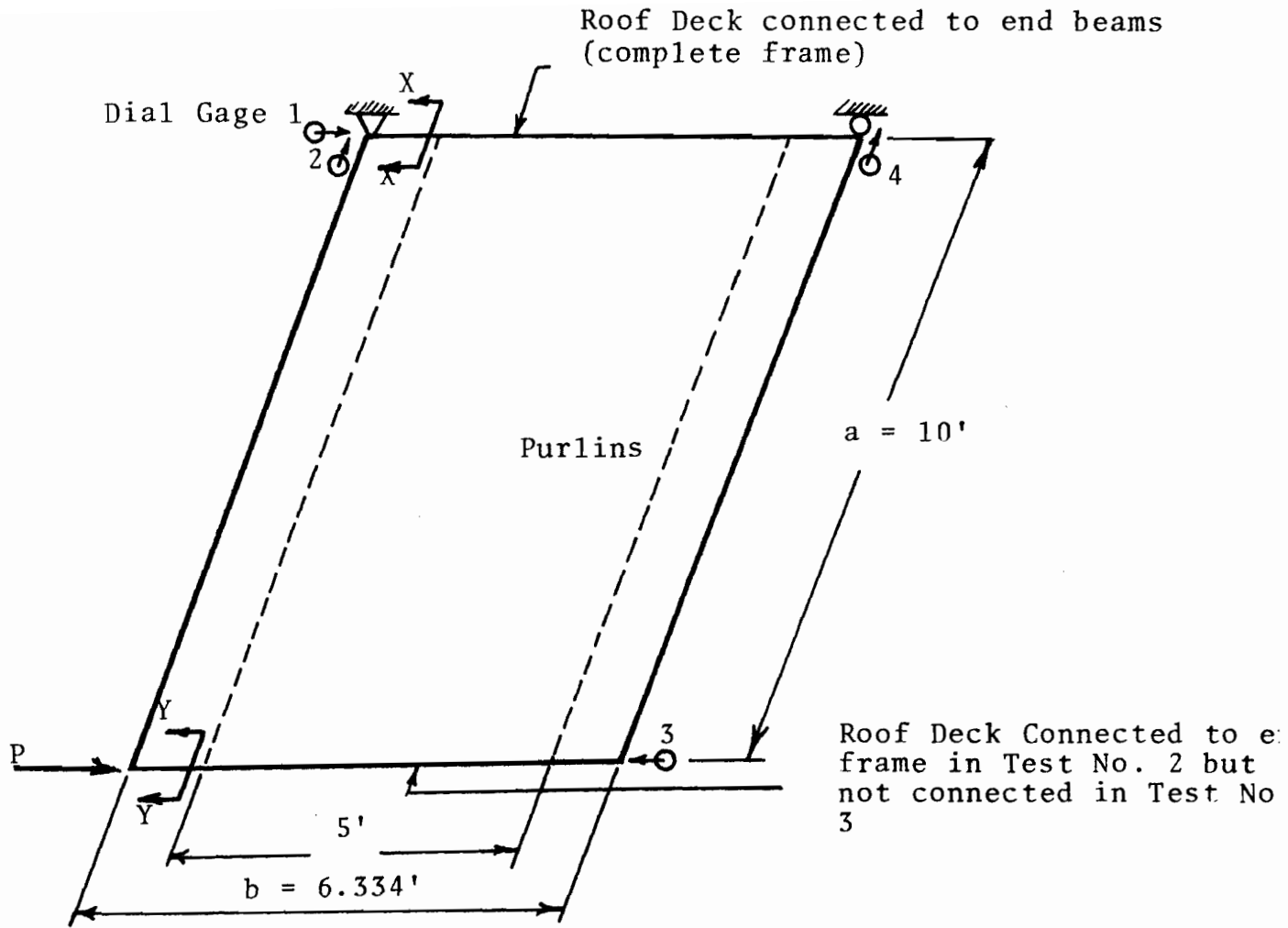


Section X-X

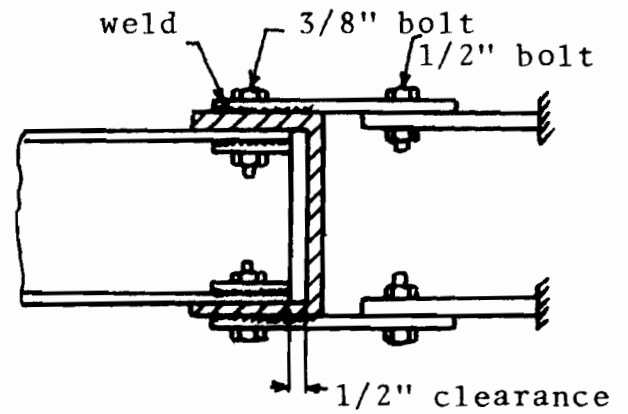


Section Y-Y

Fig. 68 Test Set-up for Determining Q - Test No. 1



Section Y-Y



Section X-X

Fig. 69 Test Set-up for Determining Q - Test No. 2 and 3

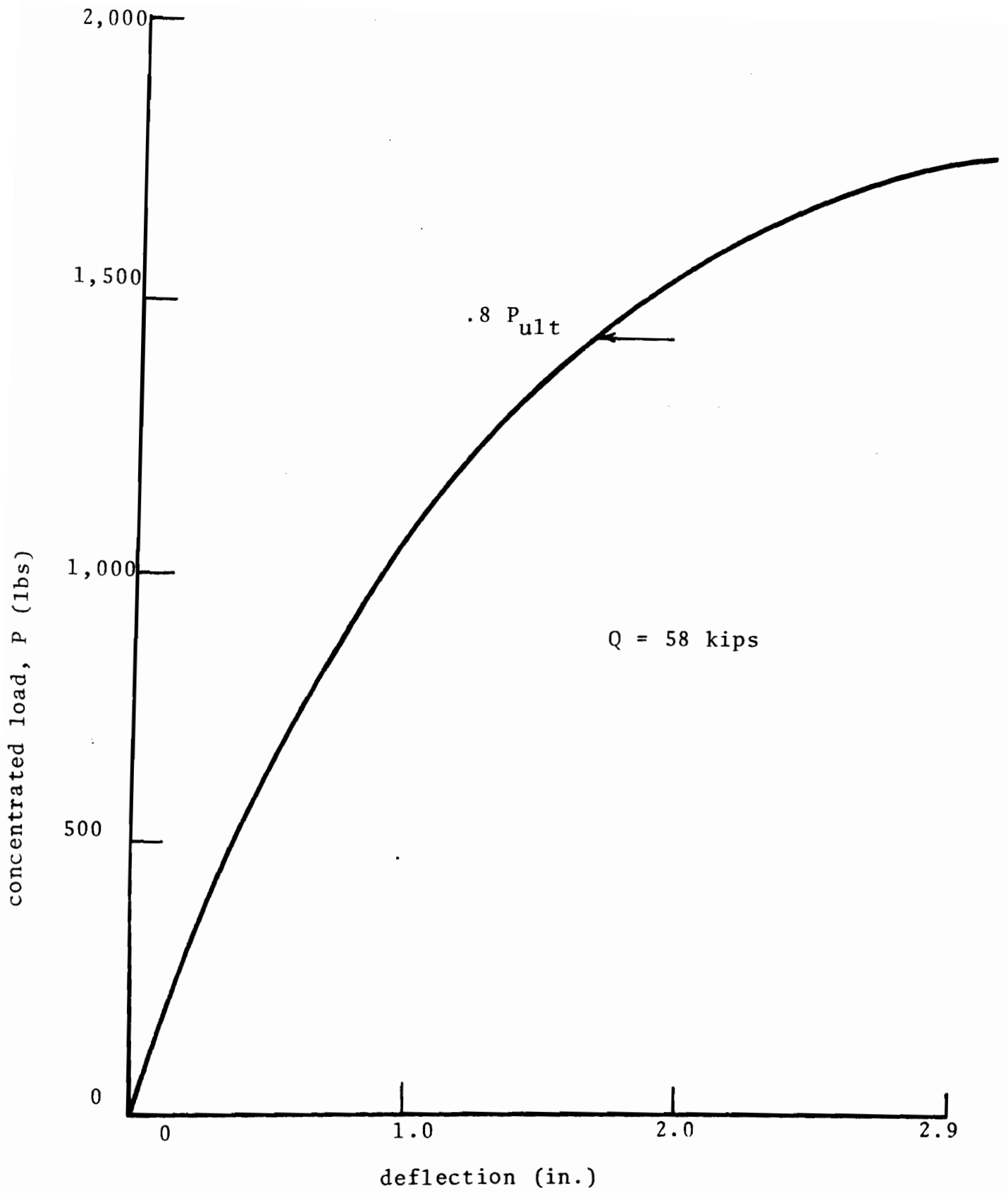


Fig. 70 Determination of Q - Test No. 1

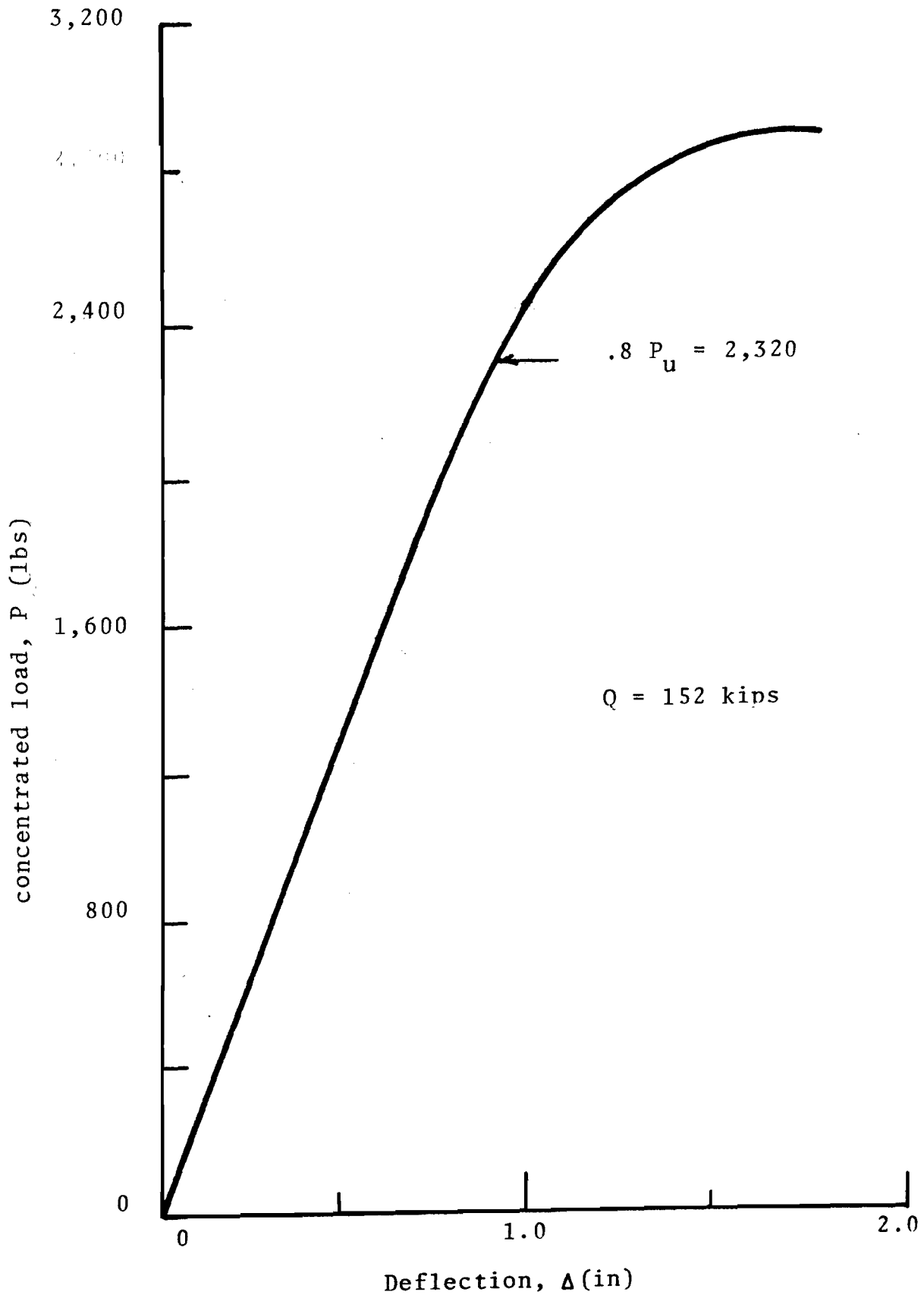


Fig. 71 Determination of Q - Test No. 2

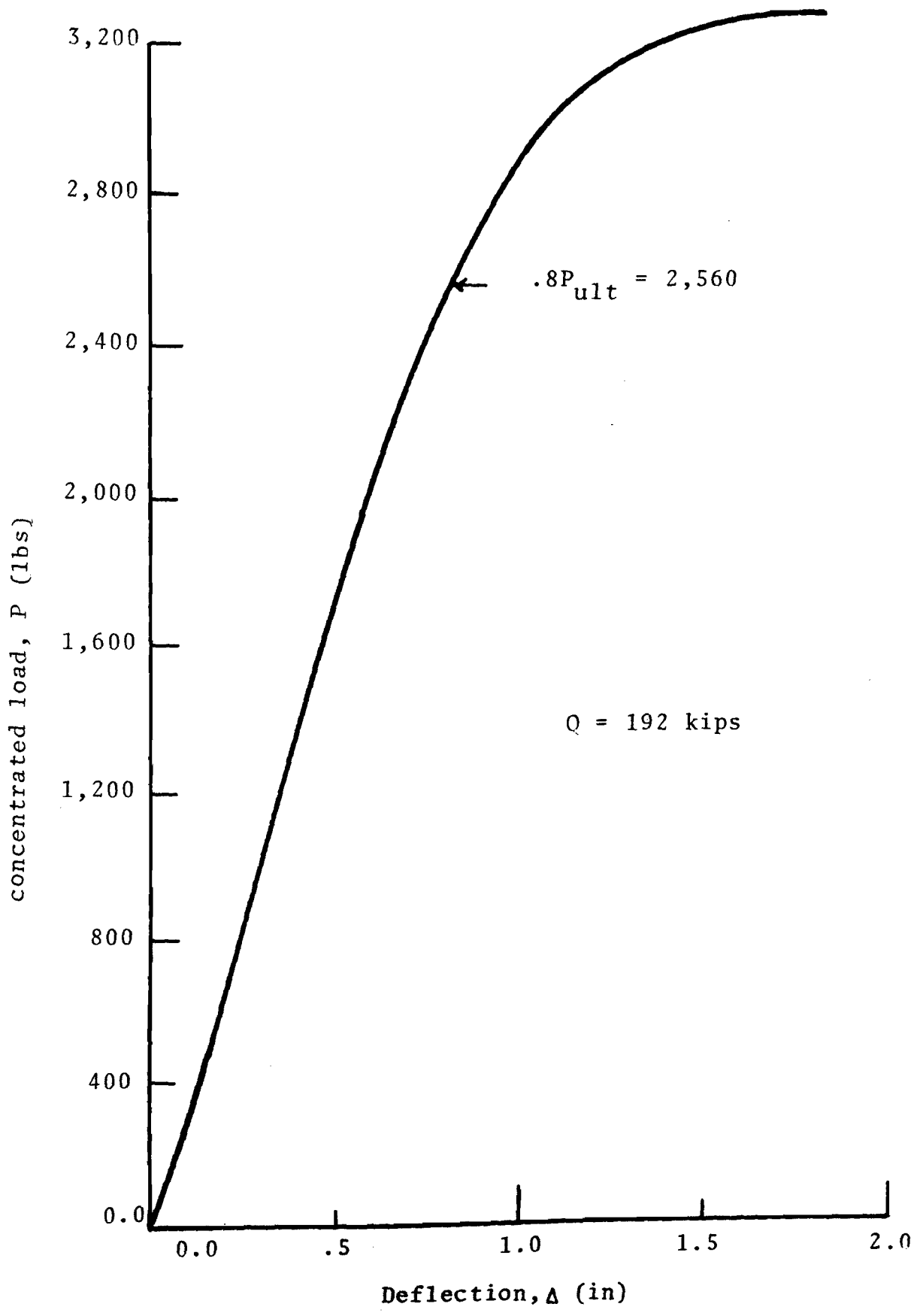


Fig. 72 Determination of Q-Test No. 3

DIAL GAGE RDGS ($\times 10^{-3}$) AND u, v (in.)

Load (psf)	1	v_1	2	v_2	3	v_3	5	v_5	6	v_6	u_6-u_5	4	v_4	7	v_7	8	v_8	u_8-u_7	9	v_9	11	u_{11}	12	u_{12}	$u_{12}-u_{11}$
0	910	-	177	-	079	-	398	-	101	-	-	316	-	262	-	290	-	-	781	-	780	-	692	-	-
6	899	.011	175	.012	393	.314	351	.047	285	.116	.069	409	.133	320	.058	447	.157	.099	744	.057	780	0	700	+.008	.038
12	829	.021	165	.022	695	.616	310	.088	158	.293	.155	765	.449	398	.136	644	.354	.218	729	.552	787	0	698	+.006	.656
18	873	.021	152	.035	1045 (114)	.966	231	.167	058 (1.05)	.363	.196	206 (1.13)	(.49)	523	.261	916	.626	.365	708	.073	780	0	687	-.005	.005
