EFFECT OF ELEVATOR-PROFILE MODIFICATIONS AND TRAILING-EDGE STRIPS ON ELEVATOR HINGE-MOMENT AND OTHER AERODYNAMIC CHARACTERISTICS OF A FULL-SCALE HORIZONTAL TAIL SURFACE

By Carl F. Schueller, Peter F. Korycinski, and H. Kurt Strass

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SUMMARY

Results are presented of tests of a full-scale horizontal tail surface made to determine the effect of elevator-profile modifications and trailing-edge strips on the elevator hinge-moment characteristics for elevators having fixed plan form and constant balance.

A reduction of 6° in the trailing-edge angle of the elevator produced incremental changes in the slopes of the curves of hinge moment against angle of attack and elevator angle of approximately -0.0026 and -0.0013, respectively. The incremental changes in \( \frac{\partial M}{\partial \alpha} \) (slope of curve of hinge moment against elevator deflection) due to elevator nose-shape modifications were of about the same magnitude as those predicted by the method presented in NACA ACR No. L4E13; whereas the nose-shape changes had little effect on the values of \( \frac{\partial C_m}{\partial \delta} \) (slope of curve of hinge moment against angle of attack). By use of a more blunt nose and a reduced trailing-edge angle, the values of \( \frac{\partial C_m}{\partial \delta} \) for the elevator could be reduced from the unsatisfactorily high value of 0.0020 to 0 without affecting the values of \( \frac{\partial M}{\partial \alpha} \). Trailing-edge strips were found to be very effective in reducing a positive value of \( \frac{\partial C_m}{\partial \delta} \) but produced an adverse increase in \( \frac{\partial M}{\partial \alpha} \). No appreciable loss in trailing-edge-strip effectiveness in producing changes in hinge-moment coefficient occurred up to the maximum test Mach number of 0.65.
INTRODUCTION

The design of highly balanced control surfaces has not been sufficiently developed for the desired control characteristics to be obtained in the first design and, for that reason, the control surfaces of most new airplanes usually must be modified.

In an investigation in the Langley 16-foot high-speed tunnel of a typical full-scale semispan horizontal tail surface of a proposed fighter airplane, a number of systematic profile modifications had to be made to produce the desired aerodynamic characteristics. The present report shows the effect of elevator nose shape, trailing-edge angle, and trailing-edge strips on the aerodynamic characteristics of the tail surface, the elevator of which had a fixed plan form and a constant ratio of balance area to elevator area.

COEFFICIENTS AND SYMBOLS

\( C_D \) drag coefficient \( \frac{D}{qS} \)
\( C_h \) hinge-moment coefficient \( \frac{H}{q\bar{c}_e^2 b_e} \)
\( C_L \) lift coefficient \( \frac{L}{qS} \)
\( C_m \) pitching-moment coefficient \( \frac{M_{c',/L}}{qSc'} \)
\( D \) drag of entire model
\( H \) hinge moment
\( L \) lift of entire model
\( M_{c',/L} \) pitching moment about quarter-chord point of mean aerodynamic chord
\( b \) span, feet
\( c \) chord, feet
\( c' \) mean aerodynamic chord
\( \bar{c}_e \) root-mean-square of elevator chord behind hinge line
\( q \)  
dynamic pressure \( \left( \frac{1}{2} \rho v^2 \right) \)

\( S \)  
total model area, square feet

\( M \)  
Mach number

\( R \)  
Reynolds number

\( V \)  
velocity of air, feet per second

\( x \)  
horizontal distance along chord from leading edge, percent chord

\( y \)  
vertical distance from chord, percent chord

\( \alpha \)  
angle of attack of stabilizer, degrees

\( \rho \)  
mass density of air, slugs per cubic foot

\( \delta \)  
angle of elevator chord with respect to stabilizer chord (positive when trailing edge is down), degrees

\( \phi_1 \)  
included angle at elevator trailing edge, degrees

Parameters:

\( C_{L\alpha} = \left( \frac{\partial C_L}{\partial \alpha} \right)_\delta \)

\( C_{L\delta} = \left( \frac{\partial C_L}{\partial \delta} \right)_\alpha \)

\( C_{h\alpha} = \left( \frac{\partial C_h}{\partial \alpha} \right)_\delta \)

\( C_{h\delta} = \left( \frac{\partial C_h}{\partial \delta} \right)_\alpha \)

(The subscripts outside the parentheses represent the factors held constant during the measurement of the parameters.)

