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TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 472

THE EFFECT OF PARTIAL-SPAN SPLIT FLAPS ON THE AERODYNAMIC CHARACTERISTICS OF A CLARK Y WING

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Washington
September 1933

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SUMMARY

Aerodynamic force tests were made in the N.A.C.A. 7 by 10 foot wind tunnel on a model Clark Y wing with a 20 percent chord split flap deflected 60° downward. The tests were made to determine the effect of partial-span split flaps, located at various positions along the wing span, on the aerodynamic characteristics of the wing-and-flap combination. The different lengths and locations of the flaps were obtained by cutting off portions of a full-span flap, first from the tips and then from the center.

The results are given in the form of curves of lift, drag, and center of pressure. They show that with partial-span split flaps both the lift and drag are less than with full-span flaps; that the lift for a given length of flap is somewhat greater when the partial span is located at the center of the wing than when it is located at the tip portion; and that the drag for a given length of flap is the same regardless of the location of the flap with respect to the wing span.

INTRODUCTION

Among the devices for increasing the maximum lift and also the drag of an airplane to improve the landing characteristics, is the split trailing-edge flap. With this arrangement the rear portion of the wing is split into upper and lower sections and the lower section is deflected downward as a flap. This type of flap is designed for use over the maximum possible length of the wing span, no portion of the flap serving for lateral control.

Some tests have previously been made on airfoils with split flaps (references 1, 2, 3, and 4) in which the effects of changes in flap chord and deflection have been investigated. The present investigation was made to determine the effects of changes in flap length and location along the wing span. The flaps were tested on a Clark Y wing in the 7 by 10 foot wind tunnel, and lift, drag, and pitching moment were measured for each size and location of flap. Only split flaps with a chord 20 percent of the wing chord were used since previous investigations indicated that flaps of this chord size would give results of most general value.

APPARATUS AND TESTS

The model used in the present tests was a Clark Y airfoil with a 10-inch chord and a 60-inch span. The airfoil was constructed of laminated mahogany to the specified ordinates given in table I. The flaps were made of 1/16-inch steel plate, 2 inches (20 percent of the chord) wide, and were screwed to the wing (fig. 1). They were deflected downward at an angle of 60° to the wing chord, which arrangement gave the highest maximum lift coefficient (reference 3).

Only flaps having a chord 20 percent of the wing chord were used since data given in references 3 and 4, and replotted in figure 2 of the present report, indicate that this size of flap, for all practical purposes, gives the highest maximum lift. Further increase in the flap chord up to 30 percent results in only a slight increase in the maximum lift, while flap chords greater than 30 percent of the wing chord cause the maximum lift to decrease.

The wing without flaps was tested first, and the wing with the full-span flaps next. Then the flap length was reduced by cutting off portions of the flap in steps of 20, 40, 60, and 80 percent of the span. The wing was tested first with the partial-span flaps having sections of equal length removed from the tips, and then with sections of the same total length removed from the center of the span.

The 7 by 10 foot tunnel, which has an open test section, is described in detail together with the balances and standard test procedure in reference 5. The tests were made at an air speed of 80 miles per hour, corresponding to a Reynolds Number of 609,000. The data were not corrected for tunnel-wall effect.

RESULTS AND DISCUSSION

Tip sections removed.- Curves of C_L, C_D, and c.p. are given in figure 3 for the wing having split flaps with different amounts removed from both tips. It will be seen that the peaks of the lift curves have a sharp drop just after the stall as compared with that for the plain wing, and that the lift and the drag decrease with increase in the amount of flap removed. The center of pressure in the region of maximum lift is about 10 percent of the chord farther aft for the wing with full-span flap than for the plain wing.

Center sections removed.- Curves of C_L, C_D, and c.p. are given in figure 4 for the wing having split flaps with different amounts removed from the center of the span. The peaks of these lift curves gradually round off at the stall with increase in the amount of flap removed, and the lift and the drag decrease. The change in the center of pressure with variation of flap length is about the same as for the flap with tip sections removed.

Comparison of effect of removing sections from the tip and from the center.- Curves of $C_{L\,max}$ and of C_D at $C_{L\,max}$ against split-flap length are given in figure 5 both for tip sections removed and center sections removed. This figure shows that a somewhat smaller part of the maximum lift is lost by cutting off the tip sections than by removing center sections of the same total length. It should be noted that the drag at maximum lift is affected only by the length of the flap and does not depend on whether the section is removed from the tips or the center.

