NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

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EFFECT OF BRAKE FORMING IN VARIOUS TEMPERS ON THE STRENGTH OF ALCLAD 75S-T ALUMINUM-ALLOY SHEET

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SUMMARY

Results are presented of tests to determine the effect of brake forming in various tempers on the strength of Alclad 75S-T aluminum-alloy sheet in the direction parallel to the brake. The tensile and compressive strengths of Alclad 75S-T sheet, formed in the O and W tempers, were either increased or little affected as compared with those of similarly treated unformed material. When Alclad 75S-T sheet "as received" was formed, however, the tensile yield stress was reduced about 7 percent for the with-grain direction and 1 percent for the cross-grain direction, whereas the tensile ultimate and compressive yield stresses were increased somewhat. The elongation was always slightly reduced as a result of forming.

INTRODUCTION

Questions regarding the effect of brake forming on the strength of Alclad 75S-T aluminum-alloy sheet arose shortly after the introduction of this new high-strength material. An investigation was therefore undertaken to determine the tensile and compressive strengths of Alclad 75S-T aluminum-alloy sheet resulting from brake forming the material in various tempers.

SPECIMENS AND METHOD OF TESTING

The dimensions of the tension and compression specimens, which included only curved material, are shown in figure 1. These specimens were cut from the corners of Z-sections that had been brake-formed of 0.102-inch-thick Alclad 75S aluminum-alloy sheets in the O, W, and T tempers. (See fig. 2.) The four different forming procedures used are outlined under RESULTS. The specimens were similar to those used in a recent investigation of the effect of brake forming on the strength of 24S-T aluminum-alloy sheet. (See reference 1.)

Reference tension and compression specimens were taken from the flat web and flanges of the Z-sections. The dimensions of the flat tensile specimens conformed to the A.S.T.M. Standards for sheet material (reference 2); the flat compression specimens had the same over-all size as the curved corner compression specimen shown in figure 1.

For the tension tests of the curved corner specimens, special inserts were required between the Templin self-alining grips and the specimens in order to maintain the original cross-sectional curvature and also to make the centroidal axis of the specimen coincide with the center of the grips when the load was applied.

For the compression tests, a Montgomery-Templin type of compression fixture (see reference 3 for the technique in using this fixture) was used for both the flat and the curved corner specimens. The supporting plates for the curved corner specimens and the fixture are shown in figure 3.

Tuckerman optical strain gages were used to measure the strain for both the tension and the compression tests.

RESULTS

The effect of brake forming on the tensile and compressive properties of Alclad 75S-T aluminum-alloy sheet in the direction parallel to the brake is presented in figures 4 and 5 for the four forming procedures. The essential results for each forming procedure and for both grain directions of the material are described briefly in the following tabulation, in which the strength of formed material is in each case compared with that of unformed material treated in all respects the same except for forming.

Procedure	Effect of brake forming
(1) Alclad 75S-T sheet "as received" was formed to an inside bend radius of six times the sheet thickness, $r = 6t$.	The tensile yield stress σ_{ty} was reduced, whereas the compressive yield stress σ_{cy} and tensile ultimate stress σ_{tu} were increased somewhat.
(2) Alclad 75S-T sheet "as received" was solution heat treated at 910° F for 20 minutes, cold-water quenched, formed to $r = 3t$ within 10 minutes after quenching, and aged at room temperature for 4 days and then at 250° F for 24 hours.	The tensile and compressive yield stresses were increased, whereas there was no appreciable change in the tensile ultimate stress.
(3) Alclad 75S-O sheet "as received" was solution heat treated 910° F for 45 minutes, cold-water quenched, formed to $r = 3t$ within 10 minutes after quenching, and aged at room temperature for 4 days and then at 250° F for 24 hours.	The results were similar to those obtained in procedure (2).
(4) Alclad 75S-O sheet "as received" was formed to $r = 3t$, solution heat treated at 910° F for 45 minutes, cold-water quenched, and aged at room temperature for 4 days and then at 250° F for 24 hours.	The results were essentially similar to those obtained in procedures (2) and (3).

In each of the four forming procedures, the percent elongation in 2 inches was reduced from about 14 or 15 percent to about 10 or 12 percent as a result of the forming.

