NACA TN 4039

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE 4039

INVESTIGATION OF THE EFFECTS OF PROFILE SHAPE ON THE AERODYNAMIC AND STRUCTURAL CHARACTERISTICS OF THIN, TWO-DIMENSIONAL AIRFOILS AT SUPERSONIC SPEEDS

By Elliott D. Katzen, Donald M. Kuehn, and William A. Hill, Jr.

Ames Aeronautical Laboratory
Moffett Field, Calif.

Washington
September 1957

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE 4039

INVESTIGATION OF THE EFFECTS OF PROFILE SHAPE ON THE AERODYNAMIC AND STRUCTURAL CHARACTERISTICS OF THIN, TWO-DIMENSIONAL AIRFOILS AT SUPERSONIC SPEEDS[1]

By Elliott D. Katzen, Donald M. Kuehn,
and William A. Hill, Jr.

SUMMARY

In order to determine the effects of thickness, trailing-edge bluntness, boattailing, and forward profile on the aerodynamic characteristics of thin airfoils, and to provide a check on the available theoretical methods, 31 airfoils were tested. The airfoils were 2, 4, and 6 percent thick and were tested at Mach numbers of 1.45 and 1.98 at Reynolds numbers of 1.0, 2.0, and 3.5 million in a clean condition and at a Reynolds number of 3.5 million with transition fixed.

The aerodynamic advantage of very thin airfoils was shown by a rapid increase of maximum lift-drag ratio (e.g., from 5.8 to 14.4 at $M = 1.45$ and a Reynolds number of 1.0 million) as the airfoil thickness ratio was decreased from 6 to 2 percent. Increased trailing-edge bluntness of the 6-percent-thick airfoils caused a small decrease in maximum lift-drag ratio but a large increase in section modulus; for the 2-percent-thick airfoils, increased bluntness caused a large decrease in maximum lift-drag ratio with only a small increase in section modulus. This has special significance for propeller designers in that it indicates that propellers whose blade elements operate at supersonic speeds should have blunt trailing edges for the thick sections near the hub and relatively sharp trailing edges for the thin sections near the tip. The importance of maintaining a laminar boundary layer on very thin airfoils was shown by the decrease of maximum lift-drag ratio from 14.4 to 11.9 caused by fixing transition at the leading edge of a sharp-trailing-edge 2-percent-thick airfoil at a Mach number of 1.45. The effects of the different forward profiles and changes in boattailing were generally such that a reduction in profile area reduced the minimum drag coefficient. The center of pressure of the airfoils moved forward with increased thickness

[1]Supersedes recently declassified RM A54B08a by Elliott D. Katzen, Donald M. Kuehn, and William A. Hill, Jr., 1954.

ratio and moved aft with increased trailing-edge bluntness. Available theoretical methods were adequate for calculating the lift and pitching moment of the airfoils under all conditions of the tests. The theoretical methods for calculating foredrag and correlation curves for estimating base pressure were adequate for predicting the total drag when the transition position was known.

INTRODUCTION

Although thin airfoils have inherent structural limitations, they are an aerodynamic necessity for wings, control surfaces, and propellers in order to attain practical lift-drag ratios for supersonic airplanes and missiles. The structural limitations of thin airfoils can be alleviated by making the trailing edges blunt and by increasing the area of the boattailed and forward parts of the profile. However, the aerodynamic penalties, if any, involved in these increases in profile area must be evaluated and balanced against the structural improvements they afford. The best means of assessing bluntness and other thickness effects, without having the results obscured by plan-form effects, is by the study of two-dimensional data.

Most of the experimental data available on blunt-trailing-edge airfoils (e.g., refs. 1 through 3) pertain to thickness ratios greater than 5 percent. Since gains in aerodynamic and propulsive efficiency are to be expected with further reductions in thickness ratio, data are required for smaller thickness ratios. For these very thin airfoils, the boundary-layer thickness is often the same order of magnitude as the airfoil thickness and large viscous effects are to be expected, particularly near the base of the model. Thus, experimental evaluation of the available inviscid theories, such as the linear, second-order, and shock-expansion theories, and of the analytical results of references 1, 2, 4, 5, and 6 is required.

The purpose of the present investigation, therefore, is to provide experimental data on thin, blunt-trailing-edge airfoils for evaluating the effects of thickness, trailing-edge bluntness, boattailing, and forward profiles, and to furnish a check on the available theoretical results. To accomplish these aims, 31 airfoils were tested in the Ames 1- by 3-foot supersonic wind tunnel No. 1 at Mach numbers of 1.45 and 1.98 and at Reynolds numbers of 1.0 to 3.5 million.

SYMBOLS

A	cross-sectional area of airfoil profile, sq in.
b	length of boattailed section, in.

c	airfoil chord, in.
c_d	section drag coefficient
$c_{d_{base}}$	section base-drag coefficient
$c_{d_{min}}$	section minimum drag coefficient
$c_{d_{min_{fore}}}$	section minimum foredrag coefficient
C_D	wing drag coefficient
c_l	section lift coefficient
c_{l_α}	rate of change of lift coefficient with angle of attack at zero angle of attack, per radian
$c_{l_{opt}}$	section lift coefficient for maximum lift-drag ratio
C_L	wing lift coefficient
c_m	section pitching-moment coefficient about midchord position
C_m	wing pitching-moment coefficient about midchord position
h	trailing-edge thickness, in.
I	section moment of inertia about chord line, in.^{4}
$\frac{I}{t/2}$	section modulus, in.^{3}
$\left(\frac{l}{d}\right)_{max}$	section maximum lift-drag ratio
M	Mach number
$\frac{p_b}{p}$	ratio of base pressure to free-stream static pressure
R	Reynolds number based on chord
t	maximum thickness of airfoil, in.

$\Delta x_{c.p.}$	distance of center of pressure forward of midchord position in chord lengths
α	angle of attack, deg
β	$\sqrt{M^2 - 1}$
γ	ratio of specific heats (1.400 for air)

EXPERIMENTAL CONSIDERATIONS

Apparatus

The tests were conducted in the Ames 1- by 3-foot supersonic wind tunnel No. 1 This single-return, continuous-operation, variable-pressure wind tunnel has a Mach number range of 1.2 to 2.5. The Mach number is changed by varying the wall contour by use of flexible plates which comprise the top and bottom walls of the tunnel.

The side-support balance used to measure the aerodynamic forces, and a typical two-dimensional model installation are shown in figure 1. Since this is the first report in which data obtained with this balance have appeared, a more complete description of the balance is given than would normally be the case. The two-dimensional installation includes a through-span model, two boundary-layer plates, and two complete balance units, one located on each side of the tunnel (only one balance unit is shown in figure 1). The model is supported at each end by the balance floating beam, which is, in turn, supported entirely by a set of six (the yawing-moment gage is not shown) interchangeable ring-type strain gages. These gages are attached to the main body of the balance through insulated supports. The complete unit of test model, floating beam, and ring gages comes in contact with the main body of the balance only through these insulated supports, thereby permitting electrical contact to detect fouling of the unit. The balance is rotated by an electric motor driving the worm gear mechanism on the main body of the balance. An airtight drum fits over the entire balance unit and is vented to free-stream static pressure. Calibration of the balance showed that interaction effects between components of the balance were negligible.

Tunnel-wall boundary-layer effects are eliminated by the use of two parallel boundary-layer plates 8 inches apart which are alined with the tunnel free stream and which remain fixed with respect to the main tunnel walls. The spacing between the tunnel wall and the boundary-layer plate is such that all side-wall tunnel boundary layer flows behind the plate. Circular plates in the boundary-layer plates rotate with the model so as to maintain a uniform, preset clearance around the model surface and model shanks. The surfaces of the circular plate and the boundary-layer plate remain flush to within 0.0015 inch. A fairing which completely envelopes the model shank, thereby relieving it of any air load, is an integral part of the rotating circular plate and is connected solidly to the balance housing. The model shank is pinned directly to the floating beam. Clearance around the model surface and model shank was maintained at all times so that the full air load on the wing would be transmitted to the ring gages. The clearance between the wing surface and the boundary-layer plate was preset at approximately 0.030 inch for all the two-dimensional wings (see fig. 2(a)). An auxiliary test arrangement, used only with a semispan wing, which eliminates the 0.030-inch gap by using a 0.007-inch-thick rubber seal is shown in figure 2(b). The semi-span wing uses only one balance and boundary-layer plate; the other boundary-layer plate is replaced by a conventional 18-inch-diameter window.

Models

All the airfoil sections used in this investigation are shown in figure 3. Each of the 31 sections was derived from one of four basic shapes (having three different forward profiles); namely, (1) biconvex (i.e., two circular arcs), $t/c = 0.04$, (2) biconvex to the midchord point with the maximum thickness constant to the trailing edge, $t/c = 0.04$, (3) biconvex to the one-third chord point with the maximum thickness constant to the trailing edge, $t/c = 0.02$, 0.04, and 0.06, and (4) NACA 16-004. Seven individual sections were obtained from each of the four blunt airfoils by altering the basic profile, as shown in figure 3. In each case, the amounts of bluntness were 100, 60, 30, and 0 percent of the airfoil maximum thickness. The boattail parameter used in the investigation was the ratio of the length of boattail section to the chord length. For the basic airfoils biconvex to $c/3$, the b/c ratios were 0.05 and 0.33; for the basic airfoil biconvex to $c/2$, the b/c ratios were 0.05 and 0.50. The biconvex airfoil was not altered. One alteration was made to the NACA 16-004 airfoil by increasing the trailing-edge bluntness to 30 percent with the boattail a straight line from the base tangent to the original profile. Each of these airfoils had a chord length of 6 inches and a span of 8 inches between boundary-layer plates.

Two other wings were used to evaluate quantities necessary for the complete analysis of the main airfoil data. They were (1) a 3/4-inch-chord wedge with a base height of 0.180 inch and a span of 8 inches between boundary-layer plates, (2) a 6-inch-chord, aspect ratio 2, double-wedge, 6-percent-thick wing with a gap that could be sealed (see fig. 2).

