NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE 1978

DATA ON THE COMPRESSIVE STRENGTH OF 75S-T6 ALUMINUM-ALLOY FLAT PANELS HAVING SMALL, THIN, WIDELY SPACED, LONGITUDINAL EXTRUDED Z-SECTION STIFFENERS

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SUMMARY

The experimental results are presented for the second part of an investigation of the compressive strength of 75S-T6 aluminum-alloy flat panels with longitudinal extruded Z-section stiffeners. This part of the investigation is particularly concerned with panels in which the ratio of the thickness of the stiffener material to the skin material is small and the ratio of stiffener spacing to skin thickness is large.

INTRODUCTION

As part of an extensive study of structural elements suitable for the compression surface of wings, the National Advisory Committee for Aeronautics has made comprehensive investigations of the compressive strength of flat, longitudinally stiffened compression panels (references 1 to 9). Because of the high structural efficiency and because of the advantages (apart from structural efficiency) inherent in a simple shape like a Z-section, the investigation of stiffened panels has been extended to cover most thoroughly the strength of flat compression panels of 75S-T6 aluminum alloy with extruded Z-section stiffeners. Some of the experimental data obtained are presented. This paper is particularly concerned with stiffened panels having proportions best suited to thick-skin construction, for which most of the material must be in the skin, and relatively little stiffening material may be used. Because the use of even less stiffening – that is, smaller values of the ratio of stiffener thickness to skin thickness or the use of smaller stiffeners – would require ridiculously short panel lengths to avoid column bending failure at low stress, the proportions covered approach what now appear to be the practical limits of proportions for stiffened panels used as columns. The data in this paper are presented without analysis in order to make the experimental results available.

SYMBOLS

Symbols for panel dimensions are identified in figure 1. Other symbols used are defined as follows:

P_i	compressive load per inch of panel width, kips per inch
L	length of panel, inches
c	coefficient of end fixity in Euler column formula
σ_{cy}	compressive yield stress, ksi
σ_{cr}	stress for local buckling of the sheet, ksi
$\bar{\sigma}_f$	average stress at failing load, ksi
$\bar{\epsilon}_f$	shortening per unit length at failing load
p	rivet pitch, inches
d	rivet diameter, inches
ρ	radius of gyration, inches

TEST SPECIMENS AND PROCEDURE

Proportions of test specimens.- The range of proportions covered in the part of the investigation presented herein is supplementary to that covered in reference 10 and covers wider stiffener spacings (values of b_S/t_S of 50, 60, and 75 in addition to the previous values of 15, 20, 25, 30, and 40) and a smaller ratio of stiffener thickness to skin thickness $\left(\frac{t_W}{t_S} = 0.26\right.$ in addition to the previous values of 0.40, 0.63, and $\left.1.00\right)$. The same four stiffener proportions, corresponding to values of b_W/t_W of 12, 20, 30, and 40, were used as in reference 10, and a total of 128 different cross sections have thus been included in the entire investigation. For each cross section the length of specimen was varied to give five values of slenderness ratio $\frac{L}{\rho} = 20$, 35, 55, 85, and 125.

In order to accommodate the high values of b_S/t_S investigated within the width of the testing space in the testing machine, the specimens were scaled down from those investigated in reference 10 by reducing the stiffener thickness from 0.102 inch to 0.064 inch and reducing all other dimensions accordingly. Even with the reduced scale of the specimens, however, at the widest stiffener spacings some of the specimens had to be limited to five stiffeners and four bays, or even to four stiffeners and three bays, instead of to the six-stiffener width of the typical specimen (see fig. 1) used throughout the rest of the investigation. The specimens having less than six stiffeners are so designated by means of footnotes in the tables (tables 1 to 4) in which the dimensions of the specimens are given.

Although the values of slenderness ratio selected gave reasonable proportions for most of the specimens, they also resulted in a number of panels for which the bay width b_S was greater than the length L when the stiffeners were small and the stiffener spacing was large. In tables 1 to 4 the values of the stress for local buckling of the sheet σ_{cr} and of the average stress at failing load $\overline{\sigma}_f$ for these panels are enclosed in brackets to distinguish them from the values for panels of more normal proportions.

In order to investigate the possibility that relatively different results might be obtained from the present and previous investigations due to the different scales of the specimens $\left(t_W = 0.064 \text{ and } 0.102,\right.$ respectively$\left.\right)$ a few specimens were built to study the scale effect. These specimens had the same proportions but two different stiffener thicknesses, so that their absolute sizes were in the ratio of $\frac{0.102}{0.064}$. The characteristics of these specimens are given in table 5.

Material properties of test specimens.- The with-grain compressive yield stress σ_{cy} for the skin material (bare 75S-T6 aluminum-alloy sheet) ranged between 69.7 ksi and 78.9 ksi with an average of 74.1 ksi and that of the stiffener material (extruded 75S-T6 aluminum alloy), between 71.4 ksi and 86.6 ksi with an average of 78.8 ksi. These values correspond very closely to those reported for the first part of the investigation (see reference 10).

Riveting of test specimens.- The stiffeners were riveted to the sheets with large-diameter, closely spaced A17S-T4 aluminum-alloy flathead rivets (AN442AD) on all panels. The rivet diameters and pitches used are given in tables 1 to 5.

Testing methods and procedure.- The panels were tested flat-ended, without side support, in the 1,200,000-pound-capacity testing machine at the Langley structures research laboratory. Within the range of loads used, the indicated load on the testing machine was within one-half of 1 percent of the applied load. The ends of the panels were ground accurately flat and parallel in a special grinder, and the method of alinement in the testing machine was such as to insure uniform bearing on the ends of the specimens. Figure 2 shows a panel prepared for testing.

The local-buckling load was determined by the strain-reversal method (reference 11) as the load at which a plot of the strains near the crest of a buckle first shows a decreasing strain with increasing load. The local-buckling load was divided by the cross-sectional area to give the stress for local buckling σ_{cr}.

The shortening per unit length $\bar{\epsilon}_f$ was measured as the average of the strains indicated by four $6\frac{1}{2}$-inch resistance-type wire strain gages mounted on the quarter points along the length of the second and fifth stiffeners. On panels that were too short for the $6\frac{1}{2}$-inch gages, 1-inch resistance-type wire strain gages were used.

Adjustment of data.- Since an end-fixity coefficient c of 3.75 has been indicated for similar panel tests in this machine and because the results of an end-fixity test of the type described in reference 12 on one of the panels of reference 10 checked this value of c, a value of $c = 3.75$ was used in reducing the test data.

In order to take into account the fact that the specimens had an unequal number of stiffeners and bays, the test data were adjusted in the manner described in reference 1. This adjustment consisted essentially of subtracting the load carried by one stiffener from the testing-machine load. This adjusted load was then divided by the cross-sectional area of the panel minus the area of one stiffener to obtain the average stress, or by the panel width to obtain the load per inch of width.

RESULTS AND DISCUSSION

The results of the investigation, adjusted as previously described for an unequal number of stiffeners and bays, are given in tables 1 to 4 and figures 3 to 6. The tables give values of the ratio of rivet diameter to sheet thickness d/t_S, the ratio of rivet pitch to sheet thickness p/t_S, the unit shortening at failing load $\bar{\epsilon}_f$, the stress for local buckling of the sheet σ_{cr}, and the average stress at failing load $\bar{\sigma}_f$ for corresponding values of the structural index $\frac{P_i}{L/\sqrt{c}}$. (See references 13 and 14.) The figures give plots of $\bar{\sigma}_f$ against $\frac{P_i}{L/\sqrt{c}}$ for the various dimension ratios used.

Although the primary purpose of this paper is to present the experimental data without analysis because the analysis may be prolonged, the following general discussion is included to aid in interpreting the trends indicated by the data obtained.

Perhaps the most striking result is that the relatively thin stiffeners having a ratio of stiffener thickness to skin thickness t_W/t_S of only 0.26 were still adequate in most cases to stabilize the sheet. At the longer lengths, however, particularly in the case of the smallest stiffeners, the decreased stress $\bar{\sigma}_f$ carried relative to the more adequately stiffened panels indicates that the small stiffeners did not provide sufficient restraint to the sheet to permit the panel as a whole to develop strength comparable to that of an Euler column before local distortions precipitated failure.

Similarly, as might be expected, the stiffeners having high width-to-thickness ratios $\left(\frac{b_W}{t_W} = 40\right)$ in many cases provided inadequate restraint to the sheet because of their lack of local stability.

At the extreme proportions studied in the present investigation (values of b_S/t_S as low as 15 and as high as 75 and values of b_W/t_W as low as 12), some abnormally high values of $\frac{P_i}{L/\sqrt{c}}$, $\bar{\sigma}_f$, and σ_{cr} were obtained. The high values of $\frac{P_i}{L/\sqrt{c}}$ were due both to the high load-carrying ability associated with the close stiffener spacings and to the short lengths associated with the small stiffeners. The short lengths were also undoubtedly responsible for the abnormally high stresses $\bar{\sigma}_f$ and σ_{cr} that were obtained at the wider stiffener spacings. If a short panel, for which the ratio of length to bay width L/b_S approaches 1.0 or less, is tested flat-ended, the test values of $\bar{\sigma}_f$ and σ_{cr} may be expected to be higher than for a panel of the same cross-sectional proportions but having greater length or less end restraint. The end restraints may cause interferences with the formation of local buckles which are different from the interferences with bending of the panel as a column so that division by $\sqrt{c}$ does not correct the test length to a pin-ended effective length. Until an analysis has been made to evaluate end effects on abnormally short specimens where the local buckling predominates, the high stress values obtained from these short specimens should be recognized to be out of line with those obtained for more normally proportioned panels.

