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COMPARISON OF THE COMPRESSIVE STRENGTH OF PANELS WITH ALCLAD 24S-T81 SHEET OR WITH ALCLAD 24S-T86 SHEET RIVETED TO ALCLAD 24S-T84 HAT-SECTION STIFFENERS

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NACA

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MEMORANDUM REPORT

for the

Army Air Forces, Materiel Command

L-587

COMPARISON OF THE COMPRESSIVE STRENGTH OF PANELS WITH ALCLAD 24S-T81 SHEET OR WITH ALCLAD 24S-T86 SHEET RIVETED TO ALCLAD 24S-T84 HAT-SECTION STIFFENERS

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SUMMARY

Compression tests were made of two groups of panel specimens with hat-section stiffeners. The groups were identical except that the flat sheet of one group was Alclad 24S-T81 and of the other Alclad 24S-T86.

Results of the tests are given in tables or charts which show the average stress at which the sheet buckles and the average stress at the maximum load.

An increase in strength of several percent was generally obtained by the use of Alclad 24S-T86 sheet instead of Alclad 24S-T81 sheet for the panels with close stiffener spacing and with the effective sheet area at maximum load greater than 20 percent of the total area of the panel.

INTRODUCTION

An extensive investigation was made of the compressive strength of flat panels of Alclad 24S-T81 sheet (commercial Alclad 24S-T sheet, artificially aged) riveted to Alclad 24S-T84 stiffeners (stretched and artificially aged Alclad 24S-T), and the results of the investigation are presented in reference 1. For the specimens reported in reference 1 the minimum guaranteed yield strengths of the Alclad 24S-T81 and Alclad 24S-T84 materials were 57,000 and 64,000 pounds per square inch, respectively. At the request of the Army Air Forces and the Consolidated Vultee Aircraft Corporation who supplied the specimens, an extension of the test program of reference 1 was made to determine if the use of Alclad 24S-T86 sheet (commerical Alclad 24S-RT, artificially aged), with a minimum guaranteed yield strength of 66,000 psi, in place of the Alclad 24S-T81 sheet would cause an increase in the strength of the panels. Accordingly, 48 panels made with Alclad 24S-T86 sheet were tested in order to compare the test results with those of a geometrically identical group of panels of reference 1.

TEST SPECIMENS AND METHOD OF TESTING

A typical cross section of a panel is shown in figure 1 and the nominal panel dimensions that correspond to the symbols of this figure are shown in table I, which presents the test program, and figure 2. The four stiffeners, equally spaced, were riveted to the sheet with commercial 100° countersunk-head rivets. The direction of the grain of sheet and stiffeners was parallel to the length of the specimen. The panels were tested with flat ends. Representative compressive stress-strain curves for each of the three tempers of the Alclad 24S-T material are given in figure 3.

Strains in the sheet and stiffeners were measured by Tuckerman optical strain gages. Sixteen gages were attached at approximately the midlength of the specimen. Shortening of each specimen was measured by means of dial indicators.

The detailed information concerning construction of the specimens and method of testing given in reference 1 also pertains to the test specimens reported herein.

RESULTS AND DISCUSSION

Tables II, III, and IV contain for each specimen of the two groups the average stress at which sheet buckling occurred and the average stress at the maximum load. The maximum strengths of the panels are shown in figure 2 by column curves. For convenience in application two abscissa scales for two values of length corresponding to end-fixity coefficients of $c = 1$ and $c = 1.5$ are given.

The test results were adjusted to give the strength of panels having equal numbers of stiffeners and bays and having the minimum guaranteed material properties listed in table V. The procedure followed in making these adjustments is outlined in reference 1.

Only the specimens with 6-inch stiffener spacing show a significant increase in strength when the flat sheet material is Alclad 24S-T86. For these panels the greatest value of b/t, the ratio of the width of flat sheet between any two adjacent rivet rows to the sheet thickness, did not exceed 45. A study of the strains in the sheet revealed that little or no sheet buckling occurred and that the sheet was almost fully effective at the maximum load. In these specimens, the effective area of the sheet at failure was between 20 percent and 40 percent of the total panel area.

The panels with stiffener spacing greater than 6 inches, and hence values of b/t greater than 45, showed considerable sheet buckling. From the test data it is seen that in general panels with wide stiffener spacing showed no gain in strength when the sheet material was Alclad 24S-T86.

Tables II, III, and IV list the increase in strength for each specimen with Alclad 24S-T86 sheet. The increase is expressed as a percentage of the strength of the corresponding panel made with Alclad 24S-T81 sheet.