The airfoils with blunt trailing edges had a 0.020-inch-diameter base-pressure orifice located symmetrically in the base with the pressure lead brought out at the root of the wing. All leading edges, except for the NACA 16-004 airfoil, and all sharp trailing edges had radii of approximately 0.002 inch for practical reasons of construction and maintenance. The ordinates for the NACA 16-004 section are given in table I.

Test Procedure

The airfoils were tested at Mach numbers of 1.45 and 1.98 and at Reynolds numbers of 1.0, 2.0, and 3.5 million at each Mach number with the airfoil surface clean. At a Reynolds number of 3.5 million, the airfoils were also tested with a 1/4-inch-wide salt band starting 1/4 inch from the leading edge. At a Mach number of 1.45, the angle-of-attack range was limited to $\pm 6^{\circ}$ due to the movement of the diffuser normal shock wave into the test section of the wind tunnel. However, at a Mach number of 1.98 an angle of attack of $\pm 18^{\circ}$ was attained before this phenomenon occurred. Simultaneous measurements of total force and base pressure were made at each angle of attack. For all tests the humidity of the tunnel air was held to a value of less than 0.0003 pound of water vapor per pound of dry air which is sufficient to reduce condensation effects to a negligible amount.

Since a salt band was used to promote boundary-layer transition, it was necessary to evaluate the wave drag of the salt. For this purpose a 3/4-inch-chord wedge (see fig. 3) was tested at zero angle of attack at both Mach numbers with and without the salt band. An attempt was made to standardize the size of salt crystals used by sifting through two screens of different mesh size thus eliminating all the very large and the very small crystals. Several repeat runs were made to check the consistency with which the salt bands could be applied. The tests indicated that the salt-band results could be repeated within the values of uncertainty in drag coefficient stated later in the section "Accuracy of Data"; that is, the differences between runs with the salt band were no larger than differences between repeat runs without the salt band. For tests of the wedge with and without salt, the total force and the base pressure were measured and the results corrected to foredrag. The difference between the foredrag results with and without salt was taken as the correction for the wave drag of the salt.

The effect of the clearance around the airfoil at the wing root on the aerodynamic forces was evaluated by using identical wing shapes with the gap around one of the wings sealed with a 0.007-inch-thick rubber seal. The change in strain-gage calibration caused by that portion of the applied force required to stretch the elastic rubber seal was determined and found to be negligible by a static-force calibration with model and balance installed in the tunnel. The double-wedge, semispan wings used for this check were run at the same test conditions as were the two-dimensional airfoils. Results of the gap tests, described later, showed that the effect of the gap was insignificant.

Reduction of Data

All force data were reduced to the usual coefficient form for drag, lift, and pitching moment. The reference length and area used for the coefficients were chord length and plan-form area, respectively. In addition to the total drag for all wings, the foredrag has also been presented in some instances. Base-pressure coefficients are given in the form of the ratio of base pressure to the tunnel free-stream static pressure.

Corrections to Experimental Results

Corrections to the measured force coefficients were computed for the wave drag of the salt band, for irregularities of the free-stream pressure and stream angle, and for the change in angle of attack due to elastic deformation of model and balance.

The correction (described in detail in the section "Test Procedure") which was applied to the main airfoil data for the wave drag of the salt band is an average of several runs made with the 3/4-inch-chord wedge. The resulting values, expressed in drag coefficient form, are 0.0035 at a Mach number of 1.45 and 0.0022 at a Mach number of 1.98. This correction was determined at zero angle of attack only, but it was applied as a drag-force correction at all angles of attack. It is believed, however, that the error introduced by this method of correction is of no practical consequence.

Since the airfoil was rotated about its midchord point and therefore always remained in nearly the same region of the tunnel stream, a single correction for stream angle sufficed throughout the angle-of-attack range. This stream-angle correction, which was small, and, in general, different for the lift and moment curves, included the amount that the model angle of attack was in error at the initial installation and any asymmetries in construction. The correction was applied very simply by shifting the lift and moment curves so that they would pass through the origin of the axes. Corrections to the force and moment coefficients due to free-stream pressure gradients were negligible for the airfoils of such small thickness ratios as were used in this investigation. The combined elastic deformation of the model and balance for all wings was negligible for all test conditions.

Accuracy of Data

The accuracy of the final parameters used in the data analysis has been estimated by considering the known accuracy of the individual quantities used in determining these final values. The total uncertainty is given by the square root of the sum of the squares of the individual uncertainties. These uncertainties are given as ± increments in the following table:

M	c_l	$R \times 10^6$	ΔM	Δc_l	Δc_d	Δc_m	$\Delta\alpha$
1.45	0	1.0	± 0.01	±0.005	±0.0010	±0.0016	±0.10
↓	0	3.5	↓	±.002	±.0004	±.0005	↓
↓	≅.45	1.0	↓	±.005	±.0013	±.0030	↓
↓	≅.45	3.5	↓	±.002	±.0008	±.0030	↓
1.98	0	1.0	±.02	±.005	±.0010	±.0016	↓
↓	0	3.5	↓	±.002	±.0004	±.0005	↓
↓	≅.80	1.0	↓	±.012	±.0051	±.0030	↓
↓	≅.80	3.5	↓	±.005	±.0020	±.0030	↓

Repeatability of data was checked by making several runs with a given model and was found to be consistent with the above values. In addition to the above quantities, another source of uncertainty is introduced by the gap around the airfoil at the root of the wing. The effect of the gap on the aerodynamic characteristics was estimated from the semispan data shown in figure 4. Since the difference between the runs with and without gap was no more than that for a given model with a gap run twice, the effect of gap was negligible.

THEORETICAL CONSIDERATIONS

Lift and Pitching Moment

Two theoretical methods of calculating the lift and pitching moment were used in the present report. Second-order theory was used for calculating the slopes at $\alpha = 0$, and shock-expansion theory was used at the higher angles of attack where nonlinearities are to be expected and greater accuracy than that of second-order theory is required. The second-order formulas used for the slopes at $\alpha = 0$ (ref. 1) were:

$$\frac{dc_l}{d\alpha} = 2C_1\left(1 + \frac{C_2}{C_1}\frac{h}{c}\right) \tag{1}$$

where

$$C_1 = \frac{2}{\sqrt{M^2 - 1}} \tag{2}$$

$$C_2 = \frac{(\gamma + 1)M^4 - 4(M^2 - 1)}{2(M^2 - 1)^2} \tag{3}$$

and

$$\frac{dc_m}{dc_l} = \frac{C_2\left(A - \frac{hc}{2}\right)}{C_1 c^2\left(1 + \frac{C_2}{C_1}\frac{h}{c}\right)} \tag{4}$$

Formulas 1 and 4 neglect the base pressure but it was shown in reference 1 that the error involved in excluding the base pressure was negligible for lift and pitching moment.

Drag

The drag of the airfoils was predicted by adding calculated values of the pressure foredrag, skin-friction drag, and the base drag. The pressure foredrag was calculated by shock-expansion theory for all the airfoils. For the two round-leading-edge sections (NACA 16-004 airfoils with $h/t = 0$ and $h/t = 0.3$), the calculations were made by approximating the leading edge with the largest wedge angle for which the leading-edge shock wave remained attached. Laminar skin-friction coefficients were estimated from the Blasius flat-plate incompressible theory since differences are negligible at the test Mach numbers between this theory and the more accurate theories which account for compressibility. Turbulent skin-friction coefficients were estimated from Cope's theory (ref. 7) since various experimental results summarized by Chapman and Kester in reference 8 have shown this theory to be as accurate as any of the available theories at the Mach numbers of the test. No estimate was made of the skin-friction coefficients for the Reynolds numbers for which natural transition and part laminar, part turbulent boundary layers were indicated on the airfoils because the location of transition was not known. The base drag was estimated from the correlation plots of reference 9. Both the base drag and the skin-friction drag were assumed constant with angle of attack.

Lift-Drag Ratio and Optimum Lift Coefficient

The maximum lift-drag ratio was calculated from the following second-order equation of reference 1 which is applicable for small values of h/c:

$$\left(\frac{l}{d}\right)_{max} = \left(\frac{C_1}{2c_{d_{min}}}\right)^{1/2}\left(1 + \frac{1}{4}\frac{C_2 h}{C_1 c}\right) \tag{5}$$

The optimum lift coefficient was calculated from

$$c_{l_{opt}} = \left(2C_1\ c_{d_{min}}\right)^{1/2}\left(1 + \frac{1}{4}\frac{C_2 h}{C_1 c}\right) \tag{6}$$

which was derived from the formulas of reference 1.

RESULTS AND DISCUSSION

Results of tests of the 31 airfoils are presented in table II in the form of lift, drag, and pitching-moment coefficients and base-pressure ratios as a function of angle of attack. The coefficients are averages of the values measured for both positive and negative angles since the airfoils were symmetrical about the chord plane and the differences for the positive and negative angles were small and consistent with the uncertainties in the data listed previously. Since the data are tabulated, the only basic plots shown (figs. 5 through 8) are typical lift, pitching-moment, drag, and lift-drag-ratio curves. The trends of the data with the parameters of the test (t/c, h/t, b/c, forward profile, M and R) and theoretical and experimental correlation plots are shown in figures 9 through 16. The experimental results of the test, with theoretical predictions for comparison, are summarized in table III as lift-curve and moment-curve slopes at $\alpha = 0$, minimum drag coefficient, maximum lift-drag ratio, and lift coefficient for maximum lift-drag ratio. The results are discussed in the following paragraphs.

Lift

Typical lift curves are shown in figure 5. The figure shows that the lift at any given angle increased with trailing-edge thickness and was relatively unaffected by airfoil thickness ratio as predicted by theory. The predicted departure from linearity with angle of attack was slightly less than that measured.

Examination of table III shows that the normalized lift-curve slopes, βc_{l_α}, are principally a function of h/c and that there was no consistent variation of βc_{l_α} with t/c, b/c, forward profile, R and M. The normalized lift-curve slopes are plotted against h/c in figure 9 for all the models. The mean of the data closely followed the predicted increase in βc_{l_α} with h/c. The spread in the data due to variations in t/c and the other parameters mentioned above did not produce deviations from the predicted curve by more than ±5 percent, with but few exceptions.