The results of the tests of panels of like proportions but of different scale are given in table 5. With the exception of the first pair of panels listed therein, there was found to be little difference between the values of $\bar{\sigma}_f$ for the panels with 0.102-inch-thick stiffeners and the corresponding panels with 0.064-inch-thick stiffeners. The maximum difference in $\bar{\sigma}_f$ was that found for the proportions $\frac{t_W}{t_S} = 0.40$, $\frac{b_S}{t_S} = 40$, and $\frac{b_W}{t_W} = 12$. This difference amounted to 7.5 ksi, or 13 percent of the value of 57.2 ksi obtained for the panel with 0.102-inch-thick stiffeners. The next greatest difference was less than 6 percent of the smaller of the two values of $\bar{\sigma}_f$ obtained. The differences for values of σ_{cr} and $\bar{\epsilon}_f$ were somewhat greater but in no case was any consistent trend shown which might be ascribed to scale effect.

Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Air Force Base, Va., September 8, 1949

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TABLE 1

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 0.26$

$$\left[\frac{r}{t_W} = 1.00;\ \frac{d}{t_S} = 1.75;\ \frac{p}{t_S} = 5.00\right]$$

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi) (c)	$\bar{\sigma}_f$ (ksi) (c)	$\frac{P_1}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(0.26)	(15)	(12)	(4.8)	(20.3)					
0.0621	0.249	15.0	12.6	4.99	21.00	4.6	[68.8]	[75.0]	11.70	780×10^{-5}
.0624	.250	15.1	12.5	4.94	20.88	8.3	------	68.0	5.94	670
.0625	.251	15.2	12.5	4.98	20.93	13.0	------	59.8	3.30	572
.0647	.265	15.4	11.9	4.76	20.60	20.5	------	39.3	1.39	334
.0639	.252	14.8	12.1	4.71	20.40	29.9	------	25.5	.63	258
			(20)	(8.0)						
.0638	.256	15.1	20.1	8.04	20.35	5.2	64.7	68.8	6.11	706
.0644	.256	14.9	19.6	7.85	20.14	9.2	62.5	63.2	3.23	677
.0649	.263	15.2	19.6	8.27	19.85	14.2	------	55.3	1.78	510
.0637	.251	14.8	19.9	8.42	20.19	22.2	------	43.7	.93	385
.0637	.252	14.9	20.1	7.89	20.37	32.2	------	23.1	.33	213
			(30)	(12.0)						
.0653	.257	14.7	29.6	11.75	19.55	5.5	57.8	62.5	3.60	633
.0639	.257	15.0	30.0	12.01	20.22	10.0	------	58.2	1.88	538
.0649	.260	15.0	29.4	11.82	20.06	15.8	------	49.6	1.03	478
.0638	.253	14.9	30.1	11.87	20.25	24.1	------	44.3	.60	419
.0654	.259	14.8	29.7	11.73	19.82	35.2	------	25.0	.23	224
			(40)	(16.0)						
.0652	.266	15.3	39.2	15.61	19.98	6.1	52.7	56.7	2.32	560
.0667	.264	14.9	38.6	15.25	19.75	10.7	------	48.2	1.15	454
.0646	.259	15.0	39.6	15.75	20.23	16.9	------	40.6	.61	418
.0666	.263	14.8	38.3	15.24	19.47	26.1	------	31.4	.31	303
.0659	.254	14.5	38.9	15.44	19.84	38.3	------	19.3	.13	188
		(20)	(12)	(4.8)						
.0618	.249	20.2	12.7	5.15	21.26	4.2	[58.8]	[74.9]	12.31	856
.0621	.250	20.1	12.5	4.96	20.99	7.6	------	66.6	6.13	599
.0623	.251	20.2	12.6	4.94	21.00	11.7	------	55.7	3.25	463
.0620	.245	19.9	12.6	4.97	20.94	18.4	------	36.5	1.41	365
.0632	.251	19.9	12.4	4.84	20.62	26.7	------	18.2	.48	175
			(20)	(8.0)						
.0637	.252	19.8	20.2	7.97	20.38	4.6	61.2	67.6	6.45	646
.0639	.255	20.0	20.1	8.11	20.23	8.2	------	59.4	3.20	579
.0645	.258	20.0	19.8	8.00	20.12	12.8	------	52.7	1.83	450
.0643	.256	19.9	19.8	7.90	20.11	19.9	------	41.0	.91	373
.0640	.254	19.9	19.9	7.93	20.19	29.2	------	21.6	.33	251
			(30)	(12.0)						
.0666	.269	20.2	28.6	11.53	19.57	5.2	56.2	61.4	3.60	585
.0663	.260	19.7	29.0	11.51	19.58	9.0	------	51.1	1.74	560
.0666	.264	19.9	29.2	11.58	19.57	13.9	------	44.9	.98	428
.0651	.259	19.9	29.3	11.64	19.94	22.1	------	44.4	.63	431
.0653	.259	19.8	29.2	11.76	20.04	32.5	------	22.6	.22	212
			(40)	(16.0)						
.0635	.255	20.2	40.6	15.88	20.53	5.6	52.0	54.4	2.30	593
.0645	.257	19.9	39.4	15.78	20.19	9.8	------	50.4	1.23	468
.0642	.258	20.1	40.1	15.85	20.36	15.3	------	42.7	.66	414
.0623	.248	20.0	41.1	16.19	20.85	23.7	------	30.3	.30	294
.0619	.245	19.8	41.6	16.50	21.23	34.8	------	21.6	.15	196

[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

TABLE 1.– Continued

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 0.26$ – Continued

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{b_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi) (c)	$\bar{\sigma}_f$ (ksi) (c)	$\frac{P_1}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(0.26)	(25)	(12)	(4.8)	(20.3)					
0.0620	0.253	25.5	12.5	5.05	21.02	3.9	[61.4]	[75.7]	13.09	888×10^{-5}
.0620	.253	25.6	12.6	4.97	20.94	7.0	[54.6]	[63.7]	6.12	580
.0623	.256	25.7	12.5	4.99	20.92	11.0	------	50.8	3.08	458
.0638	.258	25.3	12.3	4.79	20.36	17.0	------	35.7	1.41	324
.0639	.250	24.4	12.2	5.06	20.40	24.9	------	22.5	.63	194
			(20)	(8.0)						
.0629	.245	24.4	20.4	8.20	20.71	4.2	[56.5]	[63.5]	6.59	569
.0632	.248	24.6	20.1	8.12	20.55	7.6	55.4	58.8	3.38	526
.0637	.251	24.8	20.0	8.17	20.53	11.8	------	49.0	1.81	400
.0637	.251	24.7	20.0	8.02	20.38	17.8	------	35.3	.87	314
.0635	.250	24.7	20.1	8.00	20.28	26.5	------	15.6	.26	149
			(30)	(12.0)						
.0671	.263	24.6	28.7	11.30	19.34	4.7	51.1	55.7	3.56	541
.0661	.261	24.8	29.2	11.61	19.78	8.3	49.9	50.9	1.82	472
.0666	.262	24.8	28.6	11.35	19.71	13.2	------	43.6	1.00	402
.0653	.257	24.6	29.6	11.73	19.88	20.1	------	35.1	.52	308
.0656	.257	24.5	29.4	11.72	19.80	29.6	------	23.0	.23	211
			(40)	(16.0)						
.0645	.253	24.6	40.0	15.73	20.19	5.2	49.0	53.4	2.38	512
.0641	.255	24.9	40.2	15.89	20.27	9.0	47.3	48.4	1.23	466
.0641	.250	24.4	40.1	15.82	20.42	14.2	------	41.2	.67	402
.0659	.260	24.7	39.0	15.29	19.76	21.8	------	28.4	.30	271
.0636	.245	24.1	41.4	15.84	20.56	32.3	------	19.6	.14	176
		(30)	(12)	(4.8)						
.0624	.241	29.0	12.6	4.99	20.98	3.7	[60.4]	[76.7]	14.24	856
.0619	.241	29.2	12.7	5.14	21.15	6.6	[49.8]	[59.3]	6.21	724
.0622	.255	30.8	12.5	4.95	20.94	10.3	45.7	49.4	3.17	460
.0653	.266	30.6	11.9	4.69	20.18	16.0	------	30.8	1.29	354
.0620	.250	30.3	12.6	4.89	21.02	23.5	------	21.2	.61	192
			(20)	(8.0)						
.0629	.256	30.6	20.4	8.12	20.55	3.9	[55.6]	[63.6]	6.67	621
.0641	.252	29.5	20.1	7.93	20.25	7.0	46.6	51.9	3.16	460
.0645	.263	30.6	19.8	8.03	19.90	9.8	35.2	47.6	2.01	465
.0636	.262	31.0	20.2	7.99	20.27	16.8	------	30.0	.74	268
.0636	.259	30.5	20.0	7.99	20.26	25.1	------	17.4	.29	168
			(30)	(12.0)						
.0666	.252	28.4	29.1	11.44	19.50	4.4	48.8	54.5	3.63	672
.0655	.267	30.7	29.5	11.50	19.82	7.7	36.8	47.0	1.73	370
.0663	.271	30.7	29.0	11.67	19.74	12.2	38.9	39.6	.92	367
.0665	.273	30.9	29.1	11.55	19.52	18.7	------	32.9	.49	314
.0655	.261	29.9	29.5	11.65	19.97	27.5	------	22.8	.24	202
			(40)	(16.0)						
.0648	.256	29.7	39.3	15.70	19.79	4.9	42.5	50.1	2.31	560
.0674	.275	30.7	38.1	15.07	19.41	8.4	38.1	42.8	1.11	415
.0648	.261	30.3	39.6	15.71	20.27	13.3	37.0	38.4	.64	362
.0651	.268	30.8	39.7	15.70	20.11	20.4	------	31.5	.33	280
.0642	.263	30.8	41.0	15.75	20.30	30.1	------	18.4	.13	166

