TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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TESTS OF AN N.A.C.A. 23012 AIRFOIL
WITH A SLOTTED DEFLECTOR FLAP

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SUMMARY

Section aerodynamic characteristics of a large-chord N.A.C.A. 23012 airfoil with a slotted deflector flap were obtained in the N.A.C.A. 7- by 10-foot wind tunnel. The characteristics of an N.A.C.A. slotted flap and of a simple split flap are included for comparison.

The slotted deflector flap was found to have a somewhat lower maximum lift coefficient and somewhat higher drag at high lift coefficients than the N.A.C.A. slotted flap. At moderate lift coefficients, however, the drag of the slotted deflector flap was about the same as that of the N.A.C.A. slotted flap. The high drag of the open slot with the deflector flap neutral indicates that the slot should be closed for this condition.

INTRODUCTION

Many present-day airplanes use some form of lift-increasing device to aid in taking off and in landing. Among the more desirable characteristics of such devices are high maximum lift with relatively low drag, low minimum drag and, possibly, high lift with high drag. One of the most promising of such devices appears to be some form of slotted flap.

The results of an investigation of a slotted deflector flap are given in this paper. The distinguishing characteristics of the slotted deflector flap are a very large slot and a deflector plate mounted on the leading edge of the flap. Results from similar tests of a split flap and an N.A.C.A. slotted flap (one of the most promising slotted flaps developed to date by the N.A.C.A. (reference 1)) are included for comparison.

APPARATUS AND TESTS

Model.- The airfoil was built of laminated pine to the N.A.C.A. 23012 section and has a chord of 3 feet and a span of 7 feet. Data for the design of the slotted deflector flap were furnished by the United Aircraft Corporation. The deflector is a metal plate mounted on the flap leading edge, as shown in figure 1.

Wind tunnel.- The model was mounted on the standard two-dimensional-flow set-up in the N.A.C.A. 7- by 10-foot closed-throat wind tunnel, which is described in reference 1.

Tests.- The tests were made at a dynamic pressure of 16.37 pounds per square foot, corresponding to an air speed of about 80 miles per hour at standard sea-level conditions and an average test Reynolds Number of 2,190,000. The turbulence factor of the tunnel is 1.6; the effective Reynolds Number, therefore, is approximately 3,500,000.

The flap was tested in what was specified as the most effective location by the United Aircraft Corporation at deflections of 0°, 10°, 20°, 30°, 40°, 50°, and 60°. Enough angles of attack were taken to determine envelope polars over the complete lift range from zero to maximum lift.

RESULTS AND DISCUSSION

Coefficients

All test results are given in standard section non-dimensional coefficient form as follows:

c_l, airfoil section lift coefficient (l/qc).

c_{d_o}, airfoil section profile-drag coefficient (d_o/qc).

$c_{m(a.c.)_o}$, airfoil section pitching moment coefficient about aerodynamic center of section with flap in neutral position (m/qc^2).

where

l	is the airfoil section lift.
d_o,	airfoil section profile drag.
m,	airfoil section pitching moment.
q,	dynamic pressure, $\frac{1}{2}\rho V^2$.
c,	airfoil chord including flap.
and δ_f,	flap deflection.
α_o,	angle of attack for infinite aspect ratio.

The results are believed to be accurate within the following limits:

α_o	$\pm 0.1°$
$c_{l_{max}}$	± 0.03
$c_{m_{(a.c.)_o}}$	± 0.003
$c_{d_o (c_l=0)}$	± 0.0003
$c_{d_o (c_l=1.0)}$	± 0.0006
$c_{d_o (c_l=2.5)}$	± 0.002
δ_f	$\pm 0.2°$

The experimentally determined wind-tunnel correction of reference 1 has been used to correct all the lift data given in this report. All the drag data have been corrected by a constant Δc_{d_o} of −0.0008 so as to apply at an effective Reynolds Number of 3,500,000 (reference 2).

Aerodynamic Characteristics

The section aerodynamic characteristics of the N.A.C.A. 23012 airfoil with slotted deflector flap are given in figure 2. The effect of the large open slot is shown in the increased value of maximum lift coefficient and the large value of profile-drag coefficient obtained when the flap is undeflected. A door to close the slot when the flap is neutral should lower the minimum profile drag to a value about equal to that for other types of flap.

The angle of attack for maximum lift decreases from 16° with the flap undeflected to 10° with the flap down 50°. This shift in the angle for maximum lift would be desirable if center-section partial-span flaps are used because such a characteristic is favorable to the stalling of the center of the wing before the tips.

The curves of pitching-moment coefficients show no unusual characteristics.