Pitching Moment and Center of Pressure

Typical pitching-moment coefficients are shown as a function of lift coefficient in figure 6. The data are for sharp-trailing-edge airfoils 2 and 6 percent thick in figure 6(a) and are for 6-percent-thick airfoils with both sharp and fully blunt trailing edges in figure 6(b). The figure shows that at a given lift coefficient and trailing-edge thickness ratio, the effect of increased airfoil thickness ratio was to increase the pitching-moment coefficient. However, for given thickness ratio, the pitching-moment coefficient decreased with increased trailing-edge thickness. Although the predicted pitching-moment curve was slightly more nonlinear with lift for the 6-percent than the 2-percent-thick airfoils and the reverse occurred experimentally, the agreement between theory and experiment was good.

The foregoing trends of lift and pitching-moment coefficient are reflected in the forward movement of the center of pressure (fig. 10) with increased airfoil thickness ratio and in rearward movement with increased trailing-edge bluntness. For the sharp-trailing-edge airfoils shown, the center of pressure moved from 2 to 8 percent of the chord forward of the midchord position at $M = 1.45$ with an increase in airfoil thickness ratio from 2 to 6 percent. Illustrating the opposite trend with increased trailing-edge bluntness, the center of pressure shifted from 8 to 4 percent of the chord forward of the midchord position for the

6-percent-thick airfoil at $M = 1.45$ with an increase from zero to full bluntness. The center of pressure was generally 1 to 2 percent of the chord further forward at $M = 1.45$ than at $M = 1.98$. This was a trend not predicted by theory. The effect of b/c and of forward profile, with t/c and h/t fixed, was generally to shift the center of pressure forward with increased profile area. The variation of the center of pressure with Reynolds number can be seen from table III to be less than ±0.5 percent of the chord in most cases.

It can be seen from figure 11 that the predicted and experimental center-of-pressure positions usually agreed within 1 or 2 percent of the chord, with better agreement at $M = 1.98$ than at $M = 1.45$.

An example of how two-dimensional section data can be combined with linear-theory tip effects to predict the pitching moment of a finite aspect ratio wing is shown in figure 4. It can be seen that superimposing thickness effects, as given by second-order theory, on linear-theory tip effects improves the prediction of the pitching moment over that which would be calculated with thickness effects neglected.

Minimum Drag Coefficient

The variation of minimum drag coefficient with airfoil thickness ratio and trailing-edge thickness ratio is shown in figure 12. Data included pertain to various forward-facing profiles and boattail conditions, with transition fixed at $R=3.5\times10^6$ and with the airfoils in a clean condition at $R=1.0\times10^6$. The data manifest a rapid increase in $c_{d_{min}}$ with increased t/c or h/t and a decrease in $c_{d_{min}}$ with increased Mach number. The percentage increase in $c_{d_{min}}$ with increased h/t was larger for the 2-percent than the 6-percent-thick airfoil, as would be inferred from the theoretical optimum-airfoil results of reference 3. At $M = 1.45$, $c_{d_{min}}$ increased approximately 40 percent (or 0.012) for 6-percent-thick airfoils and 100 percent (or 0.006) for 2-percent-thick airfoils, with an increase in h/t from 0 to 1.0. The effects of changes in the basic airfoil and in b/c were such that, generally speaking, reduction in profile area, regardless of position on the airfoil, reduced $c_{d_{min}}$.

The effect of fixing transition at the leading edge of the airfoils is also illustrated in figure 12. The increase in $c_{d_{min}}$ shown was usually due to an increase in base drag, as well as to an increase in skin friction. It can be seen from table III that the effect of increased Reynolds number on the airfoils in a clean condition was to increase $c_{d_{min}}$. This indicates that the transition region was moving forward on the airfoil surface with increased Reynolds number because $c_{d_{min}}$ would be expected to decrease with increased Reynolds number if the boundary layer had remained completely laminar.

The theoretical and experimental $c_{d_{min}}$ were generally in good agreement, as can be seen in the correlation plots of figure 13. The airfoils for which the predicted drag coefficients were slightly higher than the experimental coefficients usually had sharp trailing edges (table III). This is probably a result of the shock wave near the trailing edge interacting with the boundary layer and causing increased pressures and reduced drag on the rear portion of the airfoils, as first pointed out in reference 10. For the blunt-trailing-edge airfoils, the trailing-edge shock wave occurs further downstream, and the pressures on the rear portion of the airfoil apparently are not increased. The data of figure 13 are presented as total-drag, foredrag, and base-drag coefficients for $R=3.5\times10^6$ with transition fixed and $R=1.0\times10^6$ with the airfoils in a clean condition. With transition fixed at $R=3.5\times10^6$, skin-friction and base-pressure coefficients corresponding to a turbulent boundary layer were used in computing the theoretical $c_{d_{min}}$. With the airfoils in a clean condition at $R=1.0\times10^6$, skin-friction and base-pressure coefficients corresponding to a laminar boundary layer were used in computing the theoretical $c_{d_{min}}$. That the boundary layer was laminar over most of the airfoil is indicated by the good agreement between theory and experiment for the foredrag. The increase in base drag over the predicted values suggests that transition is occurring near the base, thereby decreasing the experimental base-pressure ratio and increasing the base drag. Theoretical $c_{d_{min}}$ was not calculated for $R=2.0\times10^6$ and $R=3.5\times10^6$ with the airfoils in a clean condition because the location of transition on the airfoils was not known.

Reference 7 shows that base pressures at a given Mach number can be correlated on the basis of the ratio of the boundary-layer thickness at the base to the base height. Since the boundary-layer thickness at the base of the airfoils with transition fixed near the leading edge was undoubtedly different than for natural transition which did not occur near the leading edge, the base pressure with transition fixed would not be expected to coincide with the base pressure with natural transition. That they did not coincide can be seen from table II. At $R=3.5\times10^6$ the base-pressure ratios for natural transition (airfoils clean) were higher than those for transition fixed. However, the differences were not large and the differences were smaller at $M = 1.98$ than at $M = 1.45$. In general, figure 13 shows that errors in the base drag of thin airfoils do not seriously affect the prediction of the total drag.

Drag Due to Lift and Lift-Drag Ratio

Typical variations of drag coefficient and lift-drag ratio with lift coefficient are shown in figures 7 and 8. The drag curves were parabolic and the agreement between theory and experiment was good. The drag coefficient increased with increased trailing-edge bluntness at a given lift coefficient; the increase occurred at a decreasing rate with increased lift coefficient. The lift-drag-ratio curves were more sharply peaked for the 2-percent than for the 6-percent-thick airfoils and for the sharp- than for the fully blunt-trailing-edge airfoils. Furthermore, the lift coefficient for $(l/d)_{max}$ decreased with decreased t/c and h/t. These trends naturally result from the behavior of $c_{d_{min}}$ and are in good agreement with theory.

Maximum Lift-Drag Ratio

The variation of maximum lift-drag ratio with airfoil thickness ratio and trailing-edge thickness ratio is shown in figure 14. The aerodynamic advantage of very thin airfoils is illustrated by the rapid increase of $(l/d)_{max}$ with decreased t/c for the sharp-trailing-edge airfoil in a clean condition at $R=1.0\times10^6$ and $M = 1.45$; the $(l/d)_{max}$ increased from 5.8 to 14.4 with a decrease in t/c from 6 to 2 percent. The increase of $(l/d)_{max}$ with decreased t/c was larger for the sharp- than the blunt-trailing-edge airfoils, and the effect of increased h/t was to decrease $(l/d)_{max}$. The decrease was small for the 6-percent-thick airfoils and became larger with decreased t/c. The effect of the different forward profiles and changes in b/c were generally consistent with the $c_{d_{min}}$ results in that reduction in profile area increased $(l/d)_{max}$. Increasing the Mach number from 1.45 to 1.98 caused a larger decrease in $(l/d)_{max}$ for the 2-percent than for the 6-percent-thick airfoils. It is also evident from figure 14 that large gains in $(l/d)_{max}$ can be achieved by maintaining a laminar boundary layer on very thin airfoils. For the 2-percent-thick sharp-trailing-edge airfoil at $M = 1.45$, $(l/d)_{max}$ was 14.4 for the airfoils in a clean condition at $R=1.0\times10^6$ and 11.9 with transition fixed at $R=3.5\times10^6$.

In order that the various airfoils may be compared on the basis of both an aerodynamic and a structural criterion, a plot of the variation of $(l/d)_{max}$ with section modulus is shown in figure 15. The figure shows that large amounts of bluntness of the 2-percent-thick airfoils resulted in large decreases in $(l/d)_{max}$ but only small increases in section modulus. In contrast, large increases in trailing-edge bluntness of the 6-percent-thick airfoils caused small decreases in $(l/d)_{max}$ and large increases in section modulus. These trends would be essentially the same if structural parameters other than section modulus, for instance, torsional rigidity or bending stiffness, had been chosen for comparison. The results have special significance for propeller designers in that they indicate that propellers whose blade elements operate at supersonic speeds should have blunt trailing edges for the thick sections near the hub and relatively sharp trailing edges for the thin sections near the tip. It should be pointed out that airfoils designed to have the minimum wave drag for a given structural criterion (refs. 4 and 6) and for the Mach number and Reynolds number conditions of these tests have smaller leading-edge angles than the airfoils tested. For the 6-percent-thick airfoils especially, it is believed that if airfoils with the same structural characteristics but with smaller leading-edge angles had been tested, higher maximum lift-drag ratios would have been obtained.

The good agreement between theory and experiment for c_{l_α} and $c_{d_{min}}$ is mirrored in the good agreement for $(l/d)_{max}$ shown in figure 16.

CONCLUSIONS

An investigation to provide experimental aerodynamic data at Mach numbers of 1.45 and 1.98 on thin, two-dimensional, blunt-trailing-edge airfoils afforded the following conclusions:

1. The aerodynamic advantage of very thin airfoils was shown by a rapid increase of maximum lift-drag ratio with decreased airfoil thickness ratio.

2. Increased trailing-edge bluntness of the 6-percent-thick airfoils caused a small decrease in maximum lift-drag ratio and a large increase in section modulus; for the 2-percent-thick airfoils, increased bluntness caused a large decrease in maximum lift-drag ratio and a small increase in section modulus.