CONCLUSIONS

Both the lift and the drag of a wing with partial-span split flaps are less than those with full-span flaps, the lift for a given length of flap being somewhat greater when the partial-span flap is located at the center of the wing than when it is located at the tip portion. The drag for a given length of flap is the same regardless of the location of the flap with respect to the wing span.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., July 12, 1933.

REFERENCES

1. Bamber, Millard J.: Wind Tunnel Tests on an Airfoil Equipped with a Split Flap and a Slot. T.N. No. 324, N.A.C.A., 1929.

2. Noda, Tetsuwo: The Hiraki-Bane Variable Section Airfoil. Abstract in Mech. Eng., vol. 53, no. 6, June 1931, p. 448.

3. Weick, Fred E., and Harris, Thomas A.: The Aerodynamic Characteristics of a Model Wing Having a Split Flap Deflected Downward and Moved to the Rear. T.N. No. 422, N.A.C.A., 1932.

4. Gruschwitz, Eugen und Schrenk, Oskar: A Simple Method for Increasing the Lift of Airplane Wings by Means of Flaps. T.M. No. 714, N.A.C.A., 1933.

5. Harris, Thomas A.: The 7 by 10 Foot Wind Tunnel of the National Advisory Committee for Aeronautics. T.R. No. 412, N.A.C.A., 1931.

TABLE I

ORDINATES OF CLARK Y SECTION IN PERCENT OF CHORD

Rad. L. E. 1.50 Rad. T. E. 0.06

Distance from L. E.	Upper	Lower
0	3.50	3.50
1.25	5.45	1.93
2.5	6.50	1.47
5	7.90	.93
7.5	8.85	.63
10	9.60	.42
15	10.69	.15
20	11.36	.03
30	11.70	.00
40	11.40	.00
50	10.52	.00
60	9.15	.00
70	7.35	.00
80	5.22	.00
90	2.80	.00
95	1.49	.00
100	.12	.00

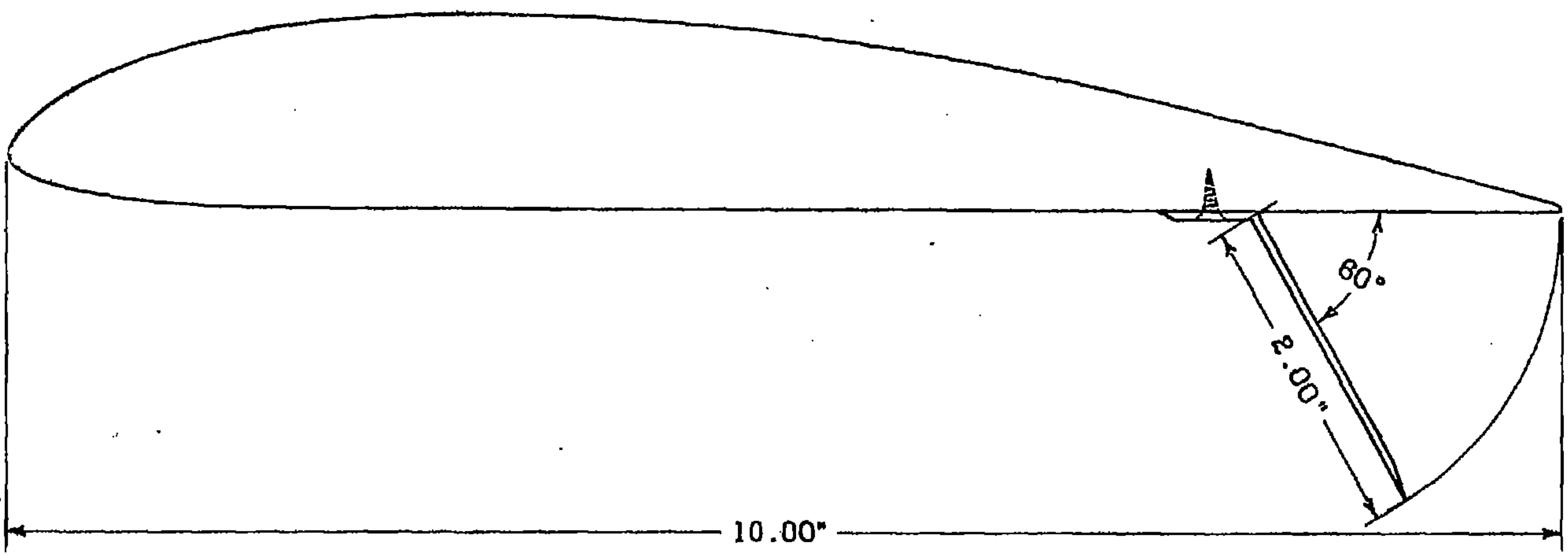

Figure 1.-Split flap tested on Clark Y wing.