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[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

TABLE 1.– Continued

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 0.26$ – Continued

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi) (c)	$\bar{\sigma}_f$ (ksi) (c)	$\frac{P_1}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(0.26)	(40)	(12)	(4.8)	(20.3)					
0.0623	0.260	41.7	12.6	5.11	21.00	3.5	[60.5]	[71.6]	13.16	620×10^{-5}
.0623	.251	40.3	12.5	4.96	20.97	6.0	[61.6]	[65.8]	7.31	570
.0623	.251	40.3	12.6	4.91	20.84	9.4	[37.5]	[47.8]	3.35	365
.0620	.247	39.9	12.5	4.93	21.09	14.7	23.2	30.4	1.41	400
.0640	.263	41.0	12.0	5.05	20.44	21.7	------	18.2	.55	178
			(20)	(8.0)						
.0631	.254	40.2	20.3	8.05	20.56	3.5	[58.9]	[65.5]	7.59	679
.0630	.252	40.1	20.4	8.23	20.62	6.2	[35.3]	[45.9]	3.03	440
.0636	.254	40.0	20.2	7.99	20.34	9.8	20.8	33.7	1.43	355
.0625	.260	41.7	20.5	8.10	20.70	15.1	------	25.9	.68	192
.0644	.267	41.6	19.8	8.04	20.23	22.2	------	14.5	.26	134
			(30)	(12.0)						
.0664	.267	40.2	29.1	11.57	19.55	4.0	[34.8]	[46.4]	3.26	625
.0672	.271	40.4	28.6	11.36	19.32	6.9	20.5	43.5	1.77	471
.0665	.276	41.6	29.1	11.55	19.67	10.9	20.8	32.1	.79	400
.0673	.273	40.6	28.5	11.38	19.29	16.8	21.5	24.4	.40	203
.0625	.259	41.5	31.0	12.13	20.85	24.4	------	19.2	.21	180
			(40)	(16.0)						
.0610	.244	40.1	42.1	16.69	21.69	4.3	27.4	37.2	1.86	358
.0644	.268	41.7	40.0	15.65	20.31	7.5	22.3	36.1	.99	358
.0622	.258	41.4	41.3	16.21	20.87	11.9	22.7	31.2	.54	292
.0656	.270	41.2	39.0	15.45	19.79	18.3	22.5	27.3	.31	266
.0637	.261	41.0	40.2	15.91	20.38	27.1	------	17.8	.14	166
		(50)	(12)	(4.8)						
.0622	.255	51.3	12.7	5.11	21.20	4.0	[68.8]	[d][71.5]	14.29	674
.0619	.246	49.7	12.6	5.03	21.15	5.7	[55.0]	[d][61.3]	7.17	524
.0618	.246	49.7	12.6	4.87	21.07	8.9	[41.6]	[d][49.6]	3.71	308
.0620	.246	49.6	12.5	4.97	21.02	13.6	[26.9]	[d][30.0]	1.47	400
.0646	.277	53.7	11.9	4.92	20.25	20.3	13.9	[d]16.8	.52	135
			(20)	(8.0)						
.0637	.272	53.5	20.0	7.97	20.37	3.3	[61.0]	[d][66.7]	7.78	659
.0631	.251	49.7	20.3	8.14	20.59	5.8	[34.9]	[d][44.4]	3.15	420
.0632	.272	53.7	20.2	8.03	20.53	9.0	[18.6]	[d][27.8]	1.17	330
.0650	.280	54.0	19.6	7.94	19.97	13.8	12.8	[d]26.3	.72	303
.0643	.278	54.2	19.9	8.06	20.36	20.4	------	[d]10.9	.20	144
			(30)	(12.0)						
.0651	.259	49.7	29.8	11.78	19.95	3.5	[40.7]	[d][47.4]	4.57	445
.0656	.281	53.7	29.2	11.55	20.01	6.3	[16.1]	[d][37.1]	1.52	520
.0655	.269	51.2	29.2	11.69	19.81	9.9	14.7	[d]28.3	.77	300
.0655	.284	54.1	29.5	11.73	19.98	15.2	14.0	[d]24.1	.40	333
.0641	.276	53.9	30.1	11.91	20.19	22.4	14.0	[d]18.8	.22	157
			(40)	(16.0)						
.0639	.254	49.7	40.1	15.85	20.39	3.9	[23.2]	[d][38.6]	2.07	645
.0651	.280	53.9	39.7	15.53	19.94	6.9	14.3	[d]29.8	.84	678
.0653	.282	54.1	39.3	15.87	20.11	11.0	13.6	[d]26.2	.47	360
.0643	.277	53.9	39.9	15.89	20.51	16.7	13.7	[d]22.3	.26	314
.0644	.264	51.1	39.8	15.81	20.23	24.6	14.2	[d]15.3	.13	135

[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

[d]Panel having only five stiffeners.

TABLE 1.– Concluded

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 0.26$ – Concluded

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi) (c)	$\bar{\sigma}_f$ (ksi) (c)	$\frac{P_1}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(0.26)	(60)	(12)	(4.8)	(20.3)					
0.0618	0.251	61.0	12.6	5.15	21.18	3.0	------	^{e}[72.4]	15.31	719 × 10^{-5}
.0625	.247	59.3	12.4	4.93	20.93	5.4	[56.3]	^{e}[64.5]	7.95	483
.0628	.248	59.2	12.4	4.90	20.67	8.4	[45.9]	^{e}[52.5]	4.13	346
.0621	.246	59.3	12.5	4.96	20.90	13.1	[22.0]	^{e}[28.8]	1.46	319
.0625	.247	59.3	13.4	4.93	20.85	19.0	[13.0]	^{e}[20.6]	.71	281
			(20)	(8.0)						
.0631	.250	59.3	20.2	8.10	20.41	3.0	[66.3]	^{e}[70.4]	9.53	641
.0632	.250	59.3	20.3	8.17	20.48	5.3	[41.6]	^{e}[47.3]	3.64	427
.0631	.250	59.3	20.3	8.05	20.48	8.3	[19.0]	^{e}[28.5]	1.39	365
.0641	.262	61.3	20.2	8.00	20.08	12.7	13.5	^{e}28.8	.88	398
.0641	.263	61.6	19.9	8.09	20.11	18.9	11.5	^{e}12.0	.25	170
			(30)	(12.0)						
.0650	.266	61.5	29.9	11.82	20.13	3.2	[45.8]	^{e}[49.1]	3.99	424
.0655	.258	59.2	29.2	11.66	19.83	5.7	[19.0]	^{e}[30.1]	1.45	398
.0657	.270	61.6	29.3	11.84	19.98	8.9	9.9	^{e}27.9	.83	355
.0648	.261	60.4	29.8	11.82	20.04	13.8	12.6	^{e}22.4	.44	289
.0658	.267	61.0	29.6	11.68	19.81	20.1	9.9	^{e}15.8	.20	166
			(40)	(16.0)						
.0639	.253	59.4	40.0	15.77	20.47	3.7	[24.7]	^{e}[32.5]	1.86	383
.0647	.253	58.7	39.6	15.75	20.08	6.4	12.2	^{e}29.8	.98	428
.0644	.264	61.4	39.9	15.65	20.16	10.0	11.8	^{e}24.9	.50	325
.0625	.256	61.4	40.0	16.37	20.93	15.9	9.8	^{e}20.9	.27	310
.0647	.263	61.1	39.8	15.70	20.14	22.7	10.8	^{e}16.1	.14	195
		(75)	(12)	(4.8)						
.0641	.265	77.7	12.0	4.80	20.32	2.9	------	^{e}[70.6]	15.37	1102
.0622	.240	72.4	12.6	4.95	20.95	5.0	[51.6]	^{e}[59.6]	7.98	473
.0622	.241	72.7	12.6	4.92	21.05	7.8	[46.4]	^{e}[50.7]	4.28	510
.0623	.242	72.8	12.5	4.95	20.93	12.1	[23.3]	^{e}[30.9]	1.70	288
.0637	.263	77.5	12.2	4.76	20.38	17.8	[5.8]	^{e}[13.7]	.48	171
			(20)	(8.0)						
.0632	.244	72.4	20.4	8.24	20.69	2.6	[59.5]	^{e}[62.8]	9.77	920
.0632	.246	72.9	20.4	8.00	20.45	4.8	[47.3]	^{e}[50.0]	4.17	478
.0632	.261	77.4	20.3	8.04	20.48	7.6	[14.9]	^{e}[24.3]	1.21	303
.0638	.264	77.6	20.1	8.12	20.34	11.8	[10.1]	^{e}[25.0]	.81	516
.0638	.264	77.6	19.8	8.12	20.34	17.4	6.3	^{e}19.0	.26	135
			(30)	(12.0)						
.0651	.252	72.6	30.0	11.72	20.02	3.0	[48.3]	^{e}[51.1]	4.66	548
.0653	.270	77.6	29.3	11.77	20.05	5.3	[14.3]	^{e}[25.6]	1.26	637
.0655	.270	77.4	29.0	11.70	19.98	8.3	[6.6]	^{e}[19.6]	.62	282
.0656	.272	77.6	29.4	11.63	20.00	12.7	7.4	^{e}16.1	.33	203
.0654	.270	77.6	29.5	11.24	19.94	18.8	5.8	^{e}15.2	.21	270
			(40)	(16.0)						
.0659	.272	77.4	38.9	15.45	19.85	3.2	[22.0]	^{e}[32.1]	1.98	367
.0611	.253	77.5	41.8	16.66	21.23	5.7	[11.5]	^{e}[26.6]	.91	478
.0678	.277	76.8	38.0	15.02	19.22	9.0	7.9	^{e}19.7	.43	315
.0611	.252	77.7	42.0	16.51	21.26	14.1	6.4	^{e}17.9	.25	303
.0645	.266	77.3	39.7	15.78	20.26	20.7	5.6	^{e}15.5	.15	226

[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

[e]Panel having only four stiffeners.