24	861	.049	141	.046	532	1.384	589	.756	522	.506	.750	883	1.130	272	.356	692	1.037	.681	686	.095	710	0	683	-.009	.309
30	848	.062	143	.044	685	1.879	256	.589	032 (.57)	.966	.397	715	1.665	570	.574	1023	1.368	.794	665	.116	753	0	680	-.012	.302
36	826	.084	143	.044	-	-	-	-	-	-	-	-	-	940 (1.014)	-	-	-	-	635	.146	720	2	678	-.014	.014

	10	u_{10}	13	u_{13}	14	u_{14}	$u_{10}-u_{13}$	15	u_{15}	17	u_{17}	18	u_{18}	$u_{10}-u_{17}$	16	u_{16}	19	u_{19}	20	u_{20}	$u_{16}-u_{19}$	21	u_{21}	22	u_{22}
0	600	-	596	-	055	-	-	373	-	746	-	747	-	-	153	-	618	-	249	-	-	545	-	021	-
6	584	.014	594	.002	055	0	-.002	337	.014	748	+.002	747	+.002	.00	193	.041	640	.022	303	.054	.032	526	.019	004	.017
12	571	.029	594	.002	055	0	-.002	408	.035	742	-.004	741	-.006	-.002	222	.049	665	.047	361	.112	.065	510	.055	-010	.027
18	554	.046	596	.000	100	.005	.005	453	.080	735	-.011	732	-.015	-.004	265	.112	699	.081	421	.172	.011	496	.049	-031	.048
24	543	.057	596	.000	100	.005	.005	464	.091	746	+.000	739	-.013	-.003	286	.133	720	.102	475	.222	.120	473	.078	-047	.064