CONCLUSIONS

The significant conclusions of this study of the effect of brake forming in various tempers on the tensile and compressive properties of Alclad 75S-T aluminum-alloy sheet in the direction parallel to the brake are as follows:

1. When Alclad 75S sheet was formed (r = 3t) in the O and W tempers and subsequently heat treated to the T temper, the tensile and compressive strengths were either increased or little affected as compared with those of similarly treated unformed material.

2. When Alclad 75S-T sheet "as received" was formed (r = 6t), the tensile yield stress was reduced about 7 percent for the with-grain direction and 1 percent for the cross-grain direction, whereas the ultimate and compressive yield stresses were increased somewhat.

3. In all cases, the percent elongation in 2 inches was reduced from about 14 or 15 percent for the flat material to about 10 or 12 percent for the formed material.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va., April 26, 1946

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2. Anon.: 1944 Book of A.S.T.M. Standards, pt. I, Metals. Standard Methods of Tension Testing of Metallic Materials (E8-42). A.S.T.M. (Philadelphia), pp. 962-972.

3. Kotanchik, Joseph N., Woods, Walter, and Weinberger, Robert A.: Investigation of Methods of Supporting Single-Thickness Specimens in a Fixture for Determination of Compressive Stress-Strain Curves. NACA RB No. L5E15, 1945.