TABLE 2

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 0.40$

$t_s = .156$

$$\left[\frac{r}{t_W} = 1.00;\ \frac{d}{t_S} = 1.60;\ \frac{p}{t_S} = 4.81\right]$$

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi) (c)	$\bar{\sigma}_f$ (ksi) (c)	$\frac{P_f}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(0.40)	(50)	(12)	(4.8)	(12.8)					
0.0624	0.403	50.5	12.6	5.02	13.27	3.9	[51.1]	[60.4]	6.50	608×10^{-5}
.0622	.409	51.2	12.5	5.00	13.14	6.8	[18.5]	[40.7]	2.49	704
.0623	.406	50.9	12.6	4.94	13.21	10.7	16.4	40.1	1.57	596
.0632	.404	49.9	12.3	4.87	13.25	16.7	15.7	23.5	.61	323
.0625	.413	51.6	12.4	5.09	12.93	24.5	11.4	13.2	.23	168
			(20)	(8.0)						
.0643	.416	50.5	19.8	8.06	12.80	4.5	[23.2]	[43.5]	2.59	578
.0644	.412	50.0	19.9	7.93	13.86	7.7	16.1	42.9	1.49	516
.0627	.399	49.8	20.3	8.18	13.37	12.4	15.9	36.1	.78	475
.0629	.402	49.8	20.3	8.36	13.32	19.1	15.9	29.8	.42	385
.0638	.423	51.6	20.1	7.96	12.98	28.0	14.5	21.9	.20	253
			(30)	(12.0)						
.0649	.418	50.4	29.6	11.83	12.75	5.1	16.0	40.4	1.49	483
.0653	.416	49.8	29.2	11.77	12.54	9.0	16.7	37.0	.78	575
.0662	.423	50.0	28.9	11.61	12.21	14.0	15.7	32.7	.44	463
.0654	.419	50.0	29.7	11.71	12.66	21.3	15.8	30.3	.26	442
.0656	.422	50.1	29.2	11.70	12.77	31.9	17.3	21.7	.13	245
			(40)	(16.0)						
.0658	.419	49.7	39.1	15.38	12.29	5.5	15.3	35.4	.94	565
.0601	.385	50.0	42.7	16.78	13.62	9.7	13.1	29.6	.44	349
.0624	.415	52.0	41.5	16.24	13.03	15.2	14.7	27.0	.25	365
.0636	.422	51.8	40.5	16.14	12.71	23.6	15.1	26.4	.16	322
.0630	.416	51.5	40.7	16.24	12.98	34.9	15.5	22.0	.09	261
		(60)	(12)	(4.8)						
.0624	.407	61.1	12.5	5.02	13.27	3.6	[62.7]	[66.8]	7.77	648
.0622	.408	61.4	12.5	5.04	13.24	6.3	[32.4]	[39.9]	2.63	368
.0641	.419	61.3	11.9	4.93	12.76	10.3	[11.7]	[29.1]	1.19	615
.0622	.408	61.5	12.7	4.95	13.31	15.3	11.8	30.6	.82	340
.0623	.408	61.2	12.5	5.10	13.13	22.8	9.4	17.3	.32	180
			(20)	(8.0)						
.0642	.421	61.4	20.0	8.04	12.82	4.2	[23.2]	[38.1]	2.36	370
.0645	.424	61.6	20.0	8.11	13.00	7.2	[13.2]	[28.8]	1.40	794
.0641	.410	61.2	19.8	8.08	13.07	11.6	9.6	32.3	.73	552
.0643	.419	60.9	19.8	8.06	13.04	17.9	9.9	26.5	.39	488
.0630	.410	60.8	20.3	8.06	13.14	26.2	9.8	19.0	.19	243
			(30)	(12.0)						
.0655	.429	61.5	29.6	11.73	12.65	4.7	[13.8]	[38.6]	1.46	590
.0658	.431	61.3	29.0	11.57	12.51	8.1	9.7	32.4	.72	614
.0661	.429	60.7	29.0	11.62	12.53	13.2	9.9	29.8	.41	490
.0655	.427	61.0	29.1	11.61	12.18	20.4	11.0	26.5	.24	383
.0660	.430	61.0	29.2	11.56	12.24	29.6	10.4	20.8	.13	290
			(40)	(16.0)						
.0658	.433	61.6	38.8	15.55	12.36	5.2	10.6	31.5	.84	489
.0641	.394	57.5	40.0	16.12	12.61	7.7	12.0	31.3	.60	431
.0628	.408	60.7	40.7	16.26	12.95	14.4	10.5	26.2	.25	389
.0629	.408	60.8	40.6	16.18	13.08	22.3	10.9	24.6	.16	342
.0628	.408	60.7	40.8	16.21	12.94	32.6	11.3	18.9	.08	265
		(75)	(12)	(4.8)						
.0623	.386	72.6	12.5	5.10	13.29	3.3	[50.5]	[56.5]	7.28	590
.0623	.384	72.1	12.5	4.95	13.13	5.7	[31.6]	[37.8]	2.86	337
.0630	.407	75.3	12.2	4.89	12.90	9.4	[14.9]	[d][27.2]	1.23	532
.0624	.360	67.7	12.6	5.15	13.36	14.0	[10.0]	[20.2]	.66	334
.0625	.364	68.1	12.4	4.93	13.09	21.0	8.8	14.1	.29	290
			(20)	(8.0)						
.0646	.398	72.2	19.8	7.87	12.83	3.8	[29.4]	[37.1]	2.61	339
.0643	.373	67.8	19.9	7.98	12.88	6.6	[14.1]	[26.7]	1.16	404
.0633	.424	78.5	20.3	8.00	13.17	10.4	7.0	22.0	.52	428
.0636	.439	80.7	19.8	8.14	12.86	16.5	5.5	21.8	.33	358
.0634	.369	68.1	19.8	8.17	13.06	24.2	8.3	17.4	.21	218
			(30)	(12.0)						
.0653	.405	72.3	29.5	11.76	12.67	4.3	[10.1]	[29.7]	1.26	508
.0658	.382	67.9	29.0	11.79	12.59	7.7	9.1	28.8	.74	508
.0650	.378	67.8	29.7	11.82	12.58	11.8	10.9	29.7	.45	426
.0653	.450	80.4	29.2	12.07	12.53	18.4	6.0	22.5	.21	362
.0659	.456	80.9	29.1	11.66	12.42	27.2	5.5	17.9	.11	324
			(40)	(16.0)						
.0619	.359	67.3	41.4	16.26	13.14	4.8	9.7	32.5	1.02	536
.0649	.401	71.8	39.2	15.84	12.60	8.5	8.0	27.0	.45	380
.0614	.426	80.5	41.7	16.42	13.16	13.3	5.9	21.5	.21	392
.0664	.446	78.0	38.5	15.47	12.24	20.5	6.5	21.9	.14	376
.0645	.435	78.2	39.9	15.78	12.60	29.9	6.2	15.6	.07	254

[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

[d]Average of two tests.

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TABLE 3

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 0.63$

$$\left[\frac{r}{t_W} = 1.00;\ \frac{d}{t_S} = 1.84;\ \frac{p}{t_S} = 6.13\right]$$