A number of tests of duplicate panels have shown that some scatter can be expected in the results of compression tests on stiffened panels which are identical except for the slight unavoidable variations introduced during fabrication. Therefore, the substitution of Alclad 24S-T86 sheet for Alclad 24S-T81 sheet should be considered to have an effect on the strength of the panels only if the test results show that a change of several percent occurs consistently.

CONCLUSIONS

The compressive strength of specimens with 9- and 12-inch stiffener spacing was in general not increased by the replacement of the sheet material. Appreciable buckling occurred so that the effective sheet area at the maximum load was less than 20 percent of the total panel area.

For specimens with 6-inch stiffener spacing, the panel strengths were in general increased several percent by the use of Alclad 24S-T86 sheet. For these specimens the effective area of sheet at maximum load was greater than 20 percent of the total panel area.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., April 7, 1944.

REFERENCE

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1. Kotanchik, Joseph N., Weinberger, Robert A., Zender, George W., and Neff, John: Compressive Strength of Flat Panels with Z- and Hat-Section Stiffeners. NACA ARR No. L4F01, 1944.

TABLE 1

Specimen dimensions and outline of test program for panels with Alclad 24S-T81 or Alclad 24S-T86 sheet riveted to Alclad 24S-T84 stiffeners.

b_w	3														
stiffener	Y20-30					Y20-32					Y20-40				
t_w	.125					.156					.188				
b_s	6			9	12	6			9	12	6			9	12
width	$22\frac{15}{16}$			$31\frac{15}{16}$	$40\frac{5}{16}$	23			32	41	$23\frac{3}{16}$			$32\frac{3}{16}$	$41\frac{3}{16}$
t_s	.080	.102	.125	.080	.080	.091	.125	.156	.091	.091	.102	.156	.187	.102	.102
specimen no. / length	273 / 21	277 / 21	280 / 21	283 / 21	286 / 21	257 / 21	261 / 21	264 / 21	267 / 21	270 / 21	241 / 21	245 / 21	248 / 21	251 / 21	254 / 21
specimen no. / length	274 / 39	278 / 43	281 / 43	284 / 43	287 / 43	258 / 39	262 / 43	265 / 43	268 / 43	271 / 43	242 / 39	246 / 43	249 / 43	252 / 43	255 / 43
specimen no. / length	275 / 57	279 / 65	282 / 65	285 / 65	288 / 65	259 / 57	263 / 65	266 / 65	269 / 65	272 / 65	243 / 57	247 / 65	250 / 65	253 / 65	256 / 65
specimen no. / length	276 / 75					260 / 75					244 / 75				

TABLE II.- AVERAGE STRESS[a] AT WHICH SHEET BUCKLING OCCURS AND AVERAGE STRESS[a] AT MAXIMUM LOAD

[Panels with stiffener section Y20-30]

		Panels with Alclad 24S-T81 sheet[b]		Panels with Alclad 24S-T86 sheet		
Specimen number	Stiffener spacing b_s, in.	Buckling stress σ_{cr}, psi	Maximum stress σ_{max}, psi	Buckling stress σ_{cr}, psi	Maximum stress σ_{max}, psi	Increase in maximum stress[c], percent
273	6	27,010	50,680	33,920	51,020	0.7
274	6	23,440	49,310	30,950	51,250	3.9
275	6	27,350	50,780	30,570	51,470	1.4
276	6	25,160	45,940	29,380	49,570	7.9
277	6	38,900	51,800	38,670	53,050	2.4
278	6	39,310	51,700	39,680	52,520	1.7
279	6	40,190	48,900	42,620	52,360	7.1
280	6	------	51,230	50,600	56,490	10.3
281	6	------	52,450	48,100	54,130	3.2
282	6	------	52,860	------	52,860	0
283	9	9,200	43,680	13,970	44,160	1.1
284	9	13,290	47,710	13,200	43,490	-.5
285	9	13,490	43,880	12,590	43,930	.1
286	12	5,960	40,310	6,670	40,900	1.5
287	12	6,270	39,930	6,760	39,660	-.7
288	12	5,760	38,540	6,870	39,680	2.9

[a]Stresses apply to panels with equal numbers of stiffeners and bays and with minimum guaranteed properties for the materials.

[b]Results are repeated from reference 1.

[c]The increase is given as percentage of the strength of the panel with Alclad 24S-T81 sheet.