Subscripts:

\( b \)  
balance
DESCRIPTION OF MODEL

For the present tests, the left side of the horizontal tail surface of a modern fighter airplane was used as a model. The airfoil was made according to the profile of the NACA 66-009 airfoil. For the metal elevator (the original elevator), this airfoil was modified to have a straight contour behind the 0.72c station. The general arrangement and geometrical characteristics of the model are presented in figure 1. Figure 2 is a photograph of the model installed in the Langley 16-foot high-speed tunnel.

Stabilizer.—The stabilizer was of metal construction and metal covered. All rivets were flush and the surface had been filled, rubbed with abrasive cloth, and waxed to increase the surface smoothness; however, considerable surface waviness existed. The gap between the elevator and the stabilizer was approximately 1/4 inch and was constant for all elevator angles. In order to reduce undesirable air flow through the elevator hinge pockets, cover plates attached to the top and bottom of each stabilizer hinge bracket were included.

Elevators.—Four modifications of the metal elevator were tested. The plan-form dimensions of all elevators were the same. The hinge line was located at 0.72c and the elevator balance was 0.48c_e (c_b/c_e = 0.48). No trim tab is used on the elevator because the angle of incidence of the stabilizer is adjustable in flight.

The metal elevator was constructed of aluminum and had a semielliptical nose and a straight taper behind the hinge line; this arrangement resulted in a trailing-edge angle of approximately 13°.

The coordinates of elevators 1 to 4 are given in table I. These elevators were constructed of spruce and incorporated systematic modifications to the elevator profile as shown in figure 3. Elevator 1 had a blunt nose and a straight taper behind the hinge line with a trailing-edge angle of 13°, the same as the metal elevator.
Elevator 2 had the same blunt nose as elevator 1 and a cusped contour behind the hinge line ($\phi_1 = 7^\circ$). Elevator 3 had a modified blunt nose and the same cusped contour behind the hinge line ($\phi_1 = 7^\circ$) as elevator 2. Elevator 4 had the semielliptical nose profile of the original elevator and the same cusped contour behind the hinge line ($\phi_1 = 7^\circ$) as elevators 2 and 3.

Examination of the model showed that the stabilizer brackets were approximately 3/32 inch above the chord line. The center line of the hinge pins for the metal elevator, however, was found to be slightly above the chord line. The net effect of these constructional defects was to cause the upper surface of the metal elevator to project approximately 1/16 inch above the contour of the tail when the elevator was in the neutral position. These defects caused the hinge-moment curves to be asymmetrical, but the incremental changes of a given coefficient, which result from the elevator modifications described herein, are believed to be correct.

**Trailing-edge strips.** Strips of $\frac{1}{8}$-inch- or $\frac{1}{16}$-inch-diameter tubing were attached to both surfaces of the metal elevator at the trailing edge. The method of attaching the tubing to the elevator is shown in figure 4. The length of the trailing-edge strips was varied first by testing the full-span length and then by cutting equal lengths from the root and tip ends of the strips. (See fig. 4.)

**APPARATUS AND METHODS**

**Model installation.** Inasmuch as a semispan model was used for the tests made in the Langley 16-foot high-speed tunnel, the center line of the horizontal tail surface had to be located in the plane of the tunnel-wall flat in order to produce air-flow conditions that approximated those of flight. (See figs. 1 and 2.) Labyrinth-type seals were used at the openings where the model support went through the tunnel-wall flat to minimize the leakage of air from the test chamber to the tunnel.

**Hinge-moment measurement.** The elevator control tube was so extended that it passed through the tunnel-wall flat and two self-alining bearings mounted on the
tunnel-balance frame. The elevator hinge moment was transferred through the elevator torque tube to a 6-inch crank and then through a jackscrew to the platform of a scale. The jackscrew was also used to vary the elevator angle. The platform scale was rigidly attached to the tunnel-balance frame and, since all other related parts were also attached to the tunnel-balance frame, the elevator hinge-moment measurements could not interfere with the measurements of lift, drag, and pitching moment. All force and moment data were recorded simultaneously.