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi) (c)	$\bar{\sigma}_f$ (ksi) (c)	$\frac{P_1}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(0.63)	(50)	(12)	(4.8)	(9.7)					
0.0617	0.602	49.8	12.5	4.99	10.18	5.1	[24.4]	[43.6]	2.67	646×10^{-5}
.0646	.627	49.6	11.9	4.61	9.41	9.1	17.5	43.2	1.49	490
.0633	.616	49.9	12.1	4.78	9.60	14.3	16.2	38.3	.84	549
.0631	.618	50.0	12.5	5.04	9.79	21.7	16.7	33.4	.47	412
.0631	.612	49.6	12.5	5.01	9.56	31.9	16.1	19.2	.19	161
			(20)	(8.0)						
.0630	.615	49.9	20.6	8.06	9.81	6.0	15.2	42.0	1.40	697
.0644	.629	49.9	19.8	8.04	9.60	10.5	17.3	40.6	.79	558
.0633	.618	49.8	20.3	8.18	9.76	16.3	17.4	37.8	.46	487
.0634	.618	49.7	20.3	8.33	9.75	25.2	16.5	35.4	.28	461
.0641	.622	49.6	19.8	7.93	9.57	37.8	17.4	21.8	.12	223
			(30)	(12.0)						
.0657	.642	50.0	29.6	11.74	9.57	6.5	15.7	38.3	.85	600
.0655	.637	49.7	29.5	12.18	9.43	11.5	17.4	35.1	.45	538
.0658	.641	49.7	29.2	11.67	9.70	18.2	18.6	34.8	.28	433
.0652	.637	49.7	29.4	11.70	9.47	28.2	17.5	33.8	.18	400
.0647	.630	49.6	29.7	11.84	9.55	41.5	17.4	22.9	.08	230
			(40)	(16.0)						
.0658	.645	50.1	39.2	15.53	9.48	7.1	16.6	33.9	.56	550
.0644	.630	49.8	39.7	15.62	9.67	12.4	17.4	31.8	.30	500
.0645	.633	50.1	39.8	15.58	9.65	19.4	17.2	29.2	.18	410
.0628	.613	50.0	40.8	16.13	9.76	30.1	18.3	26.3	.10	327
.0638	.627	50.2	40.2	16.00	9.84	44.2	18.4	20.2	.05	188
		(60)	(12)	(4.8)						
.0616	.599	59.6	12.6	5.00	10.20	4.8	[22.0]	[38.5]	2.42	556
.0620	.603	59.7	12.6	4.86	10.06	8.1	13.3	38.6	1.43	682
.0638	.620	59.6	12.2	4.99	9.69	13.3	10.8	35.0	.80	635
.0632	.591	57.3	12.3	4.96	9.79	20.6	11.8	29.6	.45	450
.0634	.609	58.8	12.2	4.86	9.59	30.2	11.2	20.2	.20	227
			(20)	(8.0)						
.0634	.613	59.3	20.1	8.01	9.59	5.7	10.3	39.6	1.37	560
.0646	.631	59.7	19.6	7.98	9.49	10.0	12.0	35.0	.69	624
.0639	.623	59.7	20.1	8.26	9.83	15.3	11.8	33.7	.42	550
.0618	.588	58.2	20.5	8.22	9.83	24.0	12.7	31.2	.26	440
.0642	.619	59.1	20.0	8.07	9.63	35.0	12.6	21.2	.12	260
			(30)	(12.0)						
.0660	.643	59.7	29.0	11.94	9.44	6.3	12.2	36.6	.82	595
.0660	.640	59.5	29.3	11.95	9.52	10.9	11.6	32.8	.42	520
.0650	.625	59.1	29.6	11.82	9.51	17.3	11.9	31.2	.26	490
.0644	.618	58.8	29.7	11.85	9.60	26.9	12.2	29.1	.15	370
.0653	.634	59.4	29.3	11.80	9.38	39.5	12.6	23.0	.08	288
			(40)	(16.0)						
.0640	.610	58.4	39.7	15.95	9.42	6.8	11.0	31.9	.53	505
.0661	.637	59.2	39.0	15.48	9.35	11.8	12.4	29.6	.28	463
.0638	.619	59.3	40.3	15.93	9.69	18.6	11.3	26.9	.16	364
.0608	.580	58.3	42.1	16.74	10.08	28.8	13.3	23.4	.09	258
.0639	.609	58.3	40.0	15.90	9.95	42.5	13.0	18.2	.05	198
		(75)	(12)	(4.8)						
.0617	.602	74.6	12.6	5.07	10.17	4.5	[17.3]	[36.1]	2.33	345
.0618	.609	75.5	12.8	4.99	10.08	7.7	[11.2]	[32.1]	1.21	493
.0614	.591	73.7	12.6	4.93	10.07	12.3	7.4	30.2	.73	703
.0635	.609	73.3	12.4	4.85	9.74	18.6	7.4	25.0	.39	368
.0625	.612	74.9	12.3	4.93	9.97	28.0	6.5	19.0	.20	265
			(20)	(8.0)						
.0638	.616	73.9	19.9	7.96	8.61	5.2	[10.0]	[36.2]	1.34	635
.0645	.631	74.9	19.7	7.96	9.59	9.2	7.6	32.2	.66	678
.0637	.616	74.1	20.0	7.97	9.70	14.3	7.0	30.6	.40	527
.0646	.629	74.6	19.7	7.87	9.42	22.3	7.8	26.4	.18	453
.0628	.616	75.2	20.3	8.09	9.92	32.6	7.8	19.6	.11	280
			(30)	(12.0)						
.0654	.633	74.1	29.4	11.67	9.53	5.8	7.4	31.6	.72	640
.0645	.635	75.5	29.7	11.92	9.43	10.3	7.5	29.7	.38	485
.0655	.637	74.4	29.2	11.73	9.51	16.2	7.4	27.3	.23	478
.0654	.637	74.5	29.7	11.75	9.46	24.7	7.8	26.2	.14	406
.0642	.618	73.5	29.8	11.97	9.40	37.0	8.6	20.7	.08	293
			(40)	(16.0)						
.0652	.632	74.2	39.4	15.62	9.40	6.4	7.0	30.1	.50	527
.0638	.619	74.0	39.0	15.92	9.21	11.4	7.6	25.8	.24	508
.0644	.624	74.2	39.9	15.81	9.68	17.5	7.9	23.7	.14	358
.0631	.622	75.7	40.4	16.14	9.80	27.3	8.1	19.9	.08	315
.0630	.623	75.8	40.6	16.16	9.98	39.9	8.5	17.4	.04	202

[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

TABLE 4

TEST DATA AND PROPORTIONS OF SPECIMENS HAVING $\frac{t_W}{t_S} = 1.00$

$\left[\frac{r}{t_W} = 1.00;\ \frac{d}{t_S} = 1.95;\ \frac{p}{t_S} = 5.86\right]$

Proportions of test specimens[a]							Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (b)	σ_{cr} (ksi)	$\bar{\sigma}_f$ (ksi)	$\frac{P_1}{L/\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
(0.064)	(1.00)	(50)	(12)	(4.8)	(6.7)					
0.0626	1.000	51.1	12.4	5.00	7.07	6.8	16.4	45.8	1.59	920×10^{-5}
.0605	.968	51.2	12.9	4.93	7.24	11.8	19.5	43.4	.87	820
.0605	.970	51.3	12.9	5.09	7.41	18.5	18.3	41.7	.53	540
.0617	.977	50.5	12.6	5.04	7.02	28.6	20.3	38.5	.32	460
.0622	.996	51.8	12.6	5.05	6.99	41.9	20.5	21.5	.12	220
			(20)	(8.0)						
.0629	.994	50.5	20.3	8.08	7.05	7.5	18.9	46.9	1.03	690
.0638	1.022	51.5	20.0	7.96	6.70	13.3	18.5	44.0	.54	605
.0637	1.025	51.5	20.0	7.97	7.03	20.7	18.6	42.5	.34	557
.0635	1.018	51.5	19.9	8.16	6.90	32.2	21.0	35.8	.18	420
.0635	1.007	51.0	20.3	8.13	6.90	46.7	21.4	23.2	.05	226
			(30)	(12.0)						
.0667	1.043	50.0	27.7	11.56	6.64	7.9	18.8	40.1	.66	486
.0656	1.028	50.6	29.2	11.71	6.60	13.8	21.8	36.9	.35	601
.0658	1.045	51.0	29.1	11.67	6.50	21.9	21.4	35.7	.21	409
.0654	1.044	51.1	29.1	11.75	6.47	34.0	20.2	31.9	.12	350
.0661	1.037	50.3	29.0	11.62	6.32	49.8	21.2	22.1	.06	202
			(40)	(16.0)						
.0627	.989	50.8	41.1	16.41	6.67	8.1	17.5	33.8	.46	540
.0644	1.014	50.6	39.6	15.80	6.49	14.3	19.3	34.8	.27	298
.0643	1.007	50.0	39.9	16.17	7.11	22.3	20.3	28.7	.14	360
.0631	1.002	50.8	40.9	16.15	6.63	34.3	19.7	24.7	.08	268
.0658	1.035	50.3	38.9	15.61	6.50	50.7	19.2	19.6	.04	186
		(60)	(12)	(4.8)						
.0623	.950	58.5	12.4	5.02	6.55	6.5	13.4	42.2	1.50	896
.0632	.963	58.5	12.3	4.92	6.62	11.2	13.5	40.4	.84	890
.0619	.945	58.7	12.7	4.95	6.92	17.4	13.6	38.0	.50	605
.0620	.943	58.4	12.4	4.94	6.82	27.6	15.3	32.4	.27	414
.0642	.969	58.2	12.1	4.95	6.51	40.3	15.8	20.7	.12	214
			(20)	(8.0)						
.0633	.904	55.1	20.2	8.03	6.45	7.2	16.1	43.8	.99	662
.0636	.925	56.1	20.2	8.15	6.50	12.5	16.0	42.1	.54	626
.0633	.963	58.7	20.3	8.35	6.92	19.9	15.5	38.9	.30	533
.0635	.926	56.2	19.9	8.00	6.58	31.2	16.0	35.3	.18	439
.0640	.967	57.9	19.9	7.86	6.45	45.4	16.3	20.1	.07	197
			(30)	(12.0)						
.0651	.987	58.4	29.4	11.88	6.58	7.7	15.8	37.2	.59	542
.0659	1.002	58.6	29.2	11.66	6.50	13.5	15.7	35.2	.32	488
.0650	.982	57.9	29.4	11.71	6.51	21.5	16.1	33.9	.19	463
.0640	1.001	59.9	29.9	12.00	6.61	33.0	15.6	29.0	.10	336
.0625	.909	56.0	30.5	12.29	6.85	48.8	17.0	19.8	.05	204
			(40)	(16.0)						
.0646	.980	58.4	39.6	15.76	6.63	8.0	14.3	32.3	.41	536
.0660	.997	58.2	39.0	15.57	6.41	13.9	14.3	30.4	.22	502
.0653	1.027	60.7	39.5	15.56	6.55	21.8	14.6	26.8	.12	396
.0631	.918	56.0	40.5	16.13	6.78	34.0	12.6	24.2	.07	287
.0648	.939	56.6	39.6	15.70	6.60	49.9	15.9	19.4	.04	174
		(75)	(12)	(4.8)						
.0627	.975	74.6	12.4	4.42	6.91	5.9	[8.3]	[40.2]	1.45	598
.0623	.918	70.9	12.5	4.92	6.88	10.6	9.8	35.6	.75	890
.0616	.902	70.5	12.6	5.00	6.87	16.6	7.2	33.1	.44	636
.0619	.900	69.8	12.6	5.02	6.91	25.5	10.3	29.4	.26	406
.0624	.896	69.0	12.2	4.90	6.70	38.5	10.0	20.9	.13	267
			(20)	(8.0)						
.0642	.943	70.9	20.2	7.97	6.67	6.8	12.0	38.3	.83	712
.0641	.932	70.1	20.9	8.09	6.53	11.9	10.3	37.0	.47	586
.0640	.940	70.6	20.0	8.15	6.69	19.0	10.7	34.3	.25	590
.0648	.949	70.1	19.7	7.84	6.53	29.4	10.4	31.7	.16	446
.0636	.929	70.1	20.2	8.07	6.65	42.9	10.5	20.6	.07	245
			(30)	(12.0)						
.0673	1.062	76.1	28.4	11.41	6.36	7.5	8.2	33.5	.48	498
.0657	1.016	74.3	29.2	11.68	6.51	13.0	10.5	32.0	.27	504
.0657	.995	72.9	29.2	11.70	6.52	20.6	10.0	30.3	.16	466
.0656	1.014	74.3	29.2	11.60	6.46	31.8	10.6	28.0	.10	403
.0660	1.055	76.8	28.9	11.65	6.82	47.1	9.4	19.6	.04	228
			(40)	(16.0)						
.0638	.932	70.2	40.4	15.97	6.56	7.8	9.8	29.4	.35	543
.0636	1.010	76.2	41.4	16.33	6.81	13.5	8.3	31.8	.21	592
.0633	1.011	76.7	40.5	16.17	6.61	21.4	9.2	25.3	.10	382
.0638	1.022	76.7	40.4	16.05	6.56	42.3	8.8	23.3	.06	239
.0602	.868	69.1	42.6	17.02	6.95	47.3	10.3	17.8	.04	183