3. The importance of maintaining a laminar boundary layer on very thin airfoils was shown by the decrease of maximum lift-drag ratio from 14.4 to 11.9 caused by fixing transition at the leading edge of a sharp-trailing-edge 2-percent-thick airfoil at a Mach number of 1.45.

4. The effects of different forward profiles and changes in boat-tailing were such that, generally, any reduction in profile area reduced the minimum drag coefficient.

5. The center of pressure of the airfoils moved forward with increased thickness ratio and aft with increased trailing-edge bluntness.

6. Available theoretical methods were adequate for calculating the lift and pitching moment of the airfoils under all conditions of the test. The theoretical methods for calculating foredrag and correlation curves for estimating base pressure were adequate for predicting the total drag when the position of transition was known.

Ames Aeronautical Laboratory
National Advisory Committee for Aeronautics
Moffett Field, Calif., Feb. 8, 1954

REFERENCES

1. Chapman, Dean R.: Reduction of Profile Drag at Supersonic Velocities by the Use of Airfoil Sections Having a Blunt Trailing Edge. NACA TN 3503, 1955. (Supersedes NACA RM A9H11)

2. Chapman, Dean R., and Kester, Robert H.: Effect of Trailing-Edge Thickness on Lift at Supersonic Velocities. NACA TN 3504, 1955. (Supersedes NACA RM A52D17)

3. Syvertson, Clarence A., and Gloria, Hermilio R.: An Experimental Investigation of the Zero-Lift-Drag Characteristics of Symmetrical Blunt-Trailing-Edge Airfoils at Mach Numbers from 2.7 to 5.0. NACA RM A53B02, 1953.

4. Chapman, Dean R.: Airfoil Profiles for Minimum Pressure Drag at Supersonic Velocities - General Analysis with Application to Linearized Supersonic Flow. NACA Rep. 1063, 1952. (Formerly NACA TN 2264)

5. Klunker, E. B., and Harder, Keith C.: Comparison of Supersonic Minimum-Drag Airfoils Determined by Linear and Nonlinear Theory. NACA TN 2623, 1952.

6. Chapman, Dean R.: Airfoil Profiles for Minimum Pressure Drag at Supersonic Velocities - Application of Shock-Expansion Theory, Including Consideration of Hypersonic Range. NACA TN 2787, 1952.

7. Cope, W. F.: The Turbulent Boundary Layer in Compressible Flow. National Physical Lab., Engr. Dept., British ARC 7634.

8. Chapman, Dean R., and Kester, Robert H.: Measurements of Turbulent Skin Friction on Cylinders in Axial Flow at Subsonic and Supersonic Velocities. Jour. Aero. Sci., vol. 20, no. 7, July 1953, pp. 441-448.

9. Chapman, Dean R., Wimbrow, William R., and Kester, Robert H.: Experimental Investigation of Base Pressure on Blunt-Trailing-Edge Wings at Supersonic Velocities. NACA Rep. 1109, 1952. (Formerly NACA TN 2611)

10. Ferri, Antonio: Experimental Results With Airfoils Tested in the High-Speed Tunnel at Guidonia. From: Atti di Guidonia, No. 17, Spet. 20, 1939. NACA TM 946, 1940.

TABLE I.- AIRFOIL ORDINATES

[Stations and ordinates given in percent of airfoil chord]

Upper and lower surface		
Station	NACA 16-004 h/t=0	NACA 16-004 h/t=0.3
	Ordinate	Ordinate
0	0	0
1.25	.43	.43
2.5	.60	.60
5.0	.83	.83
7.5	1.00	1.00
10.0	1.17	1.17
15.0	1.37	1.37
20.0	1.57	1.57
30.0	1.80	1.80
40.0	1.97	1.97
50.0	2.00	2.00
60.0	1.93	1.93
70.0	1.75	1.75
80.0	1.40	1.40
90.0	.83	1.00
95.0	.47	.80
100.0	.03	.60
L.E. radius: 0.078		

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED

(a) Basic airfoil: Biconvex to c/3, t/c = 0.02

(1) h/t = 1.0, b/c = 0

M	α, deg	R=3.5x10^6 Transition fixed				R=3.5x10^6 Airfoil clean				R=2.0x10^6 Airfoil clean				R=1.0x10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0139	0.45	0	0	0.0120	0.50	0	0	0.0113	0.51	0	0	0.0102	0.55
	.5	.030	.0007	.0139	.46	.031	.0003	.0123	.50	.032	.0004	.0117	.51	.034	.0005	.0109	.53
	1.0	.063	.0008	.0146	.46	.064	.0003	.0131	.50	.065	.0005	.0124	.52	.067	.0003	.0116	.52
	1.5	.100	.0008	.0162	.46	.099	.0004	.0165	.51	.100	.0005	.0149	.52	.104	.0003	.0142	.52
	2.0	.135	.0010	.0183	.46	.135	.0004	.0168	.51	.136	.0005	.0159	.52	.142	.0001	.0162	.52
	3.0	.207	.0020	.0246	.46	.206	.0011	.0228	.51	.207	.0006	.0223	.52	.215	.0008	.0217	.53
	4.0	.284	.0038	.0338	.46	.280	.0024	.0317	.51	.283	.0017	.0311	.53	.294	.0023	.0324	.55
	5.0	.362	.0065	.0460	.43	.357	.0040	.0434	.52	.358	.0032	.0428	.54	.373	.0037	.0429	.57
	6.0	.444	.0093	.0609	.43	.438	.0064	.0586	.52	.438	.0057	.0570	.58	- - -	- - -	- - -	- -
1.98	0	0	0	.0104	.38	0	0	.0082	.36	0	0	.0071	.47	0	0	.0064	.59
	.5	.018	.0001	.0108	.37	.017	0	.0084	.36	.018	.0003	.0072	.46	.020	.0003	.0065	.57
	1.0	.038	.0001	.0108	.38	.038	-.0001	.0085	.36	.039	.0003	.0077	.45	.040	.0003	.0069	.56
	1.5	.059	.0002	.0116	.38	.058	-.0001	.0092	.36	.060	.0004	.0083	.45	.060	.0005	.0079	.56
	2.0	.081	.0002	.0128	.38	.079	-.0001	.0105	.36	.081	.0004	.0099	.45	.084	.0005	.0093	.55
	3.0	.124	.0003	.0168	.38	.121	-.0001	.0141	.36	.124	.0004	.0135	.45	.128	.0011	.0127	.56
	4.0	.167	.0007	.0218	.39	.164	.0004	.0194	.37	.168	.0003	.0189	.44	.171	.0011	.0182	.57
	5.0	.211	.0009	.0285	.39	.206	.0010	.0259	.37	.210	.0005	.0254	.45	.215	.0011	.0247	.59
	6.0	.254	.0014	.0369	.39	.250	.0010	.0344	.37	.253	.0011	.0339	.46	.260	.0016	.0337	.60
	8.0	.342	.0028	.0586	.40	.336	.0021	.0589	.39	.340	.0020	.0554	.47	.344	.0021	.0544	.62
	10.0	.434	.0042	.0846	.42	.423	.0030	.0424	.40	.426	.0028	.0830	.48	.433	.0037	.0826	.61
	12.0	.522	.0065	.1213	.43	.512	.0049	.0830	.41	.514	.0045	.1171	.49	.531	.0056	.1199	.57
	14.0	.619	.0088	.1650	.47	.608	.0065	.1603	.42	.615	.0061	.1615	.46	.635	.0075	.1655	.52
	16.0	.739	.0086	.2242	.52	.716	.0093	.2147	.41	.726	.0087	.2170	.43	.745	.0096	.2220	.47
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.850	.0140	.2863	.44	- - -	- - -	- - -	- -

(2) h/t = 0.6, b/c = 0.05

M	α, deg	R=3.5x10^6 Transition fixed				R=3.5x10^6 Airfoil clean				R=2.0x10^6 Airfoil clean				R=1.0x10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0117	0.38	0	0	0.0096	0.55	0	0	0.0098	0.47	0	0	0.0099	0.47
	.5	.028	.0009	.0117	.38	.032	.0009	.0098	.55	.032	.0008	.0104	.44	.033	.0003	.0104	.45
	1.0	.064	.0009	.0124	.38	.064	.0010	.0105	.55	.065	.0008	.0109	.44	.068	.0003	.0108	.46
	1.5	.097	.0014	.0140	.37	.097	.0012	.0127	.55	.099	.0009	.0125	.44	.103	.0010	.0124	.46
	2.0	.132	.0015	.0159	.37	.131	.0014	.0141	.53	.132	.0010	.0144	.44	.142	.0010	.0143	.49
	3.0	.202	.0027	.0221	.38	.201	.0023	.0200	.53	.205	.0018	.0207	.46	.214	.0016	.0199	.62
	4.0	.277	.0047	.0309	.39	.273	.0037	.0288	.53	.278	.0033	.0305	.54	.290	.0033	.0293	.67
	5.0	.352	.0075	.0427	.39	.349	.0056	.0403	.53	.354	.0047	.0403	.60	.366	.0052	.0405	.69
	6.0	.430	.0105	.0570	.41	.425	.0082	.0548	.53	.433	.0080	.0550	.60	- - -	- - -	- - -	- -
1.98	0	0	0	.0082	.42	0	0	.0064	.41	0	0	.0057	.63	0	0	.0050	.67
	.5	.019	.0005	.0083	- -	.019	.0004	.0066	.41	.019	.0004	.0057	.63	.020	.0008	.0050	.68
	1.0	.039	.0006	.0086	.42	.039	.0004	.0067	.41	.040	.0004	.0060	.63	.040	.0008	.0055	.67
	1.5	.059	.0008	.0094	.42	.058	.0006	.0075	.41	.060	.0008	.0068	.63	.061	.0011	.0059	.67
	2.0	.081	.0008	.0103	.42	.080	.0005	.0087	.41	.081	.0008	.0081	.63	.083	.0008	.0072	.67
	3.0	.123	.0010	.0142	.42	.122	.0010	.0124	.41	.123	.0011	.0116	.63	.126	.0011	.0108	.67
	4.0	.165	.0016	.0191	.43	.164	.0015	.0177	.41	.166	.0017	.0169	.62	.172	.0025	.0164	.66
	5.0	.207	.0020	.0256	.43	.206	.0020	.0242	.42	.207	.0021	.0235	.61	.212	.0027	.0228	.65
	6.0	.250	.0029	.0341	.43	.248	.0024	.0324	.42	.251	.0025	.0320	.60	.256	.0033	.0313	.65
	8.0	.336	.0045	.0549	.44	.335	.0042	.0532	.44	.336	.0043	.0530	.59	.341	.0055	.0519	.62
	10.0	.423	.0064	.0820	.46	.420	.0059	.0804	.44	.419	.0060	.0797	.56	.431	.0070	.0802	.55
	12.0	.512	.0085	.1162	.48	.508	.0080	.1143	.42	.508	.0077	.1138	.52	.527	.0088	.1163	.49
	14.0	.605	.0102	.1585	.52	.602	.0099	.1567	.41	.606	.0097	.1572	.48	.633	.0109	.1626	.43
	16.0	.717	.0158	.2139	.57	.711	.0129	.2107	.42	.717	.0126	.2122	.44	.741	.0139	.2177	.40
	18.0	.832	.0220	.2795	.63	.832	.0189	.2786	.50	.838	.0179	.2804	.46	.871	.0189	.2890	.40