TABLE III.- AVERAGE STRESS[a] AT WHICH SHEET BUCKLING OCCURS AND AVERAGE STRESS[a] AT MAXIMUM LOAD

[Panels with stiffener section Y20-32]

		Panels with Alclad 24S-T81 sheet[b]		Panels with Alclad 24S-T86 sheet		
Specimen numbers	Stiffener spacing b_s, in.	Buckling stress σ_{cr}, psi	Maximum stress σ_{max}, psi	Buckling stress σ_{cr}, psi	Maximum stress σ_{max}, psi	Increase in maximum stress[c]
257	6	26,780	56,050	28,590	58,070	3.6
258	6	31,430	57,450	36,000	58,100	1.1
259	6	------	54,880	32,990	54,100	-1.4
260	6	34,270	52,430	32,380	54,930	4.8
261	6	45,200	55,740	49,600	58,180	4.3
262	6	46,900	54,240	48,200	56,890	4.9
263	6	46,700	51,170	50,900	55,430	8.3
264	6	------	56,500	------	59,310	5.0
265	6	------	55,410	------	58,020	4.7
266	6	------	53,060	------	58,280	9.8
267	9	15,710	49,010	17,720	51,180	4.3
268	9	16,920	47,520	16,760	48,230	1.5
269	9	17,550	46,710	15,200	48,590	3.6
270	12	8,380	44,870	6,140	45,510	1.4
271	12	7,240	43,270	8,120	44,480	2.8
272	12	7,370	41,590	7,280	41,460	-.3

[a]Stresses apply to panels with equal numbers of stiffeners and bays and with minimum guaranteed properties for the materials.

[b]Results are repeated from reference 1.

[c]The increase is given as percentage of the strength of the panel with Alclad 24S-T81 sheet.

TABLE IV.- AVERAGE STRESS[a] AT WHICH SHEET BUCKLING OCCURS AND AVERAGE STRESS[a] AT MAXIMUM LOAD

[Panels with stiffeners section Y20-40]

		Panels with Alclad 24S-T81 sheet[b]		Panels with Alclad 24S-T86 sheet		
Specimen numbers	Stiffener spacing b_s, in.	Buckling stress σ_{cr}, psi	Maximum stress σ_{max}, psi	Buckling stress σ_{cr}, psi	Maximum stress σ_{max}, psi	Increase in maximum stress[c]
241	6	40,100	56,810	43,700	59,010	3.9
242	6	43,000	56,830	42,770	58,170	2.4
243	6	------	53,780	43,600	55,460	1.0
244	6	41,400	47,930	43,150	50,550	5.5
245	6	------	61,150	------	61,300	.2
246	6	------	58,830	------	61,400	4.4
247	6	------	56,430	------	57,660	2.2
248	6	------	61,670	------	63,770	3.4
249	6	------	61,090	------	63,430	3.8
250	6	------	54,540	------	57,100	4.7
251	9	18,320	52,500	17,450	53,040	1.0
252	9	19,570	50,990	16,470	50,830	-.3
253	9	21,600	47,990	19,480	47,550	-.9
254	12	8,270	47,680	9,800	48,540	1.8
255	12	8,140	46,300	9,280	45,680	-1.3
256	12	9,410	43,320	9,080	44,030	1.6

[a]Stresses apply to panels with equal numbers of stiffeners and bays and with minimum guaranteed properties for the materials.

[b]Results are repeated from reference 1.

[c]The increase is given as percentage of the strength of the panel with Alclad 24S-T81 sheet.

TABLE V. - MINIMUM GUARANTEED COMPRESSIVE YIELD STRENGTHS

FOR PANEL MATERIALS

Material	Material designation	Compressive yield strength, psi
Artificially aged Alclad 24S-RT, sheet	Alclad 24S-T86	66,000
Stretched and artificially aged Alclad 24S-T, stiffeners	Alclad 24S-T84	64,000
Artificially aged Alclad 24S-T, sheet	Alclad 24S-T81	57,000