Elevator-angle measurement. An Autosyn was used to measure the elevator angle. The transmitter of this Autosyn was rigidly attached to the stabilizer at the inboard hinge cut-out. A small pinion gear on the transmitter shaft was driven by a large sector gear that was rigidly attached to the root of the elevator. Any elevator deflection that occurred was therefore multiplied by the gear ratio (approx. 12:1) and was electrically transmitted to the receiver. A calibrated dial attached to the receiver provided a continuous visual indication of the elevator angle. A template was used to check the zero reading of the Autosyn indicator. This arrangement is believed to have measured the elevator root angle within ±0.1°.

Angle-of-attack measurement. An inclinometer located on a reference surface of the model support system was used to measure the angle of attack of the chord line of the stabilizer root. The measurements are believed to be accurate within ±0.05°.

TESTS

In general, test data were obtained for \( \alpha = -3^\circ, 0^\circ, \) and \( 3^\circ, \delta_e = -8^\circ \text{ to } 8^\circ, \) and \( M = 0.35. \) Some combinations of the angle variables could not be tested because of the allowable load limitations on the model. One of the trailing-edge-strip modifications on the metal elevator was tested at Mach numbers as high as 0.65.

Tests to determine the aerodynamic characteristics of the original metal elevator and the effect of trailing-edge angle (elevators 1 and 2) were made with the original hinge location; whereas tests to determine the effect of nose shape (elevators 2, 3, and 4) were made with the
stabilizer hinge brackets lowered 3/32 inch in order to locate the hinge line exactly on the chord line of the tail section.

REDUCTION OF DATA

The data presented herein have been corrected for tunnel-wall effects by the use of the reflection-plane theory given in reference 1. The projected frontal area of the model was such a small part of the tunnel area that tunnel-constriction corrections were negligible. Corrections to pitching moment due to model deflection and balance-frame deflection also were found to be negligible. The corrected data were cross-plotted and the values used herein are for selected angles of attack, elevator angles, and Mach numbers. The average dynamic pressure and average Reynolds number corresponding to the test Mach number are shown in figure 5. The Reynolds number is based on the calculated mean aerodynamic chord of 4.27 feet. Tests in which the gap around the model support was varied from 1/4 inch to 0 showed that no corrections due to end leakage were necessary for this setup.

RESULTS AND DISCUSSIONS

Basic Data with Metal Elevator

The variation of hinge-moment, drag, lift, and pitching-moment coefficients with elevator angle at $M = 0.35$ and $\alpha = -3^\circ, 0^\circ, \text{ and } 3^\circ$ are presented in figures 6 to 9, respectively.

Hinge-moment coefficient.- For the data shown on figure 6, $C_{h_a} = -0.0015$ and $C_{h_d} = 0.0020$. A constructional defect in the hinge-bracket locations (see section entitled "Description of Model") is the main cause of the asymmetry of the curves; a slight asymmetry in the elevator contour is probably also a contributing factor.

Drag Coefficient.- No unusual drag characteristics (fig. 7) occurred. The minimum value of $C_D$, however, is 0.011, which is a relatively high value as compared with the values for surfaces having less profile discontinuity.
Lift coefficient.- The lift coefficient varies linearly with elevator angle for the range shown in figure 8. The lift parameters $C_{L\alpha}$ and $C_{L\delta}$ are 0.058 and 0.0275, respectively.

Effect of Trailing-Edge Angle

Flight investigations have shown that the value of $C_{h\alpha}$ should be approximately 0 in order to avoid adverse effects on the stability and control characteristics, particularly in gusty air, and that the value of 0.0020 obtained for the original elevator was unsatisfactorily high. Preliminary calculations based on unpublished data indicated that a value of $C_{h\alpha} = 0$ could be obtained by decreasing the trailing-edge angle from approximately 13° to 7°. This change in elevator shape is illustrated in figure 3, and its effect was evaluated by a comparison of the results obtained for elevators 1 and 2.

Hinge-moment coefficient.- The effect of trailing-edge angle on the elevator hinge-moment coefficient is shown in figure 10 for three angles of attack and for $M = 0.35$. The nonlinearity of these curves prevents the exact use of the usual parameters, but the 6° change in elevator trailing-edge angle resulted in the following changes in the parameters: $\Delta C_{h\alpha} = -0.0013$ and $\Delta C_{h\delta} = -0.0026$. The change in $C_{h\alpha}$ due to a reduction in trailing-edge angle was of the desired magnitude, but the accompanying increase in $C_{h\delta}$ was undesirable because the control moment was about doubled for the metal elevator. The undesirable increase in $C_{h\delta}$ due to a reduction in trailing-edge angle may be nullified with no appreciable change in $C_{h\alpha}$ by changing the elevator nose shape (discussed in section entitled "Effect of Nose Shape"). Figure 10(a) indicates a reversal in $C_{h\delta}$ at $\alpha = -30$. This undesirable variation is believed to be a result of the asymmetry of the hinge-bracket location.