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(a) Basic airfoil: Biconvex to c/3, t/c = 0.02 - Continued

(3) h/t = 0.3, b/c = 0.05

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0095	0.59	0	0	0.0075	0.56	0	0	0.0070	0.52	0	0	0.0077	0.49
	.5	.031	.0010	.0096	.59	.031	.0010	.0078	.56	.031	.0009	.0074	.51	.036	.0008	.0084	.48
	1.0	.065	.0014	.0102	.59	.064	.0013	.0084	.57	.065	.0013	.0081	.52	.068	.0016	.0090	.48
	1.5	.098	.0022	.0117	.60	.098	.0018	.0098	.57	.100	.0020	.0096	.53	.105	.0021	.0102	.51
	2.0	.133	.0027	.0137	.60	.131	.0022	.0118	.57	.134	.0024	.0115	.53	.141	.0029	.0110	.72
	3.0	.201	.0045	.0197	.59	.201	.0035	.0177	.59	.204	.0036	.0176	.55	.214	.0042	.0177	.78
	4.0	.274	.0070	.0285	.62	.272	.0058	.0261	.60	.277	.0056	.0260	.66	.289	.0066	.0264	.78
	5.0	.349	.0103	.0390	.64	.347	.0080	.0378	.61	.352	.0082	.0377	.67	.369	.0092	.0387	.77
	6.0	.426	.0138	.0544	.66	.424	.0113	.0523	.62	.428	.0115	.0522	.66	- - -	- - -	- - -	- -
1.98	0	0	0	.0077	.49	0	0	.0053	.47	0	0	.0041	.78	0	0	.0040	.84
	.5	.019	.0030	.0078	.48	.020	.0001	.0055	.46	.019	.0004	.0043	.78	.021	.0008	.0042	.84
	1.0	.039	.0006	.0080	.48	.040	.0003	.0057	.46	.040	.0004	.0047	.78	.041	.0008	.0045	.84
	1.5	.060	.0009	.0089	.49	.061	.0008	.0064	.47	.061	.0009	.0054	.77	.064	.0016	.0062	.84
	2.0	.081	.0010	.0100	.49	.082	.0009	.0075	.48	.082	.0009	.0068	.76	.084	.0016	.0068	.83
	3.0	.123	.0017	.0135	.49	.124	.0012	.0110	.50	.126	.0015	.0105	.74	.127	.0021	.0105	.81
	4.0	.165	.0024	.0186	.49	.167	.0017	.0160	.51	.168	.0023	.0158	.73	.171	.0034	.0159	.80
	5.0	.213	.0033	.0257	.49	.209	.0022	.0224	.52	.211	.0029	.0224	.70	.214	.0038	.0225	.76
	6.0	.249	.0041	.0333	.49	.253	.0029	.0307	.54	.255	.0037	.0308	.69	.257	.0040	.0307	.74
	8.0	.334	.0063	.0538	.49	.338	.0045	.0513	.54	.340	.0056	.0521	.64	.341	.0069	.0517	.69
	10.0	.419	.0083	.0807	.50	.422	.0060	.0780	.51	.423	.0065	.0777	.58	.430	.0088	.0762	.62
	12.0	.507	.0108	.1147	.50	.510	.0080	.1120	.48	.511	.0085	.1122	.52	.529	.0105	.1136	.59
	14.0	.598	.0137	.1560	.53	.592	.0095	.1513	.45	.611	.0098	.1558	.47	.633	.0132	.1626	.53
	16.0	.701	.0190	.2092	.57	.705	.0121	.2063	.42	.720	.0125	.2102	.43	.742	.0163	.2178	.48
	18.0	.813	.0255	.2723	.59	.824	.0178	.2729	.45	.844	.0172	.2786	.43	.867	.0229	.2862	.44

(4) h/t = 0, b/c = 0.05

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0075	- -	0	0	0.0071	- -	0	0	0.0058	- -	0	0	0.0052	- -
	.5	.031	.0011	.0078	- -	.030	.0012	.0074	- -	.029	.0010	.0060	- -	.030	.0008	.0057	- -
	1.0	.067	.0018	.0087	- -	.065	.0016	.0081	- -	.067	.0018	.0069	- -	.070	.0023	.0065	- -
	1.5	.097	.0022	.0099	- -	.097	.0020	.0095	- -	.096	.0020	.0081	- -	.095	.0025	.0075	- -
	2.0	.132	.0033	.0121	- -	.130	.0027	.0113	- -	.130	.0028	.0102	- -	.134	.0038	.0099	- -
	3.0	.201	.0052	.0179	- -	.198	.0043	.0171	- -	.199	.0043	.0162	- -	.204	.0048	.0156	- -
	4.0	.273	.0080	.0266	- -	.269	.0063	.0255	- -	.270	.0063	.0247	- -	.279	.0071	.0244	- -
	5.0	.347	.0114	.0381	- -	.342	.0091	.0366	- -	.346	.0088	.0358	- -	.359	.0101	.0360	- -
	6.0	.424	.0154	.0522	- -	.418	.0126	.0508	- -	.421	.0124	.0502	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0064	- -	0	0	.0047	- -	0	0	.0040	- -	0	0	.0041	- -
	.5	.018	.0007	.0066	- -	.018	.0005	.0049	- -	.016	.0005	.0041	- -	.013	.0005	.0037	- -
	1.0	.041	.0009	.0070	- -	.041	.0008	.0051	- -	.041	.0012	.0045	- -	.037	.0018	.0041	- -
	1.5	.060	.0011	.0078	- -	.058	.0010	.0059	- -	.057	.0013	.0053	- -	.058	.0016	.0051	- -
	2.0	.079	.0015	.0089	- -	.078	.0014	.0070	- -	.078	.0020	.0064	- -	.078	.0026	.0059	- -
	3.0	.122	.0021	.0123	- -	.120	.0019	.0104	- -	.118	.0024	.0096	- -	.120	.0034	.0090	- -
	4.0	.163	.0030	.0173	- -	.161	.0026	.0154	- -	.161	.0030	.0148	- -	.163	.0042	.0148	- -
	5.0	.205	.0038	.0236	- -	.203	.0034	.0226	- -	.203	.0039	.0211	- -	.204	.0049	.0205	- -
	6.0	.247	.0050	.0317	- -	.244	.0043	.0298	- -	.244	.0048	.0294	- -	.246	.0061	.0287	- -
	8.0	.332	.0072	.0522	- -	.329	.0061	.0503	- -	.332	.0065	.0500	- -	.332	.0082	.0491	- -
	10.0	.415	.0094	.0784	- -	.412	.0081	.0768	- -	.415	.0084	.0764	- -	.419	.0104	.0762	- -
	12.0	.501	.0121	.1117	- -	.499	.0102	.1100	- -	.504	.0100	.1105	- -	.515	.0119	.1115	- -
	14.0	.593	.0150	.1529	- -	.589	.0125	.1508	- -	.601	.0123	.1530	- -	.618	.0143	.1558	- -
	16.0	.697	.0201	.2056	- -	.691	.0161	.2022	- -	.709	.0157	.2067	- -	.730	.0177	.2112	- -
	18.0	.808	.0271	.2682	- -	.807	.0234	.2688	- -	.827	.0227	.2724	- -	.849	.0241	.2776	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(a) Basic airfoil: Biconvex to c/3, t/c = 0.02 - Continued