30	520	.080	596	.000	100	.005	.005	476	.103	750	+.004	736	-.011	-.007	297	.144	740	.122	528	.275	.153	454	.091	-064	.081
36	495	.105	593	.013	099	.004	.001	282	-.090	778	+.032	761	-.014	-.018	047	.106	756	.138	562	.309	.171	425	.120	-073	.110

	23	u_{23}	25	u_{25}	26	u_{26}	$u_{23}-u_{26}$	24	u_{24}	27	u_{27}	28	u_{28}	$u_{23}-u_{27}$
0	332	-	498	-	408	-	-	224	-	382	-	384	-	-
6	640	.308	499	+.001	408	.00	.00	523	.299	451	.069	722	.138	.069
12	956	.624	499	+.001	408	.00	.00	824	.600	547	.165	722	.138	.173
18	537	1.140	490	-.008	128	.280	.272	403	930	425	.208	574	.619	.311
24	834	1.335	485	-.013	799	.419	.406	726	1.253	604	.487	913	.978	.491
30	885	1.792	478	-.024	534	.678	.654	737	1.799	895	.778	1079	1.144	.366
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- * NEW ZERO READING
- † GAGES GONE, NO RDGS TAKEN
- (1) LIMIT OF GAGE'S REACHED, ∴ RDG IS NOT EXACT.
- © ASSUMED VALUE

AT FAILURE (WHICH WAS AT ABOUT 40 psf) DIAPHRAGM TOUCHED THE 2X6 SPACERS WHICH WERE ORIGINALLY 6" BELOW THE SHEET METAL.