Drag coefficient.- The variation of the drag coefficient for elevators 1 and 2 ($\phi_1 = 13°$ and 7°, respectively) with elevator angle is presented in figure 11 for three values of $\alpha$ and for $M = 0.35$. The drag coefficient for a given increment of elevator deflection is slightly greater for elevator 2 ($\phi_1 = 7°$) than for elevator 1 ($\phi_1 = 13°$).
Lift coefficient.- A decrease in elevator trailing-edge angle was usually accompanied by a slight increase in lift. A reduction in trailing-edge angle from 13° to 7° increased $CL_g$ from 0.061 to 0.064 and increased $CL_5$ from 0.031 to 0.032.

Pitching-moment coefficient.- Reducing the trailing-edge angle from 13° to 7° caused a rearward shift of the center of lift. When the lift was varied by changing the angle of attack at $\delta = 0^\circ$, the center of lift shifted from 22.6 to 24.2 percent of the mean aerodynamic chord; when the lift was varied by changing the elevator angle for $\alpha = 0^\circ$, the center of lift was shifted from 56 to 57.7 percent of the mean aerodynamic chord.

Effect of Nose Shape

Hinge-moment data obtained for the various trailing-edge modifications indicated that the desired value of $Ch_\alpha$ could be obtained with a trailing-edge angle of approximately 7°. The reduction in trailing-edge angle, however, caused $Ch_5$ to increase from -0.0015 to about -0.0028. Since the original value of $Ch_5$ obtained for the metal elevator (-0.0015) was considered satisfactory, it was believed desirable to reduce the new value of $Ch_5$. Reference 3 shows that the value of $Ch_5$ can be changed, without appreciably affecting the value of $Ch_\alpha$, by altering the elevator nose shape. Two alterations were accordingly made to the nose profile (see fig. 3) in an attempt to obtain a satisfactory value of $Ch_5$. Comparison of elevators 2 and 3 with elevator 4 shows the changes in elevator contour.

Hinge-moment coefficient.- The effect of the nose modifications on the hinge-moment coefficient at $M = 0.35$ is shown in figures 12 and 13. Because of the difference in structural stiffness between the wooden and metal elevators and because of the asymmetry of the metal elevator (see section entitled "Description of Model"), elevator 4, which had a semielliptical nose profile the same as that of the metal elevator, was used as a reference. Figures 12 and 13 indicate that modifying the nose profile of the metal elevator to the modified-blunt shape (elevator 3) would result in $\Delta Ch_5 = 0.0010$ and $\Delta Ch_\alpha = 0.0002$; these figures indicate also that modifying the nose profile of the metal elevator to the blunt shape (elevator 2) would
result in $\Delta Ch_0 \approx 0.0020$ and $Ch_0 \approx 0.0004$. An elevator with a balance-moment area intermediate between elevators 2 and 3 would provide the desired decrease of 0.0013 in $Ch_0$ and would thus nullify the adverse effect of reducing the trailing-edge angle to 7°. The tests of the wooden elevators therefore indicate that the desired values of $Ch_0 \approx 0$, $Ch_0 \approx -0.0015$ at $M = 0.35$ may be obtained if the profile of the metal elevator is so modified that it has a more blunt nose (intermediate between elevators 2 and 3) and a cusped contour behind the hinge line (elevator 2) with a trailing-edge angle of about 7°.

An exact quantitative check of the experimental and predicted effects (reference 3) of the elevator-nose modifications cannot be made because of the nonlinearity of the curves of hinge-moment coefficient against elevator angle. The incremental changes in $Ch_0$ due to modifications of the elevator nose, however, are of about the same magnitude as changes calculated by the method of reference 3. Very poor agreement is obtained when the value of $Ch_0$ for any one elevator is calculated from unbalanced section flap data and corrected for balance effects by the method of reference 3.