(5) h/t = 0.6, b/c = 0.33

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0109	0.38	0	0	0.0090	0.50	0.	0	0.0084	0.54	0	0	0.0082	0.52
	.5	.032	.0007	.0112	.39	.033	.0007	.0093	.51	.032	.0004	.0087	.53	.033	.0008	.0083	.52
	1.0	.067	.0010	.0118	.39	.066	.0009	.0100	.51	.066	.0009	.0092	.53	.067	.0011	.0091	.52
	1.5	.101	.0015	.0138	.39	.099	.0012	.0114	.50	.100	.0011	.0116	.53	.104	.0016	.0103	.52
	2.0	.135	.0020	.0155	.39	.133	.0016	.0136	.50	.134	.0014	.0128	.54	.141	.0017	.0125	53
	3.0	.207	.0033	.0218	.40	.202	.0027	.0197	.50	.205	.0024	.0189	.54	.215	.0026	.0189	.54
	4.0	.281	.0056	.0307	.40	.275	.0043	.0283	.50	.279	.0038	.0278	.55	.291	.0045	.0276	.59
	5.0	.358	.0084	.0426	.41	.349	.0063	.0397	.51	.356	.0060	.0397	.57	.370	.0066	.0394	.66
	6.0	.438	.0116	.0575	.42	.428	.0091	.0545	.51	.434	.0089	.0544	.58	---	---	---	--
1.98	0	0	0	.0081	.41	0	0	.0063	.36	0	0	.0056	.49	0	0	.0052	.53
	.5	.020	.0004	.0084	.42	.020	.0003	.0065	.36	.020	0	.0061	.48	.019	.0005	.0056	.53
	1.0	.042	.0005	.0086	.42	.040	.0003	.0068	.36	.042	.0003	.0065	.47	.042	.0003	.0060	.54
	1.5	.061	.0007	.0095	.41	.061	.0005	.0070	.36	.062	.0008	.0084	.48	.065	.0011	---	.55
	2.0	.082	.0008	.0106	.41	.082	.0006	.0088	.36	.084	.0008	.0086	.50	.084	.0008	.0080	.57
	3.0	.124	.0012	.0143	.41	.124	.0010	.0124	.37	.127	.0011	.0120	.58	.129	.0011	.0115	.60
	4.0	.167	.0018	.0193	.41	.166	.0015	.0176	.37	.169	.0017	.0170	.59	.170	.0022	.0166	.62
	5.0	.209	.0022	.0259	.41	.208	.0020	.0243	.38	.210	.0018	.0237	.56	.215	.0024	.0236	.61
	6.0	.253	.0031	.0343	.42	.251	.0026	.0326	.39	.255	.0025	.0323	.60	.258	.0030	.0319	.63
	8.0	.337	.0048	.0552	.42	.337	.0041	.0536	.39	.339	.0041	.0636	.58	.344	.0051	.0530	.62
	10.0	.423	.0066	.0823	.43	.422	.0056	.0808	.39	.424	.0055	.0806	.56	.431	.0068	.0811	.55
	12.0	.512	.0087	.1167	.45	.510	.0074	.1150	.40	.513	.0074	.1153	.47	.529	.0084	.1179	.51
	14.0	.605	.0113	.1590	.47	.602	.0095	.1570	.39	.611	.0094	.1591	.46	.634	.0111	.1639	.45
	16.0	.711	.0160	.2128	.50	.708	.0128	.2104	.39	.722	.0126	.2221	.41	.742	.0141	.2268	.44
	18.0	.824	.0219	.2770	.56	.824	.0195	.2767	.41	.841	.0184	.2814	.57	.866	.0198	.2879	.41

(6) h/t = 0.3, b/c = 0.33

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0084	0.58	0	0	0.0082	0.56	0	0	0.0071	0.54	0	0	0.0064	0.46
	.5	.032	.0010	.0086	.57	.032	.0008	.0085	.56	.031	.0008	.0074	.54	.033	.0005	.0070	.45
	1.0	.065	.0015	.0091	.57	.064	.0012	.0092	.56	.064	.0010	.0081	.55	.067	.0013	.0077	.45
	1.5	.098	.0020	.0106	.58	.097	.0017	.0105	.57	.097	.0016	.0094	.55	.101	.0018	.0092	.45
	2.0	.132	.0026	.0126	.58	.131	.0022	.0126	.57	.131	.0020	.0113	.57	.137	.0019	.0110	.46
	3.0	.201	.0043	.0185	.58	.199	.0036	.0185	.59	.199	.0032	.0174	.61	.207	.0030	.0167	.61
	4.0	.273	.0067	.0272	.60	.271	.0058	.0271	.60	.272	.0049	.0259	.65	.281	.0052	.0253	.77
	5.0	.347	.0098	.0388	.61	.342	.0080	.0385	.61	.346	.0072	.0373	.64	.359	.0078	.0367	.78
	6.0	.425	.0135	.0532	.63	.421	.0114	.0526	.62	.423	.0102	.0519	.65	---	---	---	--
1.98	0	0	0	.0070	.47	0	0	.0053	.47	0	0	.0050	.56	0	0	.0050	.45
	.5	.021	.0005	.0072	.47	.019	.0004	.0055	.47	.019	.0004	.0052	.56	.020	.0005	.0049	.44
	1.0	.040	.0007	.0074	.47	.039	.0004	.0059	.47	.040	.0007	.0055	.57	.040	.0005	.0056	.44
	1.5	.060	.0011	.0083	.47	.059	.0007	.0067	.46	.060	.0009	.0069	.59	.061	.0013	.0062	.43
	2.0	.080	.0011	.0093	.47	.080	.0007	.0079	.46	.080	.0010	.0074	.61	.082	.0013	.0073	.46
	3.0	.120	.0018	.0129	.47	.121	.0012	.0115	.46	.121	.0016	.0107	.68	.125	.0021	.0107	.52
	4.0	.162	.0024	.0178	.47	.162	.0020	.0166	.46	.163	.0024	.0158	.70	.166	.0032	.0155	.73
	5.0	.205	.0032	.0243	.47	.204	.0026	.0231	.46	.203	.0030	.0223	.70	.208	.0035	.0220	.74
	6.0	.246	.0040	.0324	.47	.246	.0033	.0313	.46	.246	.0037	.0304	.69	.252	.0045	.0300	.74
	8.0	.328	.0060	.0523	.48	.330	.0051	.0517	.47	.330	.0057	.0510	.64	.336	.0066	.0507	.67
	10.0	.416	.0081	.0794	.49	.413	.0069	.0783	.47	.412	.0074	.0774	.58	.423	.0088	.0784	.59
	12.0	.501	.0105	.1126	.49	.500	.0091	.1117	.46	.499	.0093	.1109	.51	.519	.0105	.1141	.55
	14.0	.589	.0134	.1531	.51	.592	.0114	.1531	.46	.596	.0117	.1535	.46	.622	.0137	.1589	.48
	16.0	.693	.0181	.2053	.55	.678	.0149	.2001	.45	.704	.0150	.2074	.43	.731	.0171	.2139	.45
	18.0	.805	.0251	.2681	.61	.806	.0223	.2689	.45	.823	.0215	.2736	.43	.851	.0236	.2813	.43

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(a) Basic airfoil: Biconvex to c/3, t/c = 0.02 - Concluded

(7) h/t = 0, b/c = 0.33

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0068	- -	0	0	0.0061	- -	0	0	0.0055	- -	0	0	0.0042	- -
	.5	.030	.0010	.0070	- -	.031	.0009	.0062	- -	- -	.0010	.0059	- -	.028	.0008	.0046	- -
	1.0	.063	.0019	.0076	- -	.063	.0016	.0070	- -	.062	.0016	.0062	- -	.066	.0016	.0053	- -
	1.5	.097	.0022	.0092	- -	.097	.0021	.0085	- -	.094	.0019	.0077	- -	.100	.0021	.0069	- -
	2.0	.130	.0032	.0112	- -	.130	.0028	.0106	- -	.130	.0026	.0097	- -	.135	.0029	.0093	- -
	3.0	.200	.0048	.0171	- -	.199	.0039	.0165	- -	.199	.0040	.0157	- -	.207	.0045	.0152	- -
	4.0	.271	.0072	.0256	- -	.270	.0064	.0251	- -	.271	.0058	.0243	- -	.282	.0068	.0244	- -
	5.0	.345	.0104	.0369	- -	.342	.0089	.0363	- -	.345	.0082	.0357	- -	.360	.0094	.0359	- -
	6.0	.420	.0145	.0511	- -	.419	.0127	.0505	- -	.421	.0116	.0501	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0062	- -	0	0	.0046	- -	0	0	.0042	- -	0	0	.0040	- -
	.5	.019	.0005	.0063	- -	.019	.0004	.0048	- -	.020	.0007	.0045	- -	.017	.0003	.0040	- -
	1.0	.041	.0009	.0068	- -	.039	.0007	.0052	- -	.039	.0010	.0048	- -	.038	.0011	.0043	- -
	1.5	.061	.0009	.0076	- -	.060	.0008	.0060	- -	.059	.0012	.0057	- -	.061	.0011	.0056	- -
	2.0	.082	.0014	.0088	- -	.080	.0012	.0071	- -	.079	.0018	.0069	- -	.084	.0016	.0070	- -
	3.0	.124	.0019	.0122	- -	.121	.0016	.0106	- -	.123	.0021	.0104	- -	.121	.0024	.0104	- -
	4.0	.166	.0026	.0173	- -	.163	.0023	.0157	- -	.165	.0026	.0156	- -	.165	.0032	.0156	- -
	5.0	.208	.0034	.0238	- -	.204	.0030	.0221	- -	.206	.0035	.0221	- -	.210	.0038	.0221	- -
	6.0	.250	.0045	.0318	- -	.245	.0040	.0301	- -	.249	.0044	.0303	- -	.250	.0053	.0299	- -
	8.0	.336	.0066	.0526	- -	.328	.0053	.0505	- -	.334	.0060	.0508	- -	.341	.0072	.0511	- -
	10.0	.420	.0090	.0792	- -	.411	.0071	.0766	- -	.416	.0080	.0772	- -	.424	.0094	.0778	- -
	12.0	.504	.0104	.1124	- -	.498	.0089	.1101	- -	.503	.0096	.1110	- -	.522	.0109	.1137	- -
	14.0	.596	.0126	.1538	- -	.588	.0105	.1508	- -	.601	.0120	.1535	- -	.625	.0138	.1590	- -
	16.0	.702	.0164	.2069	- -	.691	.0140	.2026	- -	.707	.0156	.2067	- -	.739	.0170	.1765	- -
	18.0	.815	.0239	.2715	- -	.806	.0197	.2669	- -	.826	.0222	.2726	- -	.859	.0241	.2817	- -