Comparison with Other Types of Flap

Increments of maximum lift coefficient are plotted against flap deflection for three types of flap in figure 3. The increments were taken from the maximum lift of the plain wing on the assumption that, for the flap-neutral condition, a door would be used to close the slot. The curve for the slotted deflector flap has a sharper peak than the curves for the N.A.C.A. slotted flap and the split flap. The slotted deflector flap gives higher maximum lift increments than the split flap but lower increments than the N.A.C.A. slotted flap. The two slotted flaps increase the wing area a small amount when deflected; the slotted deflector flap increases the area slightly less than the N.A.C.A. slotted flap. This change in area may be partly responsible for the difference in the maximum lift increments.

The effect on profile-drag coefficients of the three types of flap is shown in figure 4 by envelope polars. The high minimum profile drag obtained with the slotted deflector flap shows the necessity of using some means of closing the slot when the flap is neutral. If the slot is closed, the minimum drag for all three types of flap should be practically the same. For values of the lift coefficient from 1.2 to 2.4, the profile drag is about the same for the slotted deflector flap and for the N.A.C.A. slotted flap; but, for values of the lift coefficient above 2.4, the profile drag is again higher than that of the N.A.C.A. slotted flap.

At low flap deflections at the same lift coefficient, the absolute values of the pitching-moment coefficient about the aerodynamic center are slightly lower than the values of the pitching-moment coefficient for the N.A.C.A. slotted flap. At the flap deflection for maximum lift, however, the values of the pitching-moment coefficients are about the same for both types of flap (reference 1).

CONCLUSIONS

1. The slotted deflector flap gave a somewhat lower maximum lift coefficient and somewhat higher drag at high lift coefficients than the N.A.C.A. slotted flap.

2. At moderate lift coefficients the drag caused by the slotted deflector flap is about the same as that caused by the N.A.C.A. slotted flap.

3. Because of the large increase in drag due to the open slot with the deflector flap neutral, the slot entrance should be closed for this condition.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., February 3, 1939.

REFERENCES

1. Wenzinger, Carl J., and Harris, Thomas A.: Wind-Tunnel Investigation of an N.A.C.A. 23012 Airfoil with Various Arrangements of Slotted Flaps. T.R. No. 664, N.A.C.A., 1939.

2. Jacobs, Eastman N., and Sherman, Albert: Airfoil Section Characteristics as Affected by Variations of the Reynolds Number. T.R. No. 586, N.A.C.A., 1937.

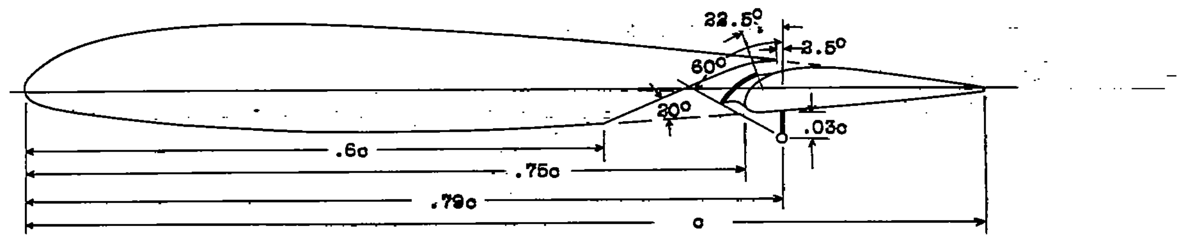

Figure 1.- Section of the N.A.C.A. 23012 airfoil and the slotted deflector flap.