Lift coefficient.- The effect of elevator-nose contour on lift is shown in figure 14 for $\delta = 0°$, $M = 0.35$, and $\alpha = -3°$ to $3°$. Figure 14 shows that $CL_0$ increases slightly as the surface discontinuity between the rearward portion of the stabilizer and the elevator nose is reduced by making the elevator nose more blunt because, as the contour of the tail surface approaches that of the true airfoil, optimum pressure distribution and lift are obtained.

Drag coefficient.- The effect of elevator-nose contour on drag is also shown in figure 14. The drag decreased slightly as the surface discontinuity between the rearward portion of the stabilizer and the elevator nose was reduced.

Pitching-moment coefficient.- The effect of elevator-nose contour on the pitching moment was not appreciable and no data are presented.
Effects of Trailing-Edge Strips

Tests were made also to determine combinations of length and diameter of trailing-edge strips that could be used on the metal elevator as a temporary expedient to obtain $C_h = 0$ for flight tests of the first experimental airplane having this tail surface. Various lengths of $\frac{1}{8}$-inch- and $\frac{1}{16}$-inch-diameter strips were tested at $M = 0.35$ and $\alpha = -3^\circ, 0^\circ, and 3^\circ$.

Hinge-moment coefficient. - Figures 15 and 16 show the variation of hinge-moment coefficient with elevator angle for various lengths of $\frac{1}{8}$-inch- and $\frac{1}{16}$-inch-diameter trailing-edge strips, respectively, at $M = 0.35$ and at $\alpha = -3^\circ, 0^\circ, and 3^\circ$. Decreasing the length of the strip decreases the slope of the hinge-moment curves, and no abrupt changes in the trend of the curves occur. The data presented in these figures have been used to obtain the hinge-moment parameters $C_{ha}$ and $C_{h6}$ shown in figure 17. The desired value of $C_{ha} = 0$ can be obtained by using $\frac{1}{8}$-inch-diameter strips 24 percent of the span in length or $\frac{1}{16}$-inch-diameter strips 38 percent of the span in length, but with an accompanying adverse increase in $C_{h6}$ over the desired value of -0.0015. The effect of speed on the effectiveness of the trailing-edge strips is shown in figure 18. No serious reduction of hinge-moment coefficient $C_h$ occurs up to the maximum test Mach number ($M = 0.65$) with the full-span $\frac{1}{8}$-inch-diameter strips on the elevator trailing-edge.

Lift coefficient. - Figures 19 and 20 show the effect of the length of the trailing-edge strips on lift coefficient for $\frac{1}{8}$-inch- and $\frac{1}{16}$-inch-diameter strips, respectively. The use of strips of either diameter usually results in an increase in lift at the higher elevator angles.

Drag coefficient. - Figures 21 and 22 show the effect of the length of trailing-edge strips on the drag coefficient for $\frac{1}{8}$-inch- and $\frac{1}{16}$-inch-diameter strips, respectively. The increase in drag due to lengthening the $\frac{1}{8}$-inch-diameter strips is usually twice the increase which
occurred with the \( \frac{1}{16} \)-inch-diameter strips. The maximum increase measured with \( \frac{1}{8} \)-inch-diameter full-span strips was 13 percent.

**Pitching-moment coefficient.** The change in pitching-moment coefficient due to trailing-edge strips was negligible and no figures are presented herein. The center of lift, however, was shifted from 23 percent to 25 percent of the mean aerodynamic chord for \( \delta = 0^\circ \) when the lift was increased by changing the angle of attack for \( \frac{1}{8} \)-inch-diameter full-span strips. The maximum shift in the aerodynamic center was from 52 percent to 58 percent of the mean aerodynamic chord for \( \alpha = 0^\circ \) when the lift was increased by changing the elevator angle.

**Conclusions**

From tests made in the Langley 16-foot high-speed tunnel of a full-scale horizontal tail surface to determine the effect of elevator-profile modifications and trailing-edge strips on the elevator hinge-moment characteristics for elevators having fixed plan form and constant balance, the following conclusions were reached:

1. A reduction of 6° in the trailing-edge angle resulted in incremental changes in the slopes of curves of hinge moment against angle of attack and against elevator angle of approximately -0.0026 and -0.0013, respectively.