NACA

[a]Nominal proportions are given in parentheses.

[b]Lengths are for actual test specimens for which $c \approx 3.75$.

[c]Bracketed values are for panels having bay width b_S greater than length L.

TABLE 5

TEST DATA AND PROPORTIONS OF SPECIMENS FOR INVESTIGATING THE EFFECT OF REDUCING THE STIFFENER THICKNESS FROM 0.102 INCH TO 0.064 INCH

Proportions of test specimens										Test data			
t_W (in.)	$\frac{t_W}{t_S}$	$\frac{b_S}{t_S}$	$\frac{b_W}{t_W}$	$\frac{b_F}{t_W}$	$\frac{b_A}{t_W}$	$\frac{L}{b_W}$ (a)	$\frac{r}{t_W}$	$\frac{d}{t_S}$	$\frac{p}{t_S}$	σ_{cr} (ksi) (b)	$\bar{\sigma}_f$ (ksi) (b)	$\frac{P_1}{L\sqrt{c}}$ (ksi)	$\bar{\epsilon}_f$
0.1028	0.413	40.9	12.0	4.84	12.81	4.1	0.92	1.76	5.02	[41.1]	[57.2]	6.27	500×10^{-5}
.0620	.400	40.3	12.6	4.97	13.35	4.3	1.00	1.61	4.84	[56.0]	[64.7]	6.48	578
.1003	.404	40.3	40.9	16.25	13.03	5.9	.94	1.76	5.03	23.4	38.6	.99	560
.0642	.415	40.5	40.1	15.98	13.06	6.0	1.00	1.62	4.85	24.0	40.0	1.01	464
.0993	.391	49.3	12.4	4.89	12.95	3.8	.94	1.73	4.95	[57.8]	[62.3]	7.23	620
.0624	.403	50.5	12.6	5.02	13.27	3.9	1.02	1.61	4.84	[51.3]	[60.4]	6.50	608
.1059	.417	49.3	39.0	15.33	12.14	5.5	.89	1.73	4.94	18.8	37.0	1.00	400
.0658	.419	49.7	39.1	15.38	12.29	5.5	.97	1.59	4.78	15.3	35.4	.94	565
.0992	.649	40.7	12.4	4.89	9.94	5.6	.95	2.04	6.52	29.6	51.6	2.88	750
.0613	.597	39.8	12.8	5.06	9.91	5.6	1.04	1.83	6.09	28.6	50.1	2.97	719
.1025	.673	41.2	40.1	15.90	9.60	7.5	.92	2.05	6.56	24.2	35.9	.60	474
.0677	.659	39.8	37.8	15.11	9.20	7.4	.95	1.82	6.07	24.9	37.6	.65	538
.1001	.636	49.7	12.3	4.76	9.76	6.2	.94	1.99	6.36	[23.3]	[43.8]	2.60	670
.0617	.602	49.8	12.5	4.99	10.18	5.1	1.04	1.83	6.10	[24.4]	[43.6]	2.67	646
.1045	.663	49.4	39.2	15.42	9.44	7.2	.90	1.98	6.34	17.9	34.4	.57	530
.0658	.645	50.1	39.2	15.53	9.48	7.1	.97	1.84	6.14	16.6	33.9	.56	550
.0980	.963	39.6	12.5	4.83	6.70	6.8	.96	1.83	6.10	33.3	52.3	2.00	856
.0620	.886	41.5	12.5	4.97	6.84	6.9	1.03	1.78	5.36	34.6	52.7	2.07	885
.1050	1.020	39.8	39.2	15.46	6.52	8.2	.89	1.82	6.08	25.8	35.6	.55	520
.0640	.965	38.8	39.8	15.95	6.40	8.3	1.00	1.88	5.69	24.7	37.6	.58	515
.0984	.966	50.0	12.5	4.83	6.66	6.8	.95	1.84	6.13	20.0	48.1	1.70	886
.0626	1.000	51.1	12.4	5.00	7.07	6.8	1.04	1.99	5.99	16.4	45.8	1.59	920
.1044	1.026	49.8	39.3	15.47	6.48	8.1	.90	1.84	6.14	18.2	32.9	.45	536
.0627	.989	50.8	41.1	16.41	6.67	8.1	1.01	1.99	5.92	17.5	33.8	.46	540

[a]Lengths are for actual test specimens for which $c \approx 3.75$.

[b]Bracketed values are for panels having bay width b_S greater than length L.

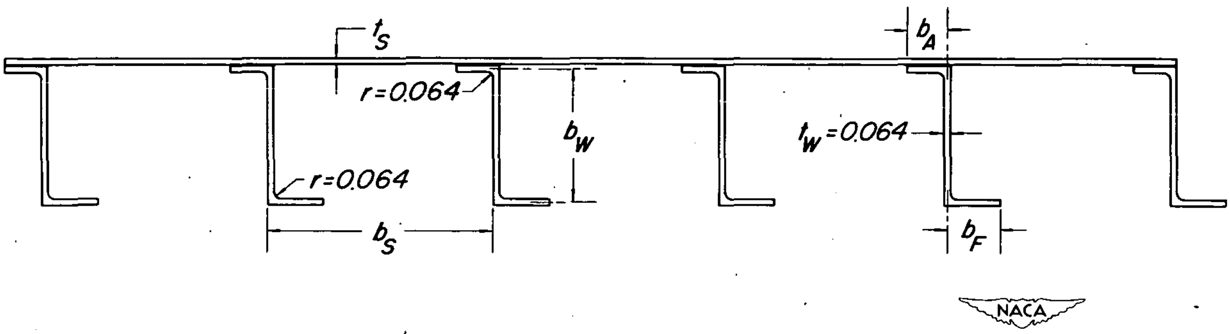

Figure 1.— Cross section of test specimens.