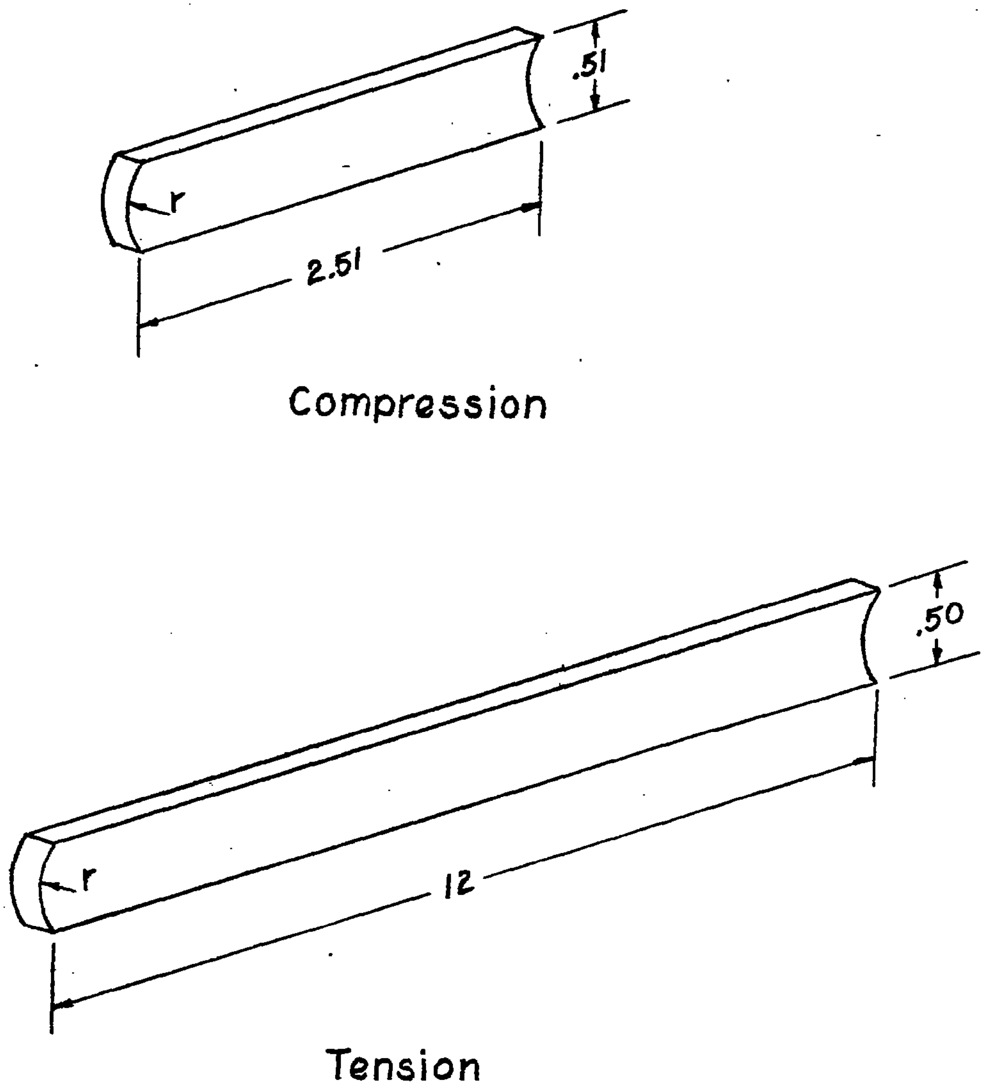

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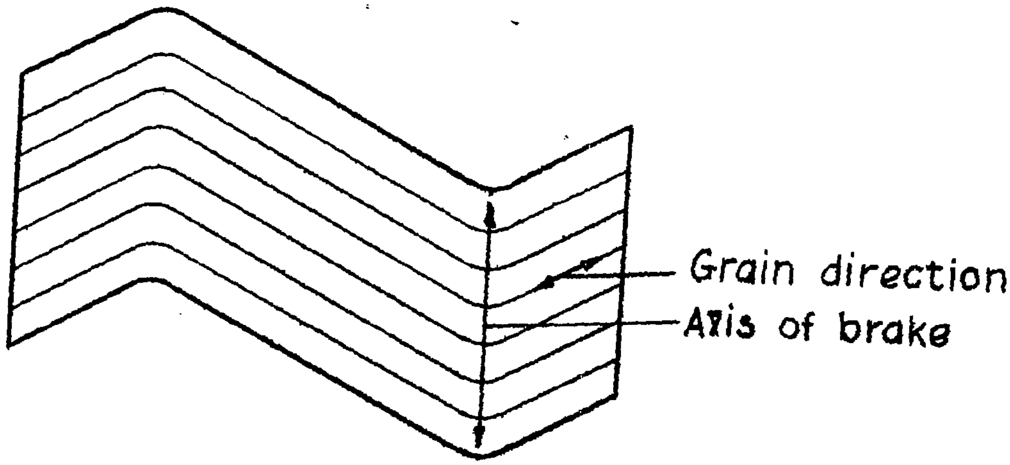
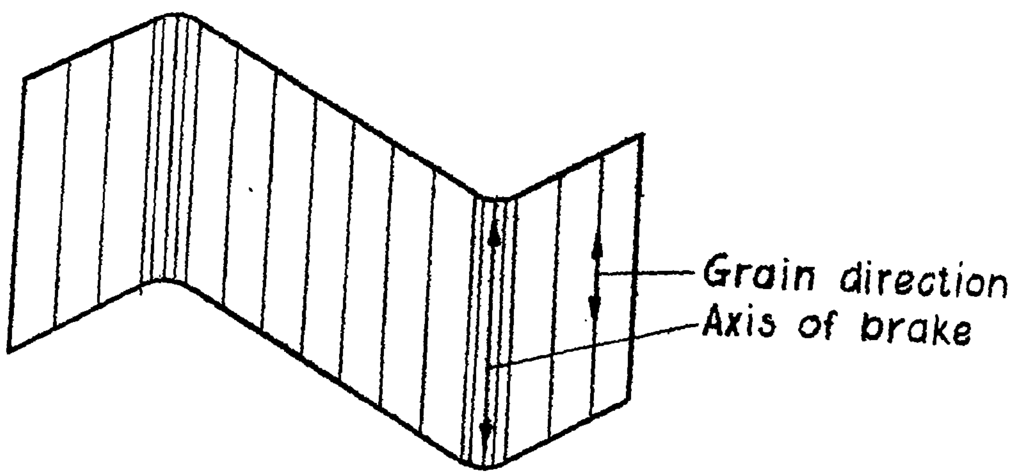
Figure 1.- Dimensions of tension and compression specimens cut from curved corners of formed Z-sections. t=0.102 inch.



(a) Brake cross grain.



(b) Brake with grain.

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Figure 2.- Directions of forming Z-sections.