2. The incremental changes in \( C_{h\delta} \) (slope of curve of hinge moment against elevator angle) due to elevator-nose modifications were of the same magnitude as the changes predicted by the use of methods given in NACA APC No. 114El3. These nose-profile changes had virtually no effect on \( C_{ha} \) (slope of curve of hinge moment against angle of attack).

3. A reduction in trailing-edge angle and an increase in the bluntness of the nose profile reduced the values of \( C_{ha} \) for the metal elevator from 0.0020, which was unsatisfactorily high, to 0 without affecting the value of \( C_{h\delta} \).

4. Trailing-edge strips were found to be very effective in reducing a positive value of \( C_{ha} \), but an adverse
increase in the values of $C_{h_5}$ accompanied the use of these strips. No appreciable loss in the effectiveness of the trailing-edge strips in producing changes in hinge-moment coefficient was apparent up to the maximum test Mach number of 0.65.

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National Advisory Committee for Aeronautics
Langley Field, Va.

REFERENCES


### TABLE I

**COORDINATES FOR ELEVATORS 1 TO 4 IN PERCENT c**

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<td>.27</td>
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</table>

**T.E. radius = 0.05 inch**

*Dash es indicate straight taper behind 0.324 c.*
Figure 1.- General arrangement of the horizontal tail surface in the Langley 16-foot high-speed tunnel. (All dimensions in inches and measured in plane of section.)
Figure 2.- Installation of model in tunnel.
Figure 3.—Contours of original metal elevator and elevators 1 to 4.
Figure 4.—Location and installation of trailing-edge strips on metal elevator.
Figure 5.—Variation of the average dynamic pressure and average Reynolds number with test Mach number.
Figure 6. — Variation of hinge-moment coefficient with elevator angle; metal elevator. M = 0.35.
Figure 7.- Variation of drag coefficient with elevator angle; metal elevator. $M = 0.35$. 

(a) $\alpha = -3^\circ$. 

(b) $\alpha = 0^\circ$. 

(c) $\alpha = 3^\circ$. 

$\sigma$, deg
Figure 8.—Variation of lift coefficient with elevator angle; metal elevator. \( M = 0.35 \).
Figure 9.- Variation of pitching-moment coefficient with elevator angle; metal elevator, M= 0.35.
Figure 10.—Effect of elevator trailing-edge angle on elevator hinge-moment coefficient. $M = 0.35$. 
Figure II.—Effect of elevator trailing-edge angle on drag coefficient. $M=0.35$. 
Figure 12a-c: Variation of hinge-moment coefficient with elevator angle for the three nose shapes. M = 0.35.
Figure 13: Effect of nose shape on hinge-moment coefficient.
\[ \theta = 0^\circ; M = 0.35. \]
Figure 14.—Variation of $C_D$ and $C_{L\phi}$ with $\alpha$ for various nose shapes. $M = 0.35; \phi = 0^\circ$. 
Figure 15. Variation of $C_h$ with elevator angle for four lengths of $\frac{1}{8}$-inch-diameter trailing-edge strips. $M=0.35$. 
Figure 16.— Variation of $C_h$ with elevator angle for three lengths of $\frac{1}{16}$-inch-diameter trailing-edge strips. $M = 0.35$. 

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Figure 17.— Effect of length of trailing-edge strips of 
\(\frac{1}{8}\)-inch and \(\frac{1}{16}\)-inch diameter on \(C_{h\delta}\) and \(C_{h\alpha}\) 
\(M = 0.35\).
Figure 18.—Variation of elevator hinge-moment coefficient with Mach number for \(\frac{1}{8}\)-inch-diameter trailing-edge strips. Full span; \(\delta = 0^\circ\).
Figure 19.—Variation of lift coefficient with length of $\frac{1}{8}$-inch-diameter trailing-edge strips. $M=0.35$. 
Figure 20.—Variation of lift coefficient with length of $\frac{1}{16}$-inch-diameter trailing-edge strips. $M=0.35$. 

(a) $\alpha = -3^\circ$. 

(b) $\alpha = 0^\circ$. 

(c) $\alpha = 3^\circ$. 

Length of trailing-edge strips, percent $b$
Figure 21.—Variation of drag coefficient with length of \( \frac{1}{8} \)-inch-diameter trailing-edge strips. \( M = 0.35 \).
Figure 22.—Variation of drag coefficient with length of \( \frac{1}{16} \)-inch-diameter trailing-edge strips. \( M = 0.35 \).