ROTATIONS & THE HORIZONTAL DISPLACEMENTS OF MIDDLE OF WEB

Load	u_5	u_6	$u_5 - u_6$	tan θ	u_m	u_7	u_8	$u_7 - u_8$	tan θ	u_m	u_{11}	u_{12}	$u_{11} - u_{12}$	tan θ	u_m	u_{13}	u_{14}	$u_{13} - u_{14}$	tan θ	u_m
0	.047	.116	.069	.01725	.0815	.058	.157	.099	.02475	.1075	.00	.008	.008	.0020	.004	.002	.00	-.002	-.0005	-.001
12	.088	.243	.155	.03875	.1655	.136	.354	.218	.0545	.245	.00	.016	.006	.015	.003	.002	.10	-.002	+.002	-.001
18	.167	.363	.196	.049	.265	.261	.626	.365	.09125	.4435	.00	-.005	-.005	-.0025	-.0025	.040	.005	.005	.00125	.0025
24	.256	.506	.250	.0625	.381	.356	1.037	.681	.17025	.6965	.00	-.009	-.009	-.00225	-.0045	.000	.005	.005	.00125	.0025
30	.589	.986	.397	.09925	.7875	.574	1.368	.794	.1985	.9710	.00	-.012	-.012	-.0030	-.0060	.000	.005	.005	.00125	.0025
36	-	-	-	-	-	-	-	-	-	-	.00	-.014	-.014	-.0035	-.0070	.003	.009	.006	.00025	.005

Load	u_{11}	u_{12}	$u_{11} - u_{12}$	tan θ	u_m	u_{19}	u_{20}	$u_{19} - u_{20}$	tan θ	u_m	u_{25}	u_{26}	$u_{25} - u_{26}$	tan θ	u_m	u_{27}	u_{28}	$u_{27} - u_{28}$	tan θ	u_m
6	+.002	+.002	.000	.00	-.002	.022	.054	.032	.0080	.038	.001	.00	.001	.00025	.0005	.069	.138	.069	.01725	.1035
12	-.004	-.006	.002	.005	.005	.047	.112	.065	.01625	.0795	.001	.00	.001	.00025	.0005	.165	.338	.173	.04325	.2515
18	-.011	-.015	.004	.010	.013	.071	.172	.101	.02275	.1265	-.008	.280	.272	-.008	-.144	.308	.619	.311	.07175	.2635
24	-.001	-.013	.013	.0325	.0065	.102	.222	.120	.020	.162	-.013	.419	.406	-.013	-.216	.487	.978	.491	.12275	.7325
30	+.004	.011	.015	.00375	.0035	.122	.275	.153	.03825	.1985	-.024	.678	.654	-.024	-.351	.778	1.144	.366	.0915	.961
36	+.032	.014	.046	.0115	-.009	.138	.309	.171	.04275	.2235	-	-	-	-	-	-	-	-	-	-

Note: (+) sign indicates that rotations & the horizontal displacements are opposite to those shown on the "dial gage locations" diagram.

YES: (1) $E = 30 \times 10^6$ psi ; (2) (-) indicates that the gage rdg decreases $[\text{STRESS} = \frac{\text{Gage Rdg}}{1,000,000} \times 30 \times 10^3]$

FINAL TEST (Z-SECTION, NO BRACE, MIDSPAN)

STRAIN GAGE RDGS ($\mu\text{in/in}$) AND STRESSES (ksi)

P/RF	RDG		STRESS		END SPAN (10' from exterior supports)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14				
0	3292 +	3287 +	3294 -	3464 -	4984 -	4952 -	4947 -	4945 +	4962 +	4942 -	4970 -	4965 -	4982 +	4948 +				
6	3325 2.79	3470 5.43	3121 5.19	3369 2.85	4720 -1.92	4826 -1.98	4750 5.91	5290 4.35	5074 3.96	4875 -2.01	4905 -1.95	4820 4.35	5135 4.59	5037 4.00				
12	3467 5.25	3648 10.77	2948 10.38	3280 5.52	4902 -2.46	4870 -2.46	4600 10.41	5270 9.75	5253 8.73	4851 -2.73	4873 -2.91	4678 8.61	5280 8.94	5240 8.7				
18	3525 6.99	3818 15.97	2786 15.20	3221 7.29	4955 -0.97	4918 -1.02	4395 16.56	5442 14.91	5400 13.14	4893 -1.62	4913 -1.71	4538 12.81	5433 13.52	5323 12.9				
24	3600 9.24	4408 21.57	2602 10.76	3134 9.97	5069 +2.55	5053 +3.03	4155 23.76	5641 20.89	5568 18.18	5025 +1.89	5033 +1.89	4358 18.21	5607 18.75	5520 15.0				
30	3662 11.10	4196 27.21	2416 26.34	3054 12.30	5300 +9.43	5305 +10.59	3877 32.10	5864 27.57	5720 22.74	5268 +9.78	5307 +10.11	4120 25.35	5770 24.24	5636 20.0				
36	3810 15.54	4520 37.23	2007 38.61	2929 16.20	6420 +43.09	6645 +50.79	2725 66.66	6295 40.57	5725 22.89	5984 +31.26	6048 +32.34	3514 43.53	6075 32.79	5620 26.0				

P/RF	MIDDLE SPAN (4')															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
0	3534 +	3270 +	4336 -	3276 -	3336 +	3275 -	3304 -	4862 -	4893 -	7397 -	7443 +	7422 +	7420 +	7389 +		
6	3385 1.53	3462 5.76	3176 4.8	3150 3.78	3358 .66	3158 3.51	3255 1.47	4852 -0.30	4881 -0.36	7333 1.92	7500 1.71	7451 .87	7505 2.55	7575 5.5		
12	3430 2.88	3650 11.40	3032 9.12	3030 7.38	3379 1.29	3046 6.87	3214 2.70	4850 -0.36	4876 -.51	7280 3.51	7544 3.03	7480 1.74	7576 4.68	7744 10.6		
18	3481 4.41	3844 17.22	2876 13.80	2902 11.22	3455 3.57	2926 10.47	3180 3.72	4852 -0.30	4877 -.48	7225 5.16	7594 4.53	7515 2.79	7633 6.39	7926 16.1		
24	3530 5.83	4064 23.82	2699 19.11	2767 15.27	3516 5.60	2765 15.30	3117 5.61	4856 -0.18	4882 -.33	7169 6.84	7644 6.03	7546 3.72	7707 8.61	8120 21.9		
30	3584 7.53	4287 30.51	2507 24.97	2632 19.32	3822 8.58	2590 20.55	3060 7.32	4866 +0.12	4889 -.12	7125 8.16	7680 7.11	7587 4.35	7768 10.44	8273 27.1		
36	3640 9.18	4596 39.78	2210 33.78	2424 25.56	3784 13.44	2337 28.14	2966 10.14	4910 +1.44	4934 +1.23	7152 7.35	7652 6.27	7540 3.54	7920 15.00	8552 34.3		

P/RF	END SPAN (10' from exterior supports)									
	29	30	31	32	33	34	35	36	37	38
0	7419 -	7420 -	1085 +	4907 -	4920 -	5299 +	4902 +	4905 -	7397 -	7382 -
6	7252 5.01	7295 3.75	1110 .75	4804 3.09	4889 .93	5154 1.65	5093 5.88	4735 5.10	7273 3.72	7196 5.58
12	7104 9.45	7190 6.90	1139 1.62	4704 6.09	4858 1.86	5194 2.85	5290 11.64	4579 9.78	7148 7.47	7015 11.01
18	6956 13.89	7101 9.57	1226 4.23	4572 10.05	4825 2.85	5263 5.07	5453 16.53	4446 13.77	7024 11.19	6801 17.43
24	6794 18.75	6995 12.75	1267 5.46	4447 13.82	4787 4.08	5303 6.21	5651 22.47	4283 18.51	6897 15.00	6543 25.17
30	6654 22.95	6913 15.21	1294 6.27	4365 16.26	4762 4.74	5304 6.15	5854 28.56	4149 22.68	6800 17.91	6181 36.03
36	6424 29.85	6785 19.05	1416 9.93	4235 20.16	4722 5.94	5307 6.24	6174 38.16	3918 27.61	6633 22.77	5396 59.58