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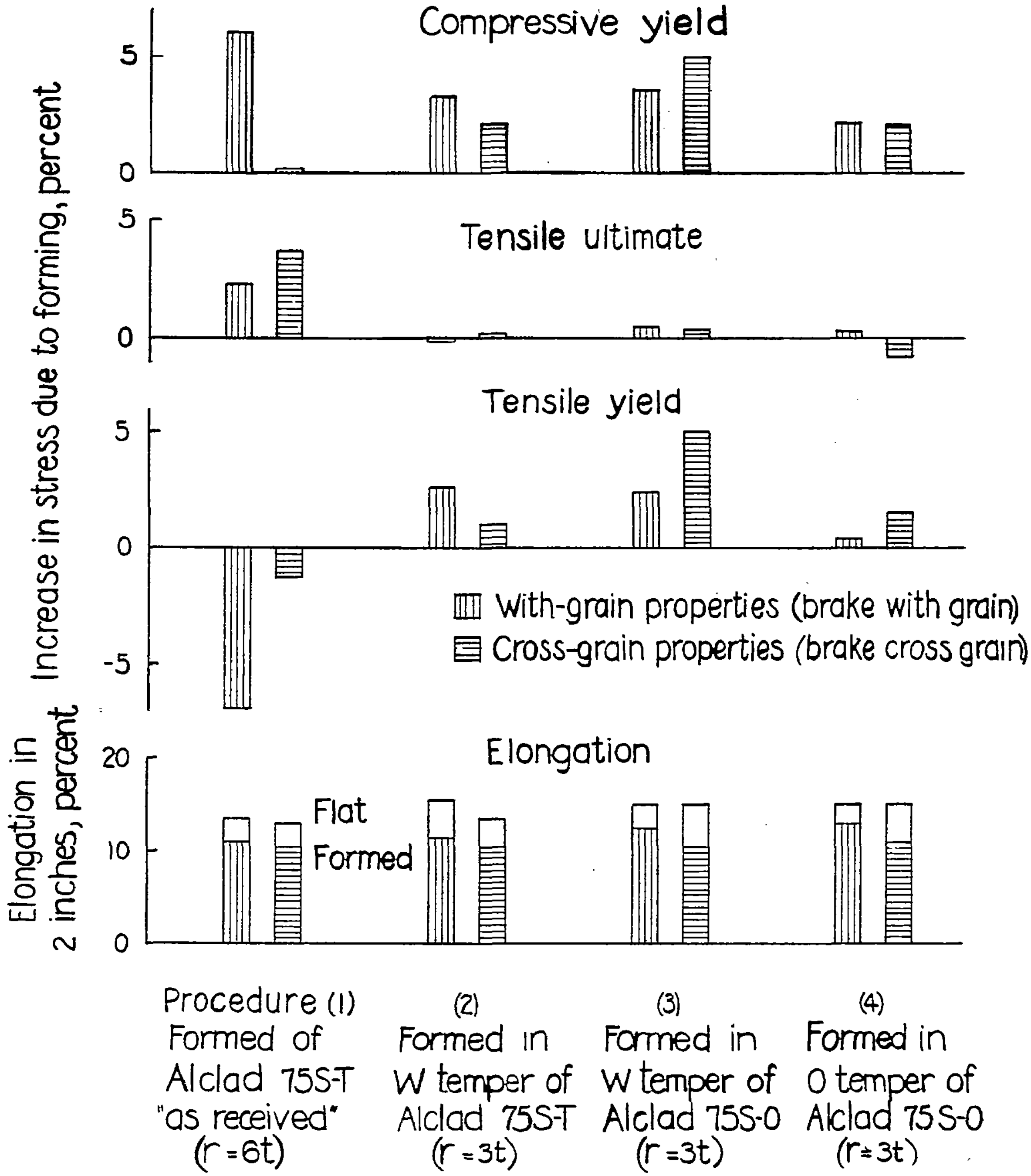

Figure 4.-Effect of brake forming on the tensile and compressive properties of 0.102-inch-thick Alclad 75S-T aluminum-alloy sheet.