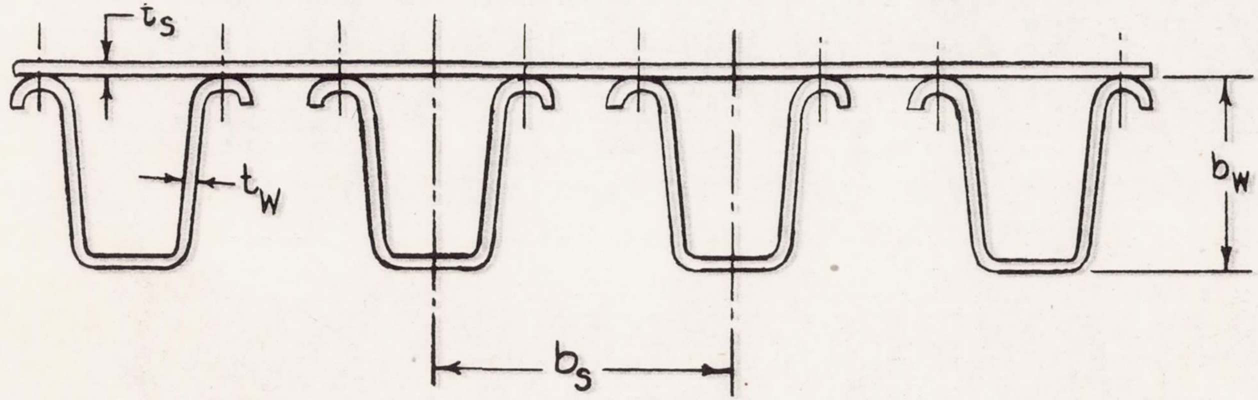

Figure 1.- Cross section of a typical specimen.

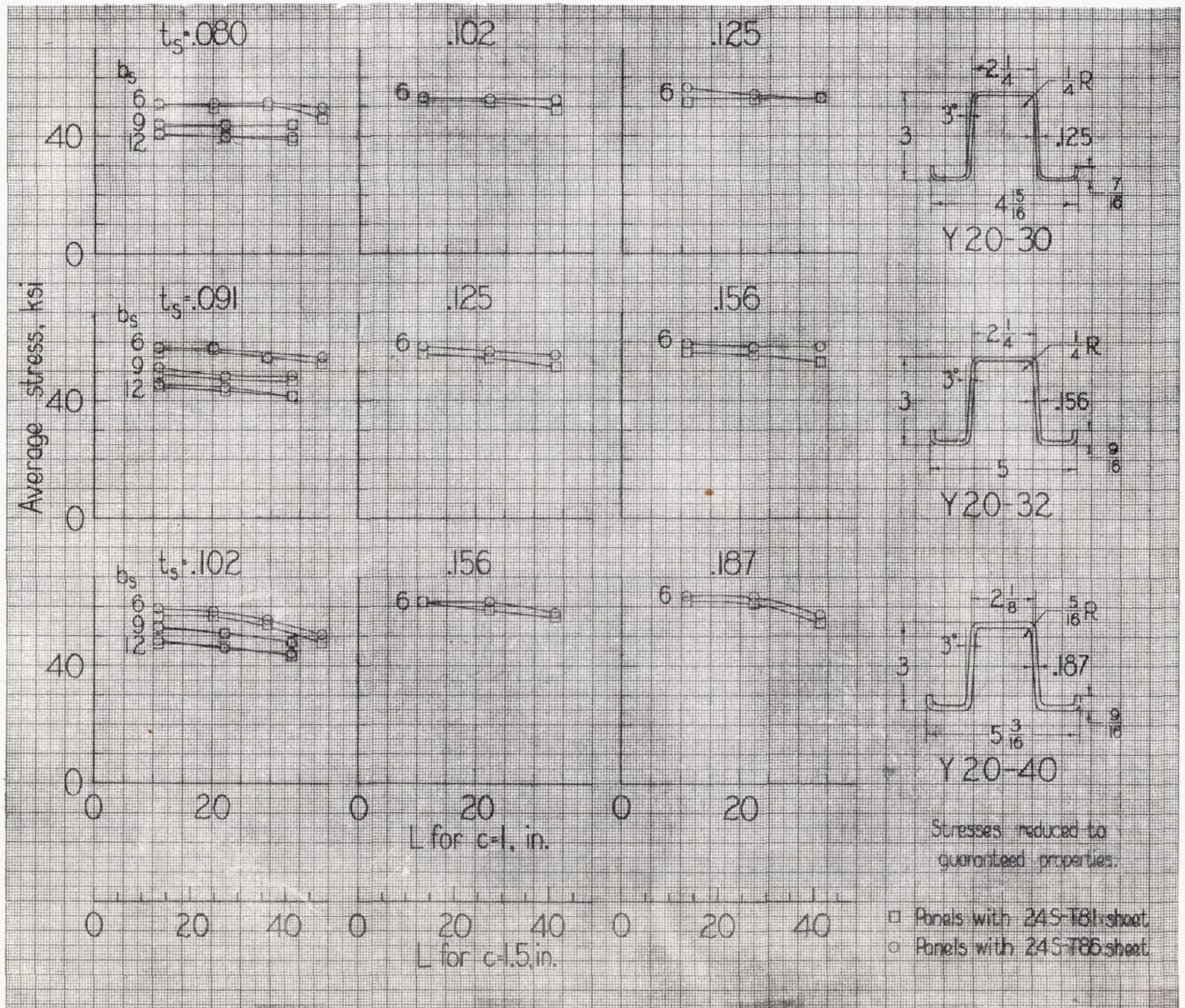

Figure 2.-Comparison of compressive strength of panels made with Alclad 24S-T81 or Alclad 24S-T86 sheet riveted to Alclad 24S-T84 stiffeners.