FAILURE AT ABOUT 40 psf

APPENDIX A - Test data for First Z-Section Purlin Assembly

Notes: (1) $E = 29,000 \text{ psi}$
 (2) Stresses = Gage Rdy. x .83 (ksi)

STRAIN GAGE READINGS ($\mu\epsilon$ in/in) AND STRESSES (ksi)

X (in)	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0	4557 +	5385 -	3497 -	4388 -	7312 -	8559 +	6613 (+,-)	6326 +	8435 +	6362 -	7112 +	6812 (+,-)	7246 +	6718 +
3	4666 3.27	5379 0.18	3479 0.54	4358 0.99	7238 2.22	8745 11.58	6588 -.75	6397 .33	8540 3.15	6288 2.22	7160 1.44	6745 -.51	7324 2.34	7045 2.31
6	4727 5.10	5353 1.56	3452 1.35	4335 1.59	7158 4.62	8895 18.08	6637 2.22	6514 3.84	8588 4.59	6210 4.56	7146 1.02	6841 .87	7358 3.36	7120 3.20
9	4815 7.74	5307 2.34	3426 2.13	4265 3.69	7092 6.60	8850 8.73	6612 -.03	-	-	-	-	-	-	-
12	4857 9.00	5286 2.97	3406 2.73	4223 4.95	6999 9.39	8663 3.12	6704 2.73	6553 5.01	8675 7.20	6124 7.14	7156 1.32	6897 -.15	7518 8.16	7200 2.54
15	4927 11.10	5267 3.54	3375 3.66	4196 5.76	6923 11.67	8706 4.41	6584 -.87	6635 7.47	8778 10.29	6054 9.12	7140 .84	6834 .66	7503 7.71	7207 2.13
18	4974 12.51	5261 3.72	3376 3.63	4165 6.69	6883 12.87	8682 3.69	6755 4.26	6740 10.02	8880 13.35	5927 13.05	7168 1.68	6999 2.64	7630 11.52	7450 2.24
21	5016 14.07	5215 3.30	3370 3.81	4135 7.59	6843 14.67	8615 4.08	6613 0.0	6825 13.17	9341 18.18	5859 15.09	7168 1.68	6848 1.08	7076 13.50	7450 2.24
24	5084 15.81	5265 3.60	3328 5.07	4082 9.18	6728 17.52	8679 3.62	6625 .36	6892 15.18	9066 18.93	5785 17.31	7164 1.56	6839 .81	7740 13.82	7450 2.24
27	5132 17.25	5237 4.44	3312 5.55	4049 10.17	6663 19.47	8102 4.29	6631 .54	6939 16.59	9041 19.68	5726 19.08	7178 1.98	6854 1.26	7796 13.20	7450 2.24
30	5197 19.10	5221 4.92	3285 6.36	4035 11.49	6570 22.26	8852 8.79	6639 .78	7041 19.65	9174 22.17	5607 22.65	7199 2.61	6869 1.71	7874 19.44	7450 2.24
33	5254 20.91	5206 5.37	3268 8.27	3962 12.78	6486 24.76	8767 6.24	6711 2.94	7157 23.13	9238 24.01	5543 24.57	7237 3.75	6908 2.38	7949 21.09	7450 2.24
36	5344 23.61	5189 5.88	3235 10.26	3913 14.25	6385 27.81	8892 7.97	6751 4.14	7175 23.67	9334 26.97	5453 27.27	7297 5.55	6911 5.37	8236 23.10	7450 2.24
39	5404 25.41	5181 6.12	3195 11.06	3851 15.81	6268 31.32	8940 11.43	6837 6.72	7275 26.67	9422 29.61	5376 29.58	7357 7.35	7046 7.02	8135 26.67	7450 2.24
0	4658 3.03	5387 +.12	3547 +1.5	4453 +.45	7298 .92	8818 7.71	6757 4.32	6738 1.56	8467 .96	6319 6.29	7302 5.7	6946 4.56	7320 2.24	7450 2.24

APPENDIX B - Test data for C-Section Purlin Assembly

NOTES: (1) $E = 29,100,000 \text{ psi}$
 (2) $\text{Stress} = \text{Gage Reading} \times .03 \text{ (ksi)}$

STRAIN GAGE READINGS ($\mu\text{in/in}$) AND STRESSES (ksi)

Point	27	30	31	32	33	34	35	36	37	38	39	40	41
0	4330 +	4286 (+,-)	3648 -	3377 -	4430 +	4385 (+,-)	5621 -	5385 -	6993 (+,-)	7775 +	6358 +	8159 (+,-)	817 +
3	4505 5.25	4510 +6.72	3635 .39	3206 5.13	4492 1.86	4361 -.72	5445 6.78	5334 1.53	7800 +.39	7247 2.16	6416 1.74	8162 +.09	2173 .73
6	4529 5.97	4243 -1.14	3588 1.80	3250 3.81	4585 4.65	4336 -1.47	5391 6.90	5266 3.57	6731 -1.86	7242 2.01	6608 7.50	8133 -.78	2162 1.53
9	-	4194 -2.76	3559 2.67	3097 8.40	4653 6.67	4305 -2.40	5311 9.30	5198 5.61	6297 -2.88	7911 4.02	6485 3.81	8125 -1.02	2194 2.31
12	4683 10.99	4196 -2.70	3533 3.45	2902 14.25	4715 8.55	4694 +1.27	5320 9.03	5153 6.96	6271 -3.66	7947 5.16	6521 4.89	8115 -1.32	2211 2.82
15	4674 10.32	4127 -2.97	3506 4.26	2861 15.48	4797 11.01	4972 +17.61	5218 12.09	5075 9.30	6234 -4.77	7969 5.82	6568 6.30	8084 -2.25	2234 3.51
18	4756 12.78	4158 -3.84	3496 4.56	3028 10.47	4865 13.05	4277 -3.24	5525 2.88	5026 10.77	6354 -4.17	2008 6.99	6605 7.41	8066 -2.79	2262 4.35
21	4839 15.27	4162 -3.72	3407 5.43	2826 16.53	4929 14.97	4266 -3.57	5158 13.89	4975 12.30	6195 -5.94	2060 8.55	6647 8.67	8094 -1.95	2222 5.95
24	4873 16.29	4164 -3.66	3425 6.69	2760 18.51	5020 17.70	4410 +.75	5165 13.65	4914 14.13	6743 -7.50	2072 8.91	6703 10.35	8043 -3.48	2318 6.03
27	4908 17.34	4194 -4.26	3411 7.11	2735 19.26	5067 19.17	4246 -4.17	5091 15.90	4862 15.69	6727 -7.98	8101 9.78	6668 9.30	8022 -4.11	2326 6.27
30	4985 17.59	4145 -4.23	3375 8.19	2683 20.82	5144 21.42	4235 -4.50	5003 16.74	4792 17.71	6678 -9.45	2145 11.10	6739 11.43	7990 -5.07	2351 7.02
33	5021 20.73	4123 -4.89	3354 8.82	2656 21.63	5202 23.16	4235 -4.50	5057 16.92	4744 19.23	6656 -10.11	8180 12.15	6793 13.05	7960 -5.97	2367 7.50
36	5086 22.68	4129 -4.71	3330 9.54	2617 22.80	5282 25.56	4226 -4.77	5114 15.21	4686 22.97	6628 -10.95	8215 13.20	6817 13.77	7929 -6.90	2385 8.04
39	5147 24.42	4119 -5.01	3296 10.56	2572 24.15	5366 28.08	4227 -4.74	5116 15.15	4618 23.01	6607 -11.52	8255 14.40	6850 15.00	7887 -8.16	2404 8.61
0	4239 -2.85	4222 -1.92	3678 +.90	3125 7.50	4440 0.30	4408 +.69	5568 1.59	5356 .87	6995 +.06	7820 1.35	6460 3.06	2084 -2.25	2427 3.00

↑
 IGNORED GAGE
 DEFECTIVE

APPENDIX B - Test data for C-Section Purlin Assembly

DIAL GAGE READINGS, δ , U and V (in.)