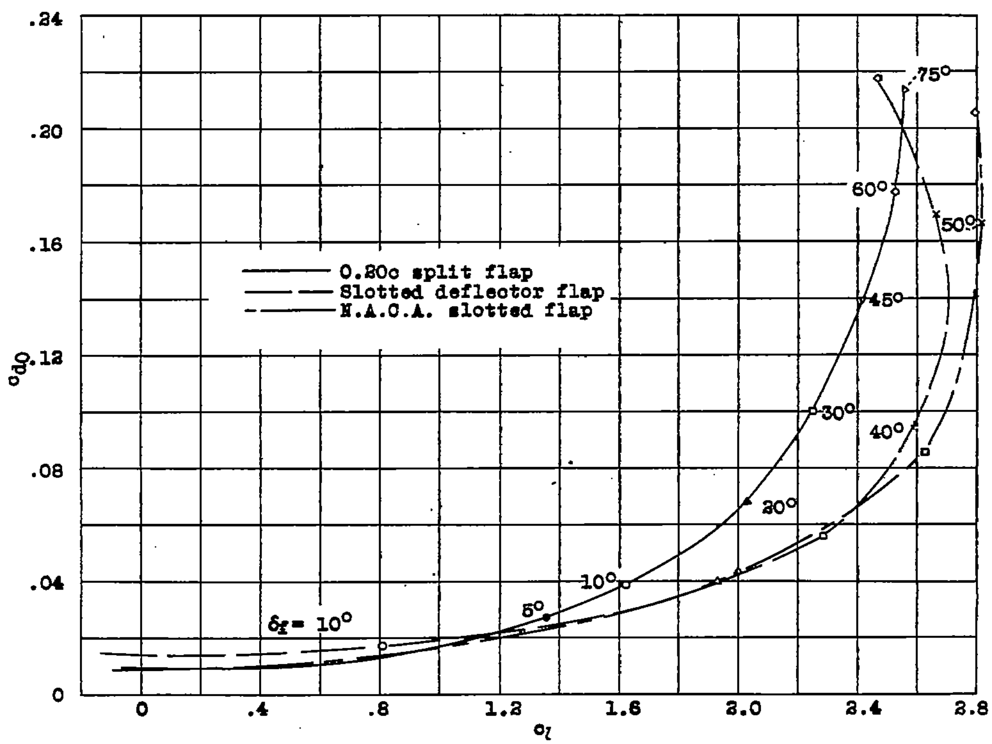

Figure 4.- Comparison of profile-drag coefficients for three types of flap.

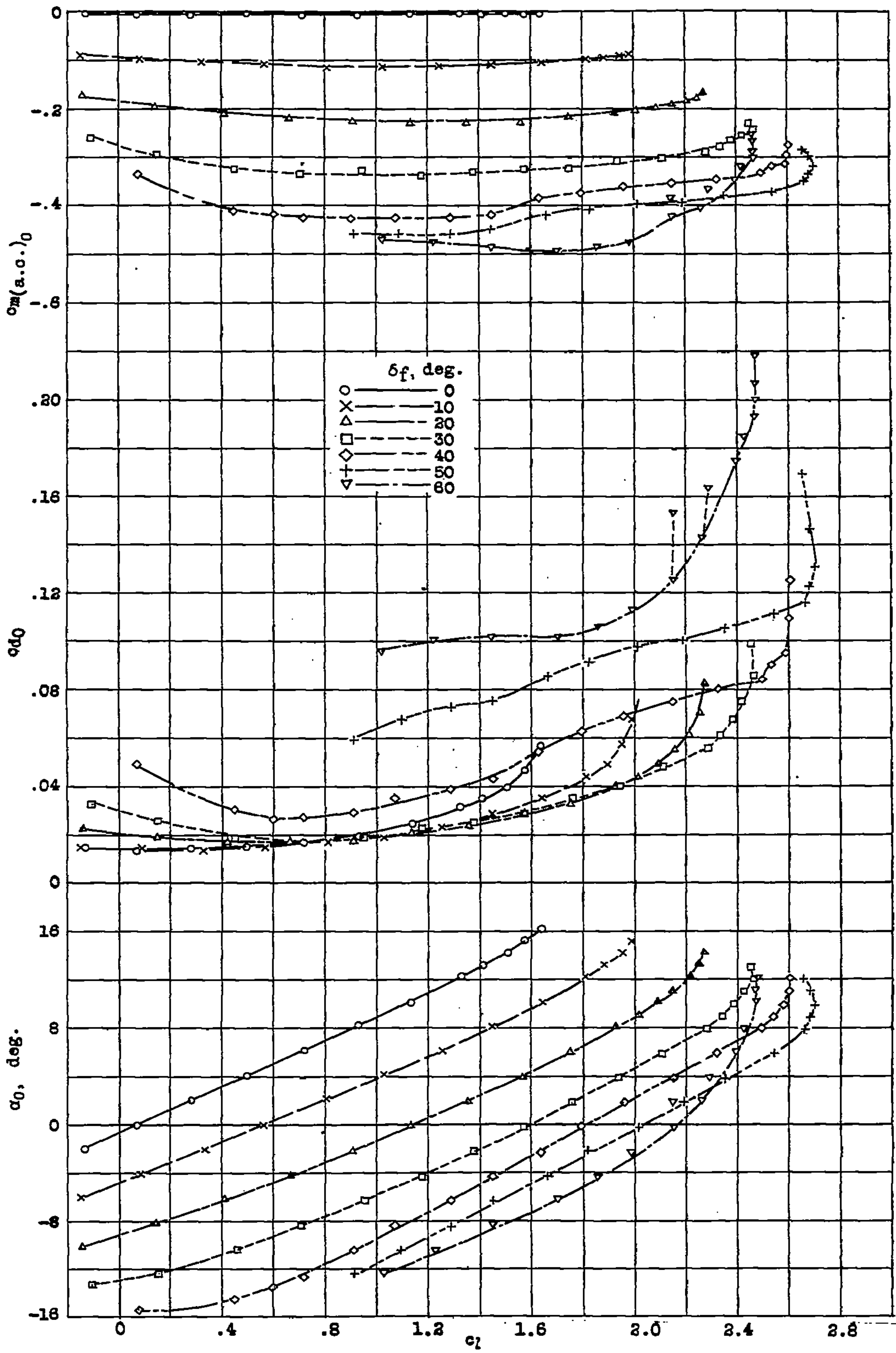

Figure 2.- Section aerodynamic characteristics of the N.A.C.A. 23012 airfoil with the slotted deflector flap.