(b) Basic airfoil: Biconvex to c/3, t/c = 0.04

(1) h/t = 1.0, b/c = 0

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0258	0.51	0	0	0.0235	0.51	0	0	0.0230	0.50	0	0	0.0222	0.53
	.5	.035	.0013	.0260	.51	.034	.0013	.0238	.51	.034	.0013	.0236	.50	.038	.0010	.0229	.53
	1.0	.068	.0021	.0274	.51	.068	.0018	.0247	.51	.069	.0018	.0244	.50	.074	.0021	.0237	.53
	1.5	.104	.0029	.0293	.51	.100	.0022	.0264	.51	.105	.0025	.0263	.50	.111	.0028	.0261	.52
	2.0	.140	.0034	.0316	.51	.136	.0025	.0286	.51	.140	.0028	.0286	.50	.150	.0031	.0280	.52
	3.0	.212	.0054	.0381	.51	.206	.0038	.0350	.51	.211	.0045	.0350	.50	.228	.0054	.0356	.52
	4.0	.289	.0077	.0472	.50	.283	.0062	.0440	.52	.289	.0072	.0443	.51	.305	.0088	.0443	.58
	5.0	.366	.0100	.0587	.51	.362	.0094	.0560	.52	.367	.0102	.0562	.53	- - -	- - -	- - -	- -
	6.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	0.0179	.37	0	0	.0147	- -	0	0	.0144	- -	0	0	.0140	- -
	.5	.018	.0006	.0183	.36	.018	.0005	.0150	- -	.019	.0007	.0147	- -	.015	.0003	.0145	- -
	1.0	.039	.0006	.0187	.37	.039	.0007	.0155	- -	.039	.0010	.0152	- -	.035	.0005	.0147	- -
	1.5	.061	.0008	.0197	.37	.060	.0008	.0165	- -	.061	.0012	.0164	- -	.058	.0016	.0162	- -
	2.0	.082	.0010	.0210	.37	.080	.0009	.0177	- -	.080	.0012	.0177	- -	.080	.0016	.0172	- -
	3.0	.126	.0015	.0247	.37	.123	.0013	.0215	- -	.123	.0017	.0214	- -	.124	.0021	.0211	- -
	4.0	.170	.0022	.0301	.38	.166	.0023	.0266	- -	.167	.0025	.0264	- -	.168	.0024	.0266	- -
	5.0	.216	.0028	.0370	.38	.210	.0026	.0334	- -	.213	.0028	.0334	- -	.219	.0032	.0337	- -
	6.0	.259	.0035	.0455	.39	.253	.0035	.0419	- -	.255	.0040	.0418	- -	.260	.0040	.0423	- -
	8.0	.346	.0056	.0668	.40	.340	.0051	.0631	- -	.345	.0058	.0638	- -	.351	.0062	.0641	- -
	10.0	.437	.0078	.0954	.42	.430	.0069	.0917	- -	.434	.0076	.0924	- -	.450	.0083	.0946	- -
	12.0	.529	.0105	.1311	.44	- - -	- - -	- - -	- -	.528	.0096	.1290	- -	.552	.0108	.1336	- -
	14.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.633	.0133	.1758	- -	.664	.0156	.1838	- -
	16.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(b) Basic airfoil: Biconvex to c/3, t/c = 0.04 - Continued

(2) h/t = 0.6, b/c = 0.05

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0233	0.51	0	0	0.0210	0.56	0	0	0.0192	0.63	0	0	0.0184	0.72
	.5	.034	.0018	.0237	.51	.034	.0018	.0215	.56	.034	.0016	.0200	.63	.033	.0019	.0191	.71
	1.0	.067	.0032	.0249	.51	.067	.0026	.0224	.55	.066	.0028	.0212	.62	.066	.0026	.0201	.70
	1.5	.102	.0042	.0268	.51	.103	.0035	.0243	.55	.101	.0035	.0232	.61	.105	.0047	.0232	.68
	2.0	.137	.0051	.0289	.52	.136	.0041	.0263	.55	.136	.0047	.0254	.59	.142	.0053	.0251	.67
	3.0	.212	.0077	.0354	.53	.209	.0064	.0326	.56	.208	.0068	.0319	.59	.218	.0079	.0325	.65
	4.0	.288	.0107	.0440	.55	.285	.0094	.0417	.57	.284	.0103	.0410	.59	.298	.0126	.0419	.63
	5.0	.364	.0138	.0554	.57	.363	.0135	.0538	.57	.358	.0145	.0526	.59	.375	.0176	.0518	.70
	6.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0159	.41	0	0	.0135	.42	0	0	.0123	.55	0	0	.0114	.61
	.5	.018	.0009	.0160	.40	.020	.0010	.0137	.42	.018	.0010	.0126	.55	.018	.0008	.0114	- -
	1.0	.038	.0013	.0164	.40	.040	.0012	.0140	.42	.039	.0014	.0130	.55	.038	.0016	.0119	- -
	1.5	.059	.0019	.0147	.40	.061	.0015	.0151	.42	.061	.0020	.0141	.54	.062	.0027	.0132	- -
	2.0	.080	.0019	.0186	.40	.082	.0018	.0163	.41	.082	.0021	.0154	.53	.082	.0027	.0145	- -
	3.0	.122	.0028	.0223	.41	.125	.0026	.0202	.41	.124	.0029	.0193	.52	.126	.0037	.0183	- -
	4.0	.165	.0040	.0274	.41	.167	.0038	.0252	.41	.168	.0042	.0246	.51	.171	.0056	.0236	- -
	5.0	.209	.0050	.0340	.41	.212	.0050	.0319	.41	.213	.0051	.0152	.49	.216	.0065	.0306	- -
	6.0	.253	.0063	.0424	.42	.254	.0057	.0402	.40	.256	.0064	.0397	.49	.258	.0075	.0390	- -
	8.0	.341	.0088	.0635	.43	.343	.0081	.0616	.41	.341	.0094	.0607	.49	.345	.0110	.0604	- -
	10.0	.430	.0094	.0912	.45	.430	.0108	.0895	.41	.427	.0118	.0884	.47	.443	.0138	.0900	- -
	12.0	.518	.0128	.1258	.49	.521	.0138	.1246	.41	.525	.0148	.1252	.47	.539	.0174	.1273	- -
	14.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.624	.0193	.1703	.45	.649	.0225	.1763	- -
	16.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.735	.0259	.2276	.43	.761	.0291	.2352	- -
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.858	.0330	.2973	.42	- - -	- - -	- - -	- -

(3) h/t = 0.3, b/c = 0.05

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0204	0.39	0	0	0.0178	0.51	0	0	0.0161	0.62	0	0	0.0147	0.79
	.5	.035	.0025	.0209	.40	.034	.0019	.0182	.50	.032	.0019	.0167	.62	.034	.0021	.0155	.79
	1.0	.070	.0038	.0221	.40	.066	.0030	.0192	.50	.066	.0033	.0176	.62	.070	.0037	.0165	.79
	1.5	.104	.0050	.0237	.40	.100	.0040	.0208	.50	.102	.0043	.0195	.62	.107	.0056	.0189	.78
	2.0	.142	.0066	.0259	.40	.137	.0050	.0229	.52	.136	.0052	.0216	.62	.144	.0068	.0206	.76
	3.0	.212	.0094	.0321	.41	.207	.0073	.0289	.55	.207	.0078	.0282	.62	.218	.0096	.0278	.74
	4.0	.287	.0131	.0406	.42	.282	.0107	.0378	.55	.282	.0117	.0374	.62	.300	.0145	.0376	.72
	5.0	.359	.0164	.0516	.56	.359	.0155	.0497	.57	.361	.0165	.0494	.62	.382	.0199	.0502	.71
	6.0	.435	.0198	.0651	.61	.436	.0210	.0690	.60	.436	.0222	.0636	.61	- - -	- - -	- - -	- -
1.98	0	0	0	.0137	.44	0	0	.0112	.42	0	0	.0102	.62	0	0	.0089	.75
	.5	.019	.0009	.0139	.44	.024	.0008	.0115	.42	.020	.0012	.0103	.62	.013	.0011	.0089	.76
	1.0	.041	.0015	.0144	.45	.043	.0013	.0119	.42	.039	.0018	.0106	.61	.033	.0022	.0090	.76
	1.5	.061	.0020	.0153	.45	.065	.0018	.0128	.43	.060	.0022	.0125	.58	.053	.0032	.0107	.75
	2.0	.082	.0025	.0166	.45	.085	.0021	.0140	.43	.082	.0026	.0129	.56	.074	.0032	.0112	.75
	3.0	.124	.0034	.0203	.45	.126	.0030	.0176	.43	.122	.0036	.0167	.56	.116	.0043	.0149	.74
	4.0	.168	.0048	.0255	.45	.167	.0042	.0227	.44	.165	.0053	.0218	.56	.160	.0062	.0200	.72
	5.0	.214	.0061	.0323	.45	.210	.0054	.0293	.45	.208	.0062	.0282	.55	.209	.0074	.0265	.68
	6.0	.255	.0074	.0403	.45	.254	.0067	.0378	.45	.250	.0077	.0364	.55	.249	.0086	.0351	.70
	8.0	.342	.0106	.0613	.45	.341	.0096	.0585	.47	.334	.0108	.0569	.55	.337	.0127	.0559	.65
	10.0	.432	.0143	.0891	.47	.426	.0127	.0855	.47	.422	.0136	.0843	.53	.433	.0162	.0851	.56
	12.0	.521	.0183	.1237	.52	.515	.0162	.1202	.46	.511	.0171	.1189	.48	.531	.0194	.1224	.55
	14.0	.619	.0239	.1679	.56	.612	.0203	.1634	.42	.613	.0217	.1636	.43	.638	.0248	.1697	.53
	16.0	.725	.0306	.2212	.59	.720	.0267	.2182	.39	.728	.0287	.2204	.40	.751	.0321	.2279	.48
	18.0	.832	.0363	.2840	.61	.830	.0360	.2824	.45	.843	.0370	.2868	.40	.868	.0383	.2954	.43

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(b) Basic airfoil: Biconvex to c/3, t/c = 0.04 - Continued