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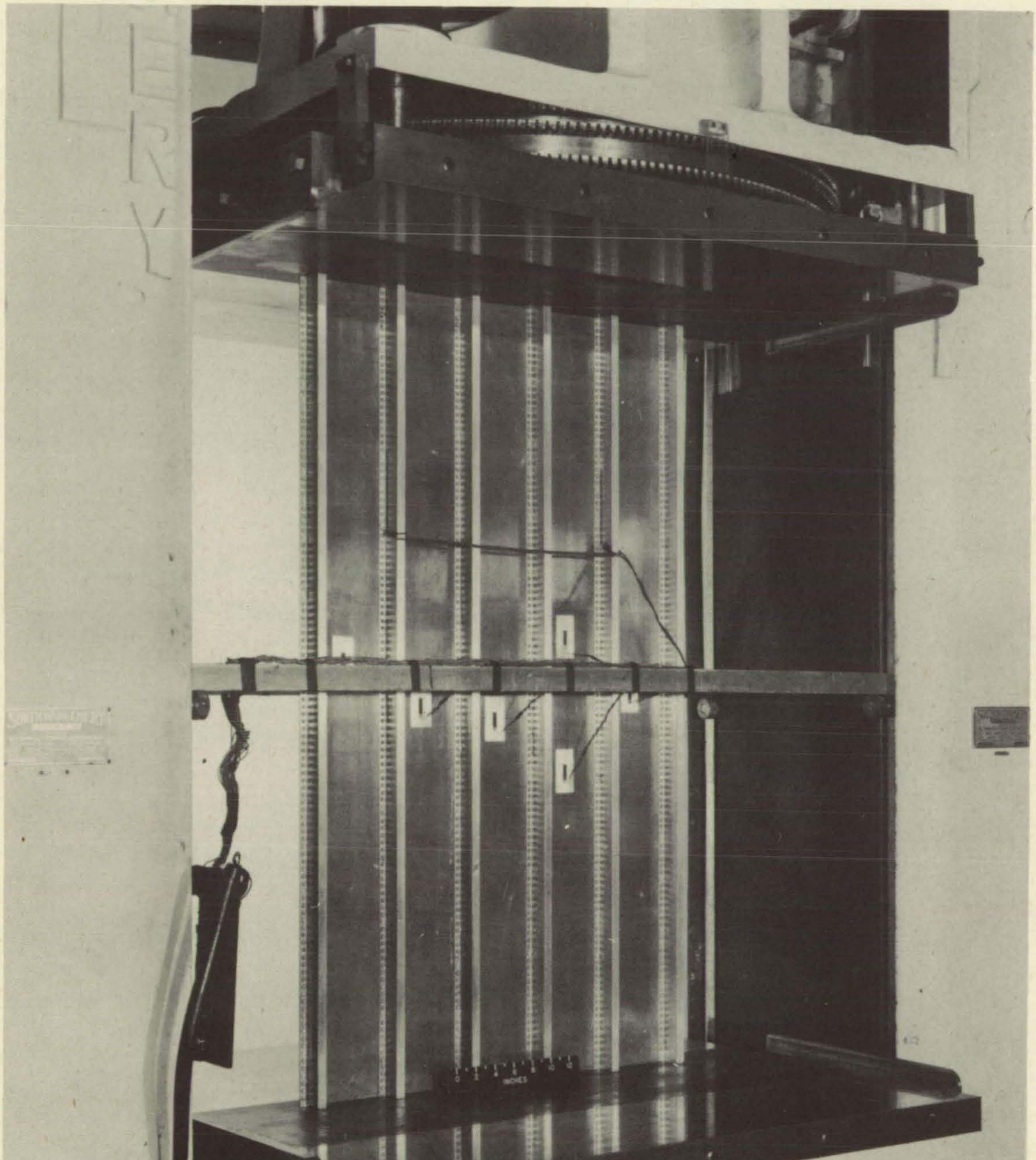

Figure 2.- Panel prepared for testing.

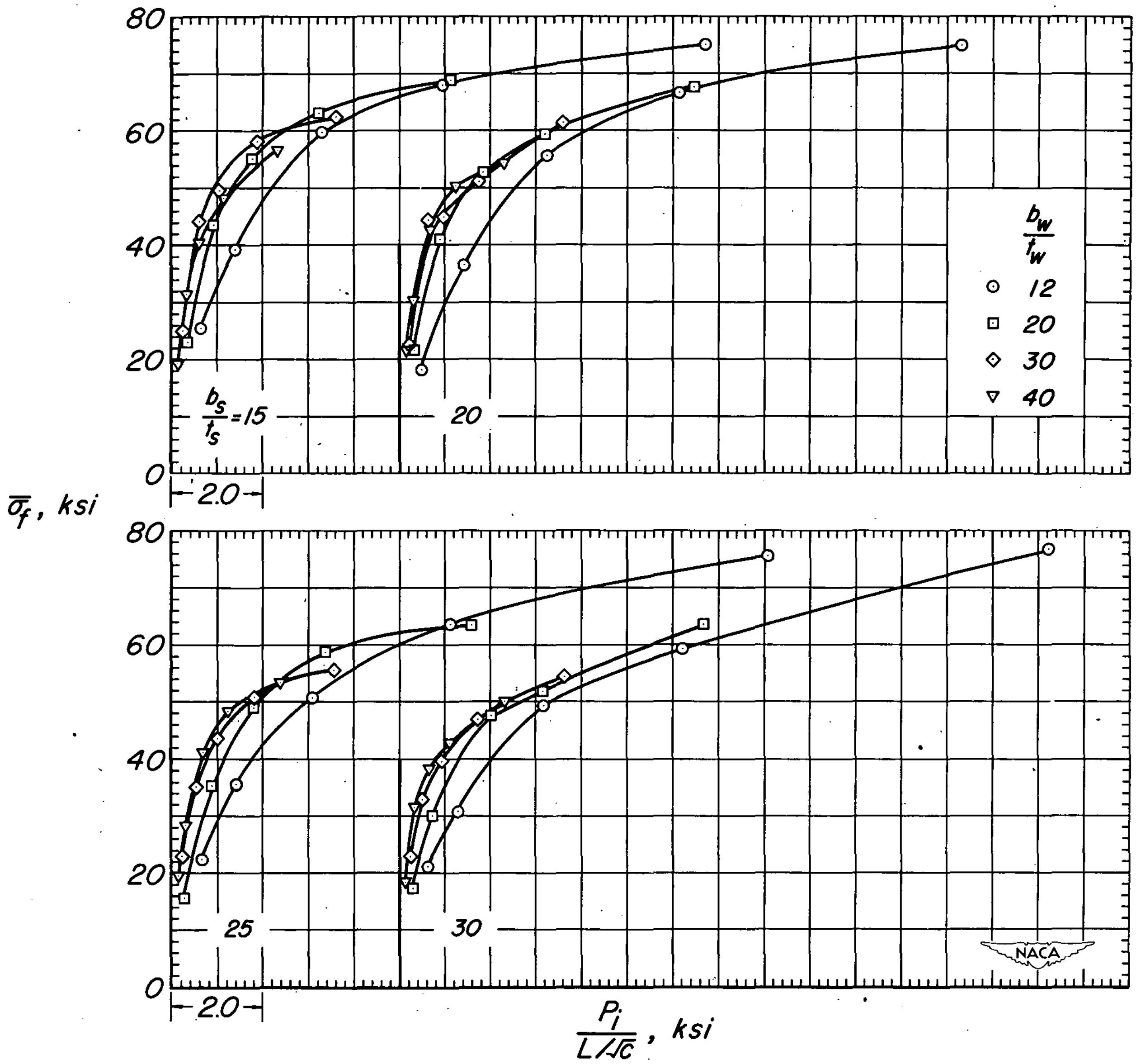

Figure 3.— Compressive strength of 75S-T6 aluminum-alloy flat panels with extruded Z-section stiffeners. $\frac{t_w}{t_s} = 0.26$.

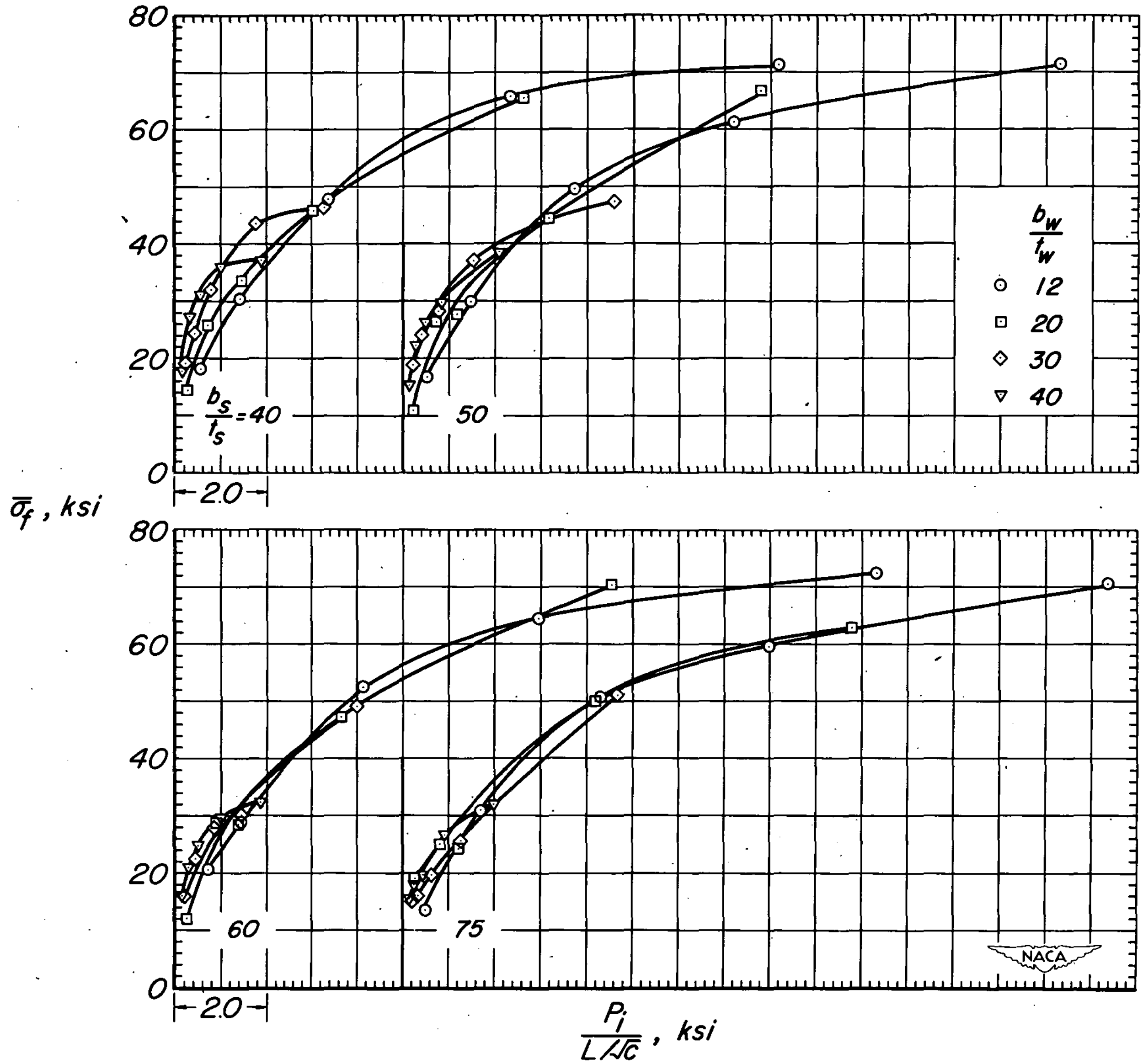

Figure 3.– Concluded. $\frac{t_w}{t_s} = 0.26$.