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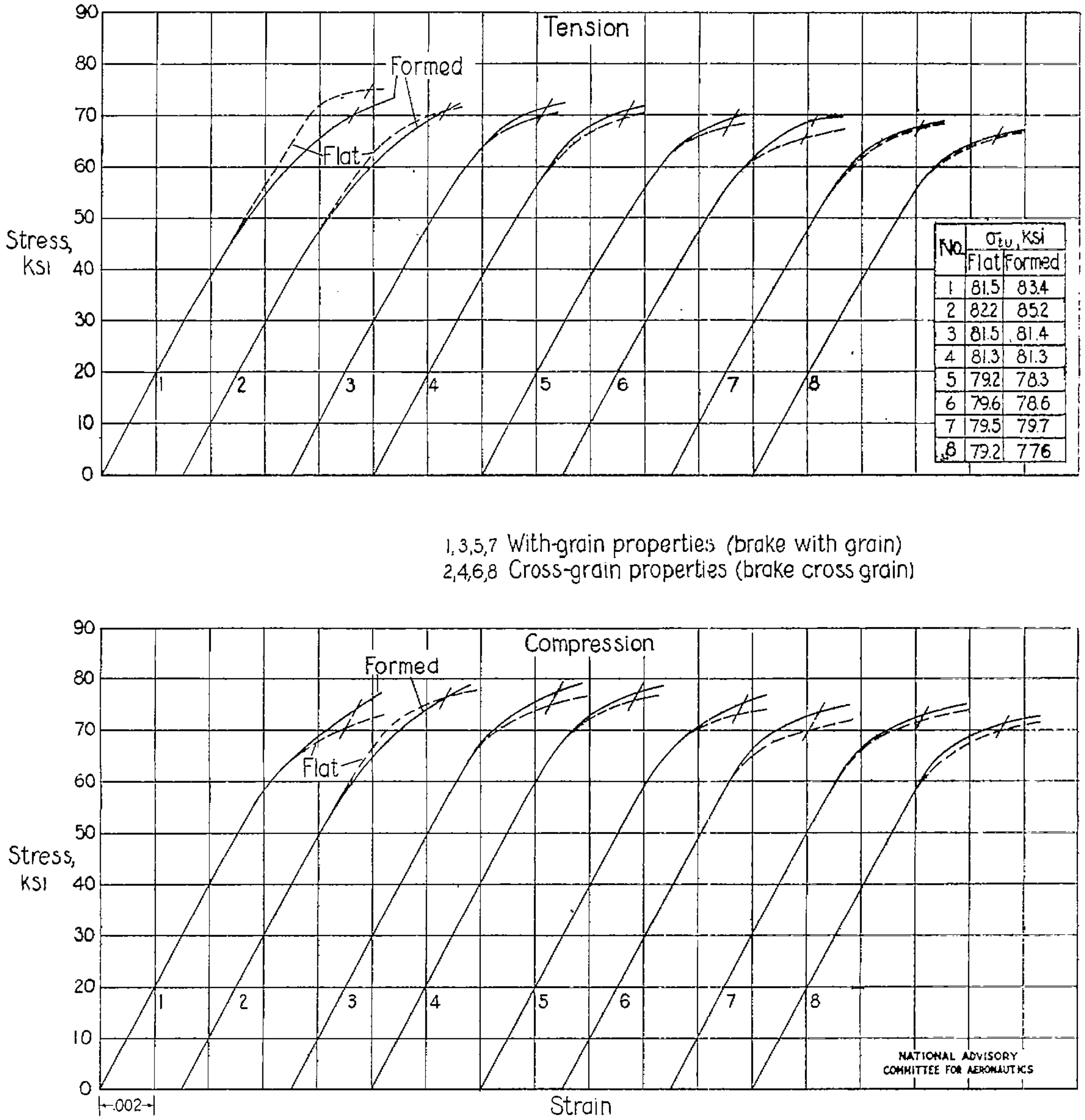

No.	σ_{tu}, ksi Flat	Formed
1	81.5	83.4
2	82.2	85.2
3	81.5	81.4
4	81.3	81.3
5	79.2	78.3
6	79.6	78.6
7	79.5	79.7
8	79.2	77.6

Procedure (1)	(2)	(3)	(4)
Formed of Alclad 75S-T "as received" (r = 6t)	Formed in W temper of Alclad 75S-T (r = 3t)	Formed in W temper of Alclad 75S-O (r = 3t)	Formed in O temper of Alclad 75S-O (r = 3t)

Figure 5.- Effect of brake forming on the tensile and compressive stress-strain curves of 0.102-inch-thick Alclad 75S-T aluminum-alloy sheet.