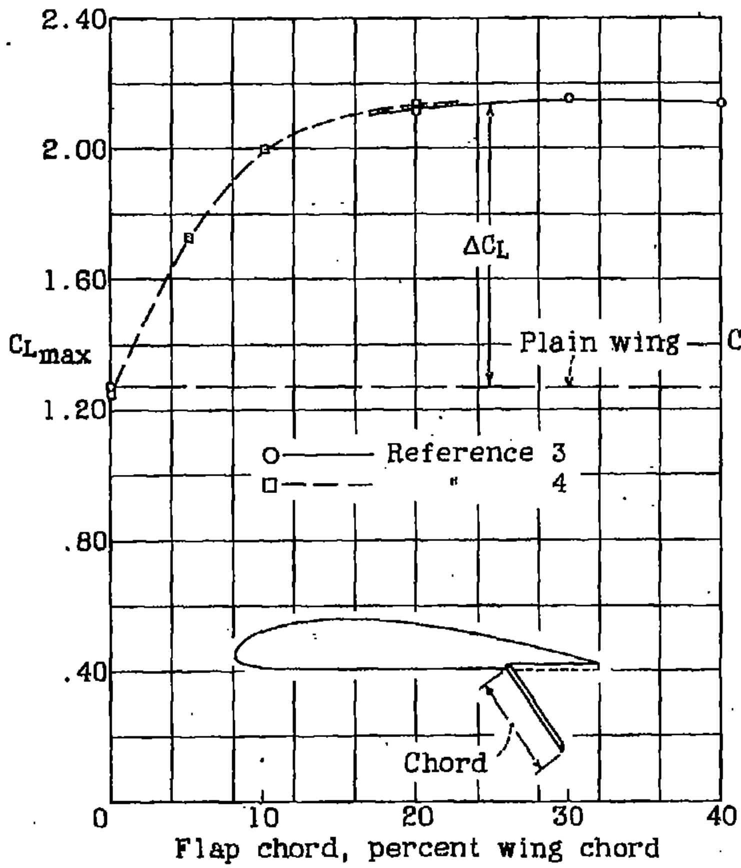

Figure 2.- Effect of chord of split flap on $C_{L_{max}}$

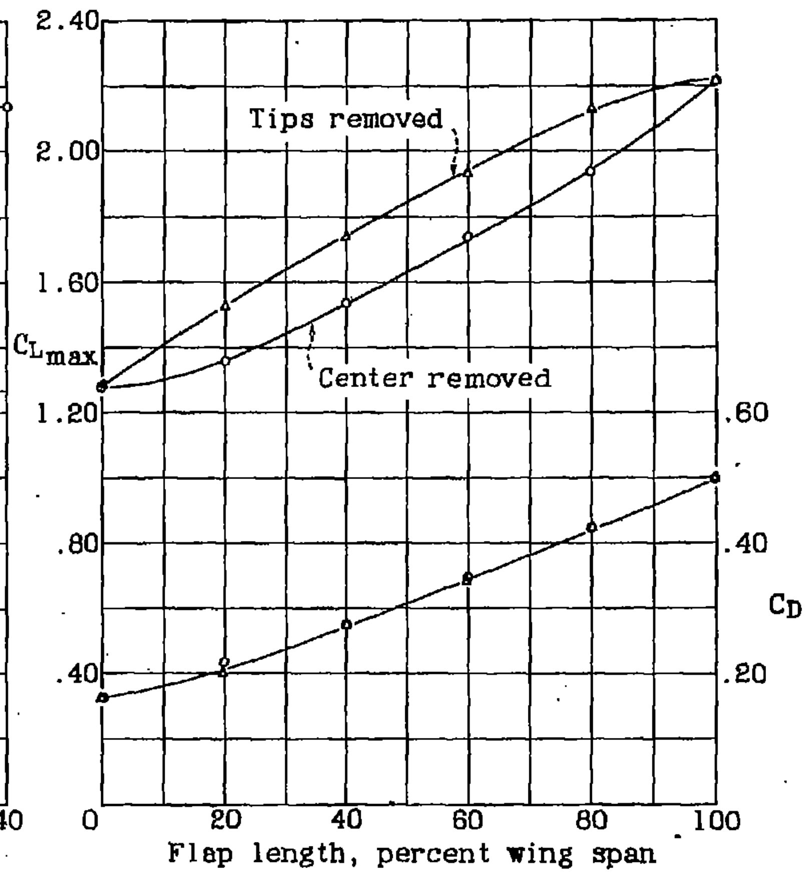

Figure 5.- Effect of partial-span split flaps on $C_{L_{max}}$ and on C_D at $C_{L_{max}}$