C-SECTION (FINAL TEST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	107	107	107	107	115	172	254	287	439	449	533	579	579	921	921
3	128	107	105	110	149	361	214	096	109	091	327	394	394	821	821
6	120	107	104	104	149	360	215	102	015	184	378	402	402	696	696
9	127	107	103	105	145	357	217	106	019	223	427	412	412	571	571
12	141	104	100	103	146	353	220	111	026	367	456	424	424	416	416
15	143	106	100	103	140	320	276	115	028	451	483	483	483	404	404
18	148	108	101	103	147	322	277	113	025	523	512	446	446	324	324
21	152	108	102	104	148	322	282	122	041	671	526	456	456	269	269
24	150	107	102	104	148	322	282	120	038	669	557	461	461	210	210
27	159	111	106	105	152	325	283	123	048	711	579	477	477	281	281
30	160	107	105	107	148	322	282	120	043	848	600	495	495	262	262
33	167	108	106	108	150	320	282	119	051	879	664	495	495	205	205
36	170	108	106	108	150	319	289	128	061	878	678	504	504	125	125
39	177	110	107	109	153	319	283	132	065	1004	703	510	510	131	131

0.0001 in.

Dial Gage Readings

J-Section (Final to

	15	16	17	18	19	20	21	22	23	24	25	26	27
	U ₁₅	V ₁₆	V ₁₇	V ₁₈	U ₁₉	U ₂₀	V ₂₁	U ₂₂	U ₂₃	V ₂₄	U ₂₅	U ₂₆	V ₂₇
0	589	659	44	119	489	282	867	342	074 (574)	030	213	427	075
3	562 .027	614 .155	4 .0.0	124 .005	398 .091	263 .019	210 .143	338 .024	068 .006	040 .010	290 .077	449 .022	108 .033
6	515 .074	781 .322	"	126 .007	213 .276	243 .039	366 .299	332 .010	065 .009	041 .011	367 .154	465 .038	135 .065
9	480 .119	692 .514	"	127 .008	506 .350	228 .054	544 .477	324 .018	060 .014	045 .015	400 .234	486 .059	168 .093
12	452 .137	716 .688	"	131 .012	351 .505	216 .066	668 .601	214 .028	052 .022	049 .019	464 .298	503 .076	197 .122
15	426 .163	896 .328	"	133 .014	295 .561	208 .074	831 .764	208 .034	047 .027	052 .022	544 .378	522 .095	233 .158
18	395 .194	437 .997	415 .001	137 .018	219 .637	190 .092	494 .914	191 .151	032 .042	080 .050	592 .426	528 .101	270 .195
21	376 .213	598 .1158	"	141 .022	184 .672	192 .090	662 .1082	176 .166	434 .140	065 .035	654 .488	548 .121	223 .248
24	367 .222	777 .1337	"	144 .025	191 .665	156 .126	822 .1242	172 .170	426 .148	065 .035	708 .542	581 .134	343 .268
27	355 .234	870 .1450	416 .002	147 .028	104 .752	185 .097	223 .1377	158 .184	415 .199	068 .038	710 .580	556 .137	376 .301
30	327 .262	353 .1706	"	151 .032	853 .803	120 .102	440 .1594	145 .197	405 .169	072 .062	479 .649	575 .156	414 .339
33	310 .279	509 .1862	"	154 .035	328 .847	173 .109	591 .1745	133 .209	396 .178	075 .045	519 .689	585 .166	444 .369
36	283 .306	733 .2086	417 .003	158 .039	263 .912	165 .117	290 .1961	120 .222	384 .190	079 .049	575 .745	695 .276	476 .401
39	258 .331	312 .2325	"	160 .041	178 .997	160 .122	514 .2185	109 .233	372 .202	081 .051	625 .795	610 .191	505 .430

⊙ Assumed value

APPENDIX B - Test data for C-Section Purlin Assembly

Dial Gage Readings

	28	U ₂₈	29	U ₂₉	30	U ₃₀	31	U ₃₁	32	U ₃₂	33	U ₃₃
0	391	-	680	-	267	-	260	-	2.684	-	304	-
3	358	.017	541	.139	225	.042	426	.166	2.975	.291	308	.014
6	369	.028	421	.259	189	.078	611	.351	3.275	.591	308	.014
9	379	.038	204	.476	(643) 568	.154	(186) 382	.547	(6.8%) 1.214	.709	310	.006
12	391	.150	(596) 518	.594	547	.175	564	.229	1.505	1.200	312	.008
15	397	.056	441	.631	531	.191	745	.910	1.802	1.497	314	.010
18	410	.069	354	.718	508	.214	(449) 301	1.062	(.111) 0.349	1.735	319	.015
21	419	.078	272	.800	492	.230	494	1.255	0.615	2.001	322	.018
24	419	.078	190	.882	332	.390	662	1.423	1.865	2.251	322	.018
27	439	.098	(581) 498	.945	(651) 037	.404	862	1.623	1.011	2.397	335	.031
30	445	.104	Cancelled here, moving the string to next count 402	1.041	020	.421	(152) 428	1.898	(297) .666	2.766	332	.028
33	457	.116	(402) 366	1.157	(447) 415	.453	626	2.096	1.018	3.118	331	.027
36	467	.126	163	1.360	362	.506	895	2.365	1.249	3.349	334	.030
39	472	.131	494 (1.111)	1.528	371	.497	(280) 356	2.641	1.593	3.693	336	.032