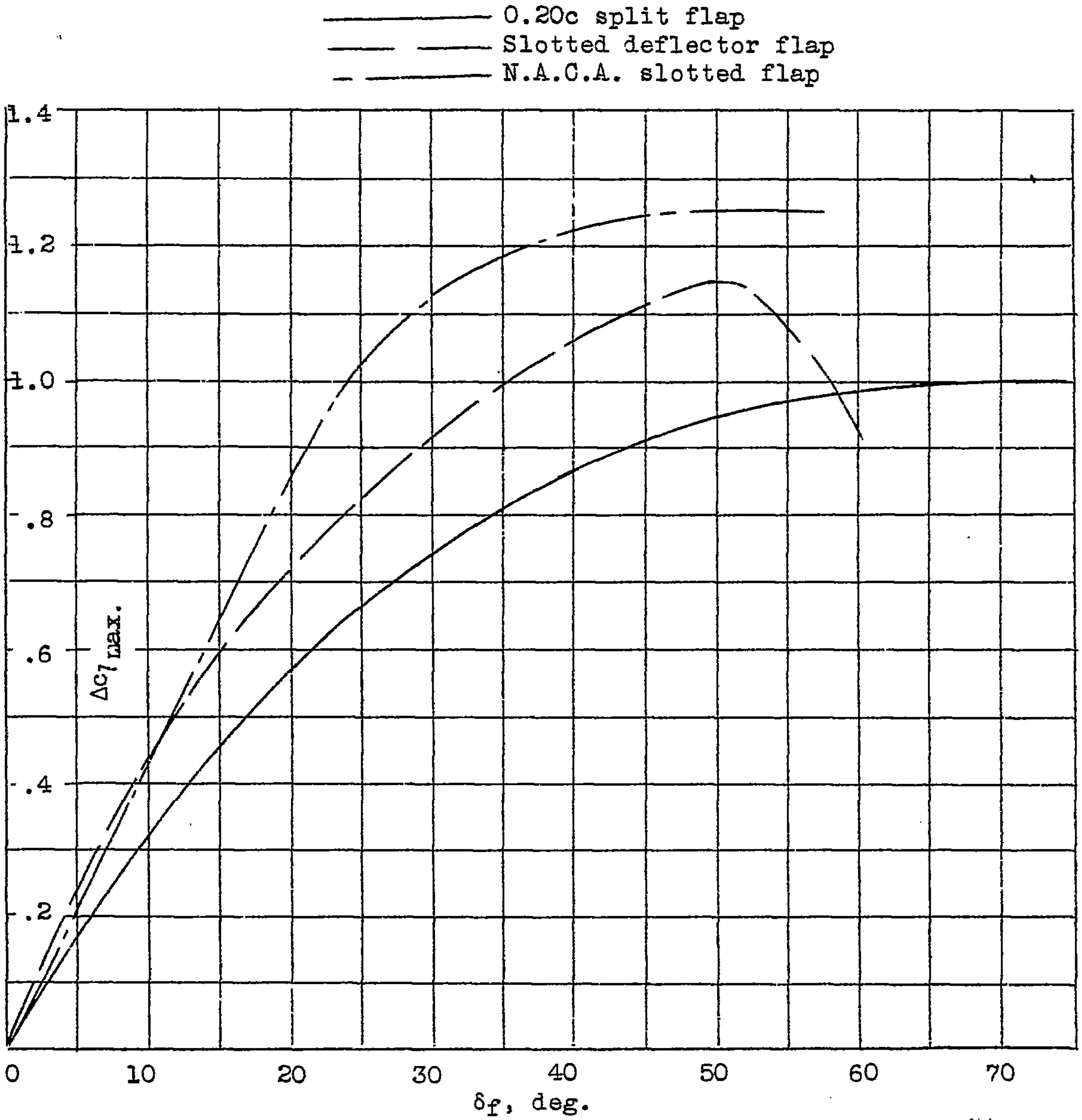

Figure 3.- Comparison of increments of maximum lift for three types of flap.