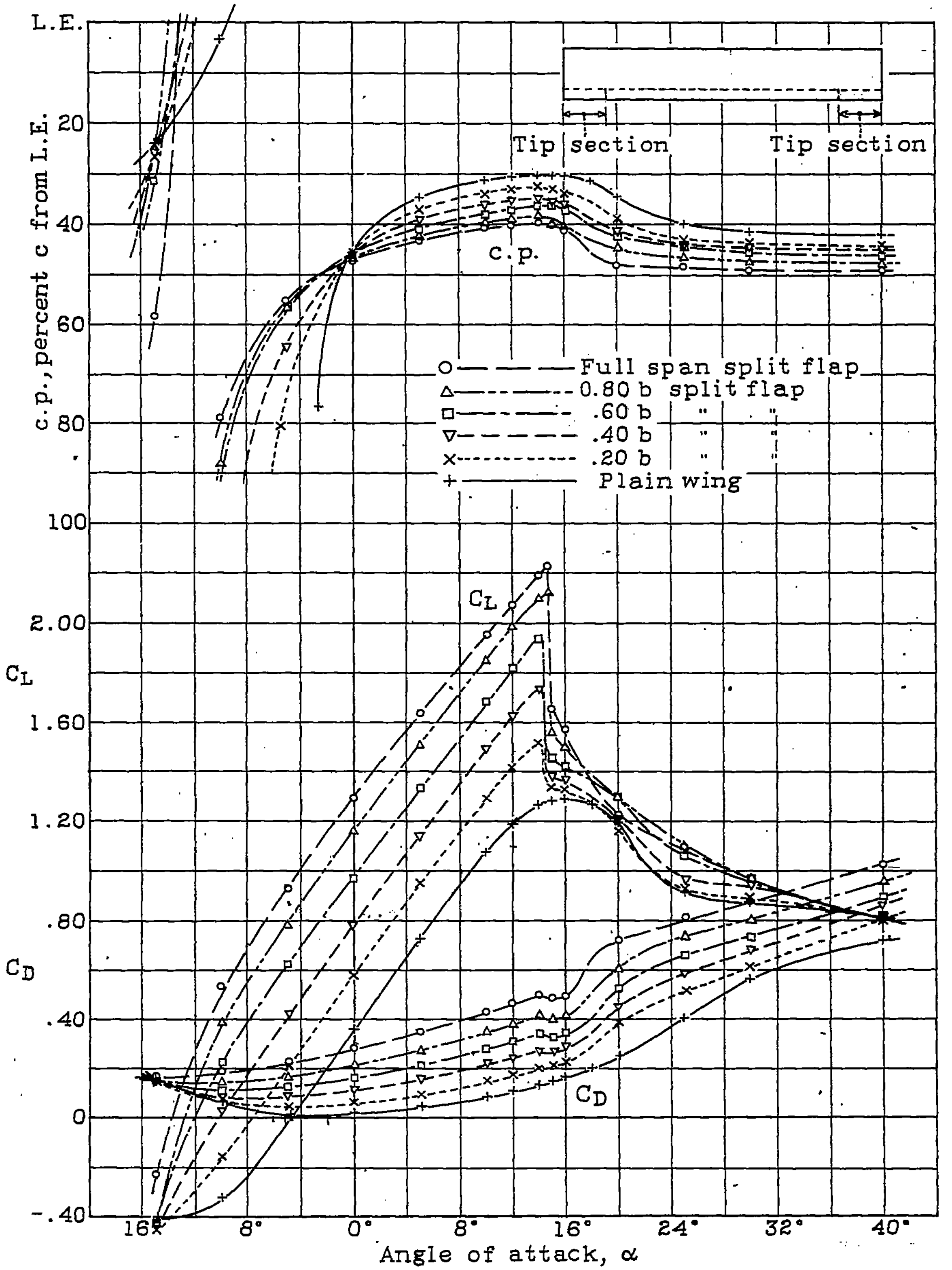

Figure 3.- Split flaps with tip sections removed