APPENDIX B - Test data for C-Section Purlin Assembly

Page: 7

LOAD (Psi)	1	U ₁	2	U ₂	3	U ₃	$\frac{U_2+U_3}{2}$	$\frac{U_2-U_3}{4}$	4	U ₄	5	U ₅	6	U ₆	$\frac{U_5+U_6}{2}$	$\frac{U_5-U_6}{4}$		
0	.116		.796		.901				.307		.858		.620				.015	
3	.283	.167	.754	.042	.883	.018	.030	.006	.340	.033	.857	.021	.609	.011	.016	.0025	.192	.177
6	.440	.324	.717	.079	.869	.032	.055	.011	.370	.063	.822	.036	.601	.019	.027	.0043	.361	.346
9	.552	.436	.689	.107	.858	.043	.080	.016	.390	.083	.812	.046	.596	.024	.035	.0055	.472	.457
12	.676	.560	.658	.138	.848	.053	.096	.021	.416	.109	.801	.057	.590	.030	.043	.0068	.612	.597
15	.795	.680	.629	.167	.839	.062	.115	.026	.442	.135	.793	.065	.586	.034	.050	.0078	.737	.722
18	.905	.838	.581	.215	.825	.076	.145	.035	.487	.180	.780	.078	.578	.042	.060	.009	.859	.872
21	1.000	.998	.539	.267	.811	.090	.178	.044	.527	.220	.765	.093	.569	.051	.072	.0105	1.039	1.039
24	1.055	1.185	.474	.323	.796	.103	.213	.055	.561	.251	.753	.107	.561	.056	.081	.0128	1.209	1.209
27	.742	1.372	.402	.395	.779	.120	.257	.069	.603	.293	.742	.118	.555	.062	.090	.0140	1.372	1.372
30	.901	1.531	.328	.469	.761	.138	.304	.083	.641	.331	.732	.128	.549	.068	.098	.0150	1.535	1.535
33	1.055	1.718	.216	.581	.735	.164	.373	.104	.682	.372	.723	.137	.543	.074	.106	.0158	1.767	1.767
36	.936	1.927	.804	.689	.822	.189	.439	.125	.731	.431	.711	.149	.536	.081	.115	.017	1.969	1.969
39	.812	2.143	.676	.817	.787	.224	.520	.148	.738	.482	.694	.166	.526	.091	.128	.0188	2.264	2.264
42	.411	2.406	.520	.973	.744	.267	.620	.187	.774	.518	.682	.178	.518	.099	.138	.0198	2.510	2.510
45	.732	2.727	.319	1.174	.696	.315	.745	.215	.790	.538	.673	.187	.510	.107	.147	.0200	2.909	2.909
48	.695	3.272	*	*	*	*	*	*	.743	.585	.674	.186	.507	.110	.148	.0190	*	*
0	.586		.681				11	U ₁₁	12	U ₁₂	13	U ₁₃	$\frac{U_{12}+U_{13}}{2}$	$\frac{U_{12}-U_{13}}{4}$	14	U ₁₄	15	U ₁₅
3	.539	.047	.661	.020	.033	.00675	.479	.163	.402	.042	.309	.020	.031	.0055	.274	.035	.478	.045
6	.492	.094	.648	.033	.066	.014	.632	.316	.445	.085	.329	.040	.062	.01125	.307	.068	.508	.075
9	.469	.117	.639	.042	.080	.0188	.732	.416	.480	.120	.346	.057	.089	.01575	.330	.091	.528	.095
12	.433	.153	.629	.052	.103	.0225	.838	.542	.524	.164	.366	.077	.120	.02175	.360	.121	.553	.120
15	.396	.188	.620	.061	.125	.0318	.956	.760	.569	.209	.386	.097	.153	.028	.388	.149	.574	.141
18	.348	.238	.605	.076	.157	.0405	1.09	.813	.635	.275	.415	.126	.200	.03725	.430	.191	.601	.168
21	.289	.297	.589	.092	.195	.0512	1.21	.966	.710	.350	.452	.163	.206	.04675	.477	.238	.630	.197
24	.231	.353	.573	.105	.229	.062	1.35	.987	.703	.439	.487	.199	.319	.0600	.519	.279	.656	.226
27	.157	.427	.552	.126	.276	.07525	1.51	1.310	.703	.545	.526	.245	.395	.07500	.599	.340	.687	.248
30	.905	.494	.533	.145	.320	.08725	.481	1.480	.316	.655	.174	.293	.474	.0900	.365	.406	.255	.267
33	.810	.569	.511	.167	.378	.1055	.698	1.697	.584	.823	.243	.342	.583	.12025	.456	.497	.287	.299
36	.693	.706	.481	.197	.452	.12725	.322	1.889	.395	.980	.310	.409	.694	.14275	.504	.545	.312	.324
39	.545	.854	.447	.231	.543	.15575	.534	2.101	.579	1.164	.386	.485	.824	.16975	.554	.595	.340	.352
42	.388	1.011	.411	.267	.639	.1860	.772	2.339	.796	1.381	.498	.577	.979	.201	.580	.631	.376	.388
45	.173	1.266	.367	.311	.788	.23875	.432	2.660	.481	1.656	.598	.697	1.176	.23975	.636	.758	.392	.404
48	*	*	*	*	*	*	.934	3.162	.941	2.116	.802	.901	1.509	.30375	.734	.956	.410	.422

APPENDIX C - Test data for Second Z-Section Purlin Assembly

LOAD (PSI)	16	U_{16}	$\frac{U_{15}+U_{16}}{2}$	$\frac{U_{15}-U_{16}}{4}$	17	U_{17}	18	U_{18}	19	U_{19}	$\frac{U_{18}+U_{19}}{2}$	$\frac{U_{18}-U_{19}}{4}$
0	.428	.019	.032	.0065	.088		.191		.250			
3	.447	.019	.032	.0065	.239	.151	.231	.040	.266	.016	.028	.006
6	.460	.032	.054	.01075	.384	.296	.272	.081	.280	.030	.056	.01275
9	.469	.041	.068	.0135	.475	.387	.301	.110	.291	.041	.076	.01725
12	.480	.052	.086	.017	.591	.503	.343	.152	.306	.056	.104	.024
15	.490	.062	.102	.01975	.700	.612	.394	.203	.324	.074	.139	.03225
18	.504	.076	.122	.0230	.830	.742	.463	.272	.351	.101	.187	.04275
21	.519	.091	.144	.0265	.263	.883	.548	.357	.385	.135	.246	.05375
24	.520 *.531	.102	.164	.0310	.395	1.030	.548 *.629	.443	.416	.166	.305	.06925
27	.201 *.218	.111	.180	.03425	.218	1.167	.059 *.247	.640	.121 *.206	.206	.423	.1085
30	.230	.123	.195	.0360	.369	1.378	.256	.649	.161	.246	.448	.10075
33	.245	.138	.219	.04025	.592	1.541	.403	.796	.216	.301	.548	.12375
36	.260	.153	.239	.04275	.225	1.703	.079 *.265	.922	.280	.365	.643	.13925
39	.275	.168	.260	.0460	.442	1.920	.379	1.096	.345	.430	.761	.1665
42	.291	.184	.286	.0510	.637	2.115	.040 *.550	1.267	.415	.500	.884	.19175
45	.307	.200	.302	.0510	.332	2.381	.040 *.267	1.494	.507	.592	1.043	.2255
48	.321	.214	.318	.052	.765	2.814	.621	1.848	.660	.745	1.297	.27575

NOTE: 1) The values in the boxes are reset values

2) * indicates these values were not recorded.