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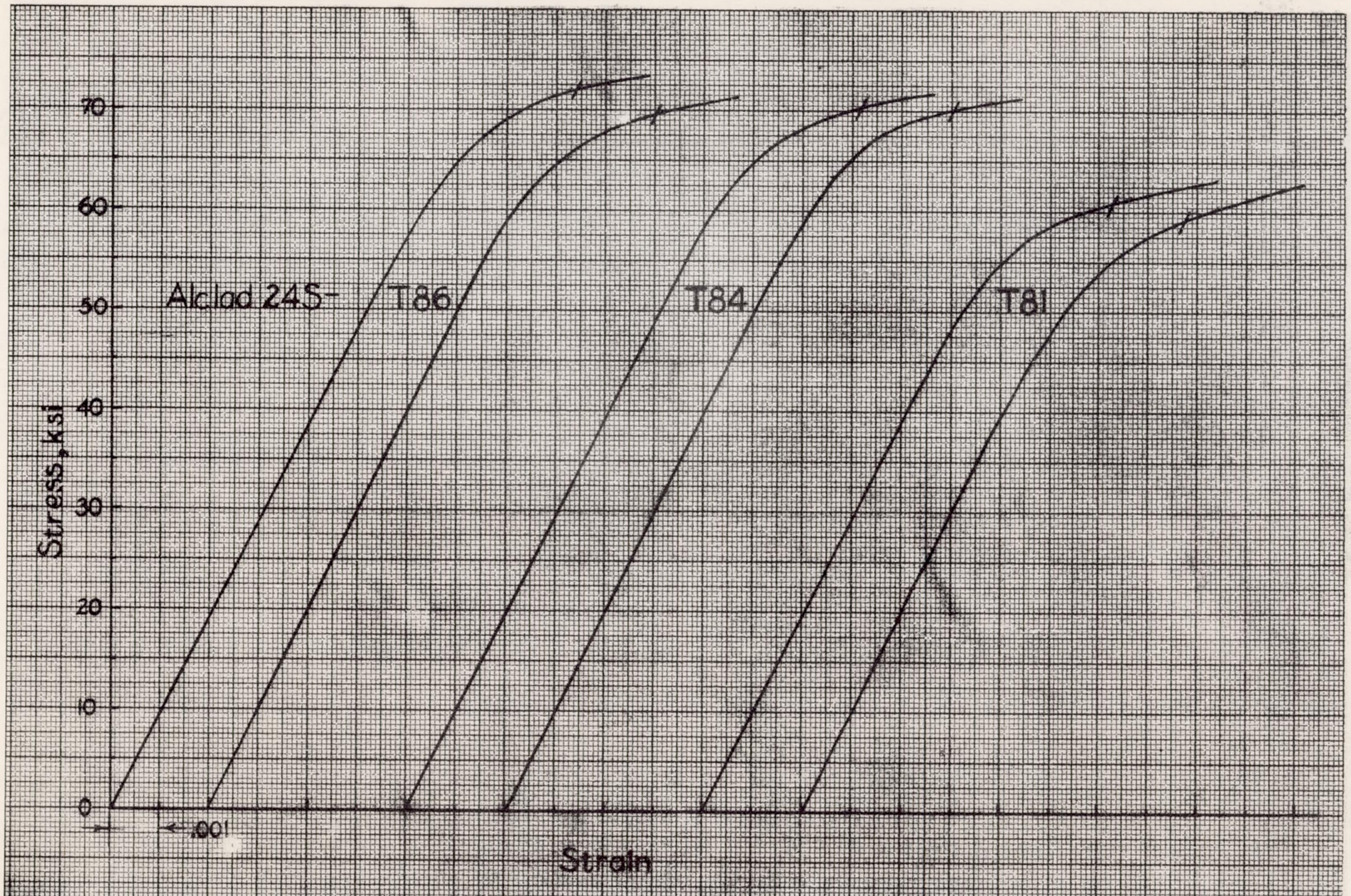

Figure 3.- Typical stress-strain curves for compression in the direction of the grain for sheet and stiffener materials.