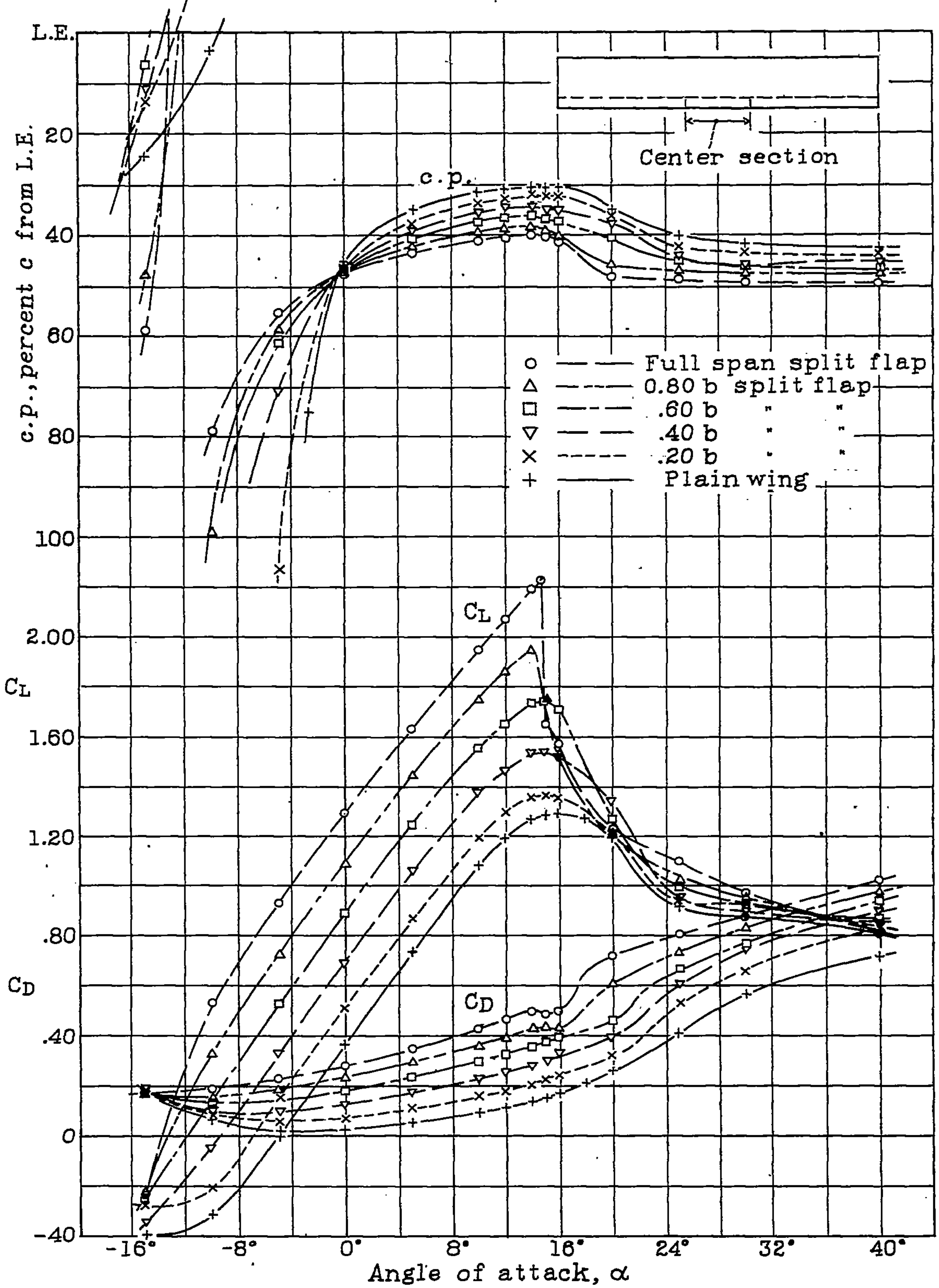

Figure 4.- Split flaps with center sections removed