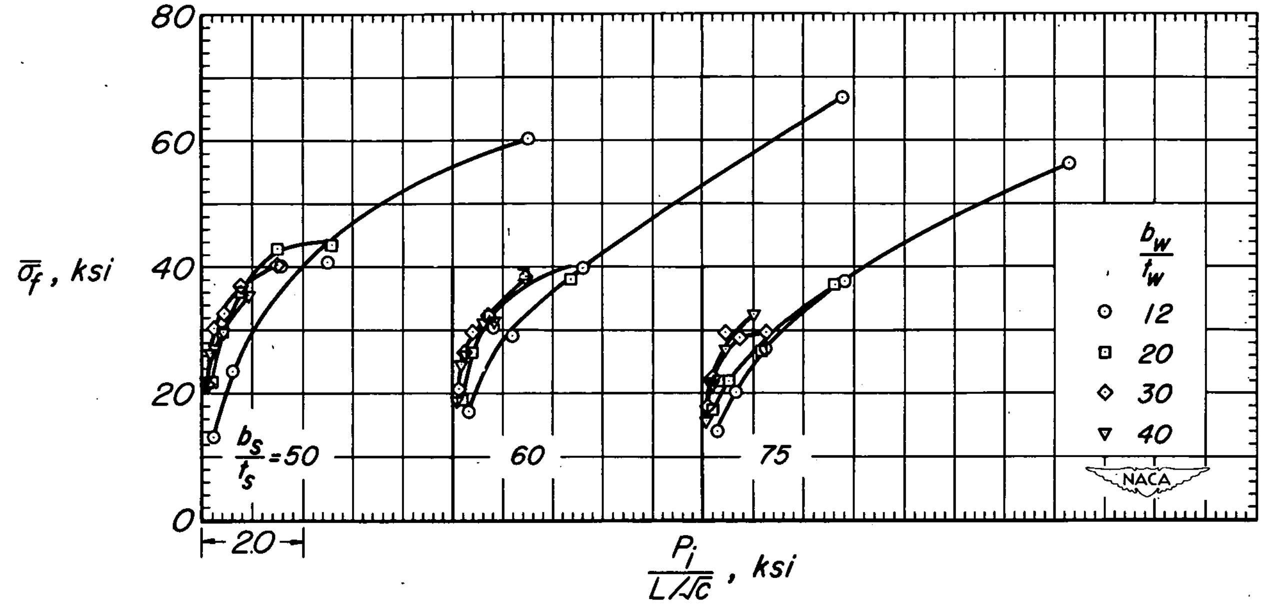

Figure 4.—Compressive strength of 75S-T6 aluminum-alloy flat panels with extruded Z-section stiffeners. $\frac{t_w}{t_s} = 0.40$.

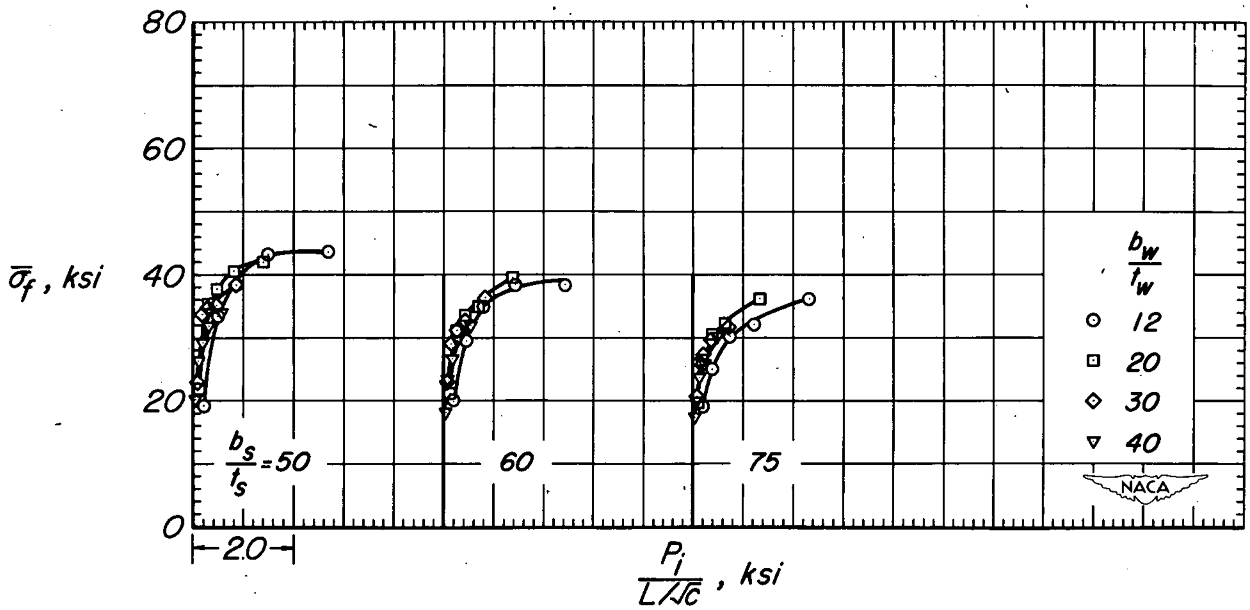

Figure 5.—Compressive strength of 75S-T6 aluminum-alloy flat panels with extruded Z-section stiffeners. $\frac{t_w}{t_s} = 0.63$.

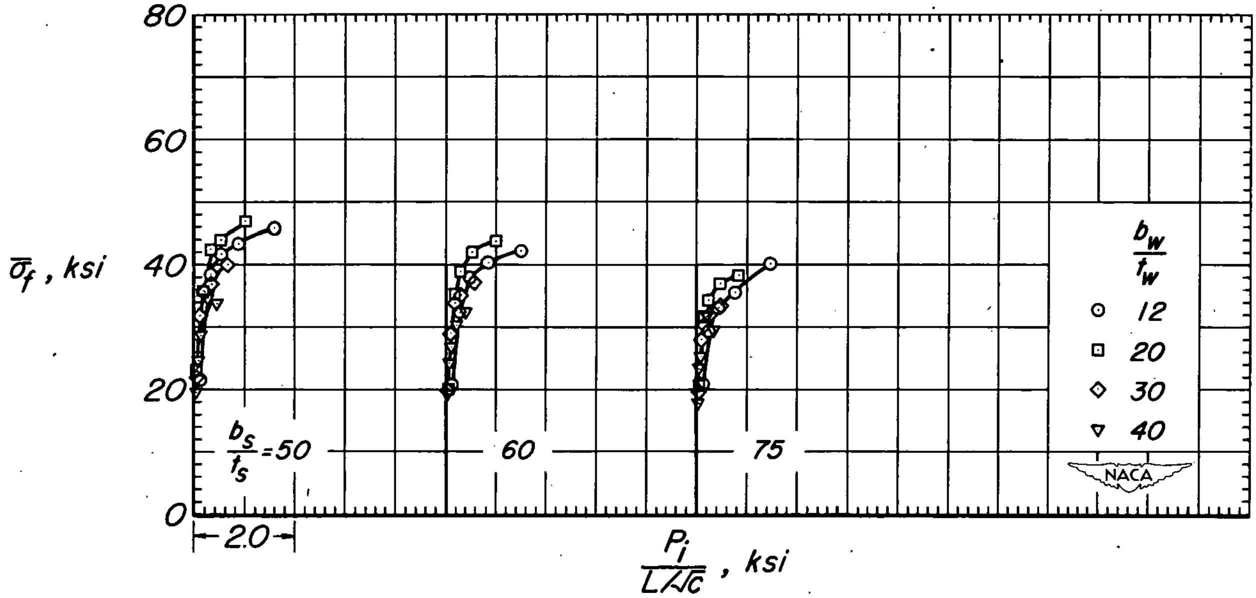

Figure 6.— Compressive strength of 75S-T6 aluminum-alloy flat panels with extruded Z-section stiffeners. $\frac{t_w}{t_s} = 1.00$.

Abstract

The experimental results are presented for the second part of an investigation of the compressive strength of 75S-T6 aluminum-alloy flat panels with longitudinal extruded Z-section stiffeners. This part of the investigation is particularly concerned with panels in which the ratio of the thickness of the stiffener material to the skin material is small and the ratio of stiffener spacing to skin thickness is large.