APPENDIX C - Test data for Second Z-Section Purlin Assembly

P (kN)	1 Rdg 11083	2 Rdg 10722	3 Stress	4	5	6	7	8
0	11050	10687	-1.05	10292	8834	9860	10668	5.42
3	11013	10653	-2.07	10223	8794	9819	10595	9125
6	11000	10635	-2.61	10155	8753	9777	10516	9126
9	10987	10623	-2.97	10112	8734	9755	10480	9160
12	10980	10615	-3.21	10066	8716	9736	10422	9334
15	10968	10605	-3.51	10015	8696	9716	10370	9397
18	10966	10602	-3.6	9945	8679	9694	10303	9465
21	10966	10598	-3.33	9874	8666	9695	10230	9532
24	10970	10607	-2.49	9876	8646	9680	10238	9518
27	11000	10635	-1.53	9805	8658	9673	10184	9608
30	11028	10667	0.24	9736	8672	9683	10094	9686
33	11086	10726	2.40	9671	8666	9697	10099	9749
36	11154	10798	5.43	9579	8724	9739	9940	9843
39	11234	10899	8.88	9544	8790	9801	9874	9926
42	11366	11014	13.56	9422	8898	9908	9755	10038
45	11524	11170	23.55	9343	9038	10048	9684	10146
48	11851	11503	23.55	9236	9160	10273	9660	10265

ULTIMATE LOAD = 50 kSF

APPENDIX C - Test data for Second Z-Section Purlin Assembly

	9	10	11	12	13	14	15	16
0	7781	7933	7136	6855	7780	3980	0575	7115
3	7741	7883	7062	6730	7658	3921	0515	7039
6	7668	7833	6996	6956	7938	3884	479	6972
9	7658	7812	6957	6959	7955	3866	462	6926
12	7619	7777	6909	7023	8054	3836	450	6869
15	7555	7746	6860	7115	8109	3808	418	6816
18	7538	7703	6800	7074	8164	3770	392	6752
21	7485	7661	6736	7097	8219	3730	368	6684
24	7457	7656	6704	7092	8198	3738	373	6695
27	7447	7618	6683	7135	8279	3702	346	6616
30	7405	7587	6630	7178	8345	3682	331	6552
33	7377	7570	6588	7190	8387	3658	321	6488
36	7363	7558	6569	7186	8444	3649	328	6430
39	7344	7538	6530	7215	8502	3641	329	6382
42	7313	7522	6470	7231	8547	3661	376	6349
45	7284	7503	6409	7251	8604	3667	390	6291
48	7252	7493	6336	7277	8669	3668	453	6222
51	7224	7477	6254	7299	8758	3650	410	6188

APPENDIX C - Test data for Second Z-Section Purlin Assembly

	17		18		19		20		21		22		23		24	
0	1058		2824		7706		3152		6742		9940		6978		4370	
3	1128	2.10	2554	1.50	7634	-2.16	4115	-1.56	6778	-4.32	9987	1.41	6888	-2.70	4507	4.11
6	1196	4.14	2942	3.84	7620	-2.58	4583	-2.07	6760	-5.46	10066	3.78	6848	-3.90	4479	3.27
9	1244	5.58	2990	4.98	7555	-4.53	4668	-2.52	6693	-7.47	10134	5.82	6790	-5.64	4526	4.68
12	1306	7.44	3044	6.60	7526	-5.40	4640	-3.36	6657	-8.55	10173	6.99	6740	-7.11	4687	9.51
15	1351	8.79	3104	8.40	7492	-6.42	4604	-4.44	6593	-10.47	10226	8.58	6774	-6.12	4718	10.44
18	1407	10.27	3138	9.42	7462	-7.32	3986	-4.98	6546	-11.88	10292	10.56	6624	-10.62	4778	12.24
21	1476	12.81	3190	10.98	7442	-7.92	3953	-5.97	6489	-13.59	10339	13.77	6575	-12.09	4780	12.3
21	1446		3175		7415		3947		6545		10302		6569		4757	
24	1513	12.75	3236	12.81	7391	-8.64	3918	-6.84	6433	-16.95	10390	14.61	6497	-14.25	4780	12.99
27	1566	14.94	3292	14.49	7355	-9.72	3587	-7.77	6396	-18.06	10438	16.05	6441	-15.93	4883	16.08
30	1632	16.32	3330	15.63	7338	-10.23	3858	-8.64	6373	-18.75	10456	16.59	6401	-17.13	4878	15.93
33	1691	18.89	3379	17.10	7346	-9.99	3526	-9.60	6306	-20.76	10518	18.45	6344	-18.84	4996	19.47
36	1735	19.41	3394	17.55	7318	-10.83	3795	-10.53	6253	-22.35	10553	19.50	6297	-20.25	4993	19.38
39	1760	20.16	3383	17.22	7328	-10.53	3745	-12.03	6198	-24.10	10633	21.90	6240	-21.96	5040	20.79
42	1619	21.93	3396	17.61	7254	-12.75	3720	-12.78	6143	-25.65	10623	21.60	6212	-22.80	5033	20.58
45	1684	23.88	3421	18.36	7205	-14.22	3676	-14.04	6069	-29.07	10717	24.48	6153	-24.57	5168	24.63
48	2012	27.72	3456	19.41	7152	-15.81	3630	-15.48	5974	-30.72	10792	26.67	6026	-28.38	5150	24.09

APPENDIX C - Test data for Second Z-Section Purlin Assembly

	25	26	27	28	29	30	31	32
0	9886	7512	8361	6115	7774	10029	9160	9807
3	9802	9454	8358	-0.33	7804	9995	9161	9809
6	9830	9467	8357	-0.36	7843	9988	9167	9815
9	9860	9463	8357	-0.30	7873	9963	9176	9821
12	9890	9450	8357	-0.36	7900	9946	9176	9823
15	9912	9428	8345	-0.72	7915	9925	9178	9824
18	9930	9400	8327	-1.26	7932	9891	9164	9810
21	9951	9375	8318	-1.53	7963	9886	9162	9808
24	9966	9361	8318	6.63	7950	9857	9155	9803
27	9984	9347	8304	-1.80	7980	9826	9171	9805
30	9999	9334	8298	-1.78	8016	9788	9172	9799
33	9999	9319	8279	-2.55	8052	9744	9151	9787
36	9977	9305	8265	-2.52	8090	9736	9168	9797
39	9921	9286	8265	-2.61	8113	9765	9183	9806
42	9904	9273	8275	-2.67	8145	9663	9193	9816
45	9889	9260	8274	-2.55	8161	9645	9198	9828
48	9869	9246	8267	-1.71	8168	9648	9200	9848

APPENDIX C - Test data for Second Z-Section Purlin Assembly

	49	50	51	52	53	54	55	56
	7673	7675	7271	4889	13353	8405	14440	14337
3	9822	7632	7238	4867	13321	8372	14380	14430
	9932	7601	7225	4855	13323	8374	14353	14547
9	9999	7577	7219	4847	13322	8372	14329	14620
12	9955	7498	7070	4695	13197	8247	14170	14687
15	10017	7388	7076	4682	13174	8218	14100	14670
16	10055	7397	7114	4702	13158	8205	14056	14718
21	10208	7351	7223	4790	13230	8277	14071	14886
21	10234	7404	7280	4853	13289	8340	14167	14962
24	10451	7515	7457	5012	13425	8473	14196	15152
27	10092	7048	7073	4657	13030	8072	13710	14830
30	10125	6995	7086	4604	13049	8070	13636	14909
33	10174	6940	7111	4608	13094	8138	13537	14995
36	10218	6890	7131	4613	13152	8193	13469	15052
39	10261	6841	7151	4619	13237	8286	13358	15150
42	10319	6811	7160	4619	13360	8413	13224	15287
45	10377	6855	7152	4601	13552	8601	13134	15358
46	10473	1143	7151	4588	13957	9019	12889	15606

APPENDIX C - Test data for Second Z-Section Purlin Assembly