(4) h/t = 0, b/c = 0.05

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0168	- -	0	0	0.0156	- -	0	0	0.0146	- -	0	0	0.0137	- -
	.5	.032	.0026	.0171	- -	.032	.0025	.0160	- -	.031	.0020	.0152	- -	.033	.0028	.0141	- -
	1.0	.064	.0047	.0182	- -	.063	.0040	.0170	- -	.064	.0042	.0160	- -	.067	.0048	.0148	- -
	1.5	.098	.0065	.0199	- -	.096	.0054	.0186	- -	.097	.0057	.0177	- -	.102	.0069	.0169	- -
	2.0	.132	.0081	.0219	- -	.130	.0066	.0205	- -	.131	.0070	.0196	- -	.136	.0087	.0186	- -
	3.0	.201	.0116	.0279	- -	.199	.0097	.0264	- -	.201	.0104	.0255	- -	.209	.0130	.0253	- -
	4.0	.273	.0161	.0360	- -	.270	.0138	.0345	- -	.273	.0150	.0341	- -	.284	.0183	.0340	- -
	5.0	.345	.0201	.0466	- -	.345	.0189	.0459	- -	.350	.0203	.0457	- -	.361	.0237	.0461	- -
	6.0	.418	.0245	.0652	- -	.420	.0249	.0599	- -	.425	.0260	.0603	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0121	- -	0	0	.0100	- -	0	0	.0093	- -	0	0	.0088	- -
	.5	.019	.0014	.0123	- -	.020	.0014	.0103	- -	.019	.0014	.0095	- -	.017	.0016	.0089	- -
	1.0	.039	.0023	.0127	- -	.040	.0022	.0107	- -	.040	.0021	.0098	- -	.039	.0024	.0093	- -
	1.5	.059	.0029	.0136	- -	.060	.0028	.0117	- -	.060	.0031	.0108	- -	.060	.0037	.0106	- -
	2.0	.080	.0034	.0148	- -	.080	.0033	.0128	- -	.079	.0037	- - -	- -	.081	.0042	.0114	- -
	3.0	.121	.0049	.0182	- -	.121	.0046	.0163	- -	.121	.0055	.0154	- -	.121	.0066	.0146	- -
	4.0	.163	.0066	.0231	- -	.162	.0062	.0211	- -	.163	.0073	.0204	- -	.163	.0090	.0198	- -
	5.0	.204	.0083	.0293	- -	.204	.0078	.0272	- -	.204	.0088	.0266	- -	.205	.0107	.0261	- -
	6.0	.247	.0100	.0373	- -	.246	.0093	.0352	- -	.247	.0105	.0349	- -	.251	.0127	.0345	- -
	8.0	.331	.0139	.0573	- -	.328	.0130	.0550	- -	.329	.0144	.0547	- -	.332	.0166	.0541	- -
	10.0	.415	.0182	.0836	- -	.413	.0167	.0813	- -	.415	.0183	.0813	- -	.424	.0209	.0821	- -
	12.0	.504	.0228	.1167	- -	.502	.0208	.1149	- -	.504	.0220	.1152	- -	.521	.0248	.1181	- -
	14.0	.598	.0287	.1591	- -	.597	.0255	.1567	- -	.604	.0273	.1590	- -	.626	.0312	.1640	- -
	16.0	.701	.0359	.2110	- -	.697	.0326	.2081	- -	.713	.0347	.2134	- -	.737	.0386	.2207	- -
	18.0	.805	.0428	.2714	- -	.810	.0423	.2723	- -	.824	.0439	.2774	- -	.849	.0463	.2850	- -

(5) h/t = 0.6, b/c = 0.33

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0213	0.46	0	0	0.0181	0.51	0	0	0.0175	0.54	0	0	0.0159	0.63
	.5	.035	.0019	.0222	.45	.032	.0019	.0190	.50	.032	.0018	.0180	.54	.037	.0021	.0173	.59
	1.0	.069	.0028	.0233	.45	.065	.0024	.0198	.50	.066	.0025	.0188	.54	.073	.0029	.0178	.58
	1.5	.105	.0040	.0251	.45	.101	.0032	.0215	.50	.102	.0033	.0206	.54	.107	.0036	.0203	.56
	2.0	.140	.0048	.0274	.44	.136	.0037	.0237	.50	.137	.0040	.0228	.54	.147	.0044	.0225	.55
	3.0	.214	.0073	.0341	.41	.208	.0056	.0301	.50	.210	.0059	.0294	.54	.222	.0073	.0293	.55
	4.0	.293	.0103	.0432	.37	.283	.0086	.0391	.51	.285	.0091	.0386	.55	.301	.0112	.0389	.57
	5.0	.366	.0130	.0545	.36	.360	.0124	.0510	.51	.364	.0132	.0505	.55	.384	.0154	.0506	.60
	6.0	.445	.0160	.0688	.42	.438	.0174	.0655	.53	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0147	.39	0	0	.0124	.37	0	0	.0112	.46	0	0	.0102	.61
	.5	.019	.0009	.0149	.38	.019	.0008	.0127	.36	.020	.0009	.0115	.44	.019	.0008	.0106	.60
	1.0	.040	.0013	.0152	.38	.039	.0011	.0129	.36	.041	.0012	.0118	.46	.041	.0013	.0109	.58
	1.5	.061	.0016	.0162	.38	.060	.0014	.0138	.37	.062	.0018	.0129	.47	.062	.0019	.0125	.57
	2.0	.082	.0016	.0174	.38	.082	.0016	.0150	.37	.080	.0020	.0139	.47	.085	.0021	.0138	.57
	3.0	.125	.0024	.0212	.39	.124	.0023	.0188	.37	.123	.0025	.0178	.46	.127	.0026	.0178	.56
	4.0	.169	.0033	.0265	.39	.167	.0030	.0240	.38	.166	.0035	.0229	.46	.173	.0042	.0227	.57
	5.0	.215	.0043	.0334	.39	.214	.0040	.0308	.38	.213	.0043	.0298	.47	.219	.0049	.0295	.57
	6.0	.259	.0053	.0418	.40	.257	.0048	.0391	.39	.255	.0052	.0383	.47	.262	.0056	.0383	.58
	8.0	.346	.0080	.0630	.42	.344	.0071	.0603	.40	.341	.0074	.0595	.48	.350	.0085	.0600	.59
	10.0	.438	.0106	.0915	.43	.434	.0096	.0882	.42	.432	.0099	.0878	.48	.444	.0113	.0890	.57
	12.0	.527	.0140	.1265	.45	.524	.0126	.1233	.45	.524	.0128	.1235	.48	.539	.0130	.1264	.53
	14.0	.629	.0186	.1719	.49	.621	.0160	.1671	.43	.629	.0173	.1699	.44	.653	.0201	.1758	.50
	16.0	.737	.0243	.2264	.54	.730	.0220	.2229	.40	.742	.0237	.2274	.40	.767	.0270	.2348	.47
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.859	.0310	.2953	.40	- - -	- - -	- - -	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(b) Basic airfoil: Biconvex to c/3, t/c = 0.04 - Concluded

(6) h/t = 0.3, b/c = 0.33

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0180	0.43	0	0	0.0165	0.50	0	0	0.0157	0.52	0	0	0.0160	0.54
	.5	.032	.0027	- - -	.43	.031	.0020	.0170	.48	.032	.0019	.0163	.52	.036	.0021	.0161	.54
	1.0	.066	.0035	.0193	.43	.064	.0030	.0179	.48	.065	.0030	.0172	.52	.072	.0034	.0171	.54
	1.5	.099	.0045	.0213	.43	.098	.0038	.0196	.48	.101	.0043	.0190	.52	.107	.0048	.0193	.54
	2.0	.133	.0057	.0234	.44	.133	.0048	.0217	.49	.135	.0048	.0211	.53	.143	.0053	.0210	.56
	3.0	.206	.0086	.0297	.44	.203	.0071	.0278	.48	.206	.0075	.0275	.55	.220	.0087	.0276	.61
	4.0	.277	.0122	.0379	.45	.279	.0106	.0367	.48	.281	.0112	.0364	.59	.295	.0129	.0365	.66
	5.0	.351	.0155	.0488	.47	.351	.0152	.0481	.52	.358	.0157	.0481	.60	.373	.0174	.0487	.68
	6.0	.426	.0193	.0630	.48	.427	.0204	.0623	.54	.433	.0212	.0627	.61	- - -	- - -	- - -	- -
1.98	0	0	0	.0126	.42	0	0	.0107	.38	0	0	.0103	.46	0	0	.0099	.73
	.5	.019	.0013	.0127	.42	.017	.0010	.0109	.38	.020	.0015	.0105	.46	.020	.0012	.0102	.74
	1.0	.039	.0017	.0132	.42	.036	.0015	.0114	.38	.039	.0017	.0113	.46	.042	.0015	.0109	.73
	1.5	.059	.0021	.0140	.42	.059	.0020	.0121	.38	.059	.0020	.0120	.46	.061	.0022	.0119	.73
	2.0	.080	.0025	.0153	.42	.078	.0022	.0134	.38	.086	.0024	.0135	.46	.081	.0029	.0131	.73
	3.0	.121	.0035	.0189	.42	.118	.0032	.0168	.38	.123	.0034	.0167	.47	.123	.0039	.0166	.70
	4.0	.164	.0047	.0239	.42	.159	.0042	.0217	.41	.164	.0047	.0218	.49	.167	.0051	.0217	.69
	5.0	.206	.0058	.0279	.43	.201	.0051	.0278	.42	.203	.0054	.0277	.52	.206	.0066	.0278	.68
	6.0	.249	.0071	.0384	.43	.243	.0064	.0357	.43	.245	.0066	.0360	.53	.250	.0081	.0362	.67
	8.0	.334	.0101	.0590	.44	.326	.0091	.0560	.45	.321	.0093	.0551	.55	.336	.0115	.0567	.64
	10.0	.421	.0134	.0859	.46	.409	.0122	.0825	.45	.414	.0130	.0830	.53	.424	.0154	.0842	.59
	12.0	.508	.0171	.1196	.49	.495	.0157	.1153	.44	.500	.0162	.1164	.49	.517	.0189	.1197	.55
	14.0	.605	.0220	.1625	.54	.591	.0198	.1570	.42	.570	.0211	.1527	.42	.622	.0247	.1663	.50
	16.0	.710	.0285	.2153	.61	.694	.0235	.2110	.42	.677	.0279	.2022	.40	.732	.0309	.2225	.44
	18.0	.815	.0349	.2769	.62	.821	.0247	.2710	.47	.795	.0363	.2695	.40	.841	.0370	.2837	.42

(7) h/t = 0, b/c = 0.33

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0157	- -	0	0	0.0149	- -	0	0	0.0139	- -	0	0	0.0131	- -
	.5	.032	.0024	.0160	- -	.034	.0023	.0151	- -	.032	.0022	.0143	- -	.032	.0034	.0133	- -
	1.0	.065	.0043	.0168	- -	.065	.0039	.0161	- -	.065	.0038	.0154	- -	.064	.0057	.0145	- -
	1.5	.097	.0064	.0185	- -	.098	.0054	.0177	- -	.099	.0053	- - -	- -	.101	.0063	- - -	- -
	2.0	.130	.0079	.0206	- -	.132	.0067	.0198	- -	.135	.0065	.0190	- -	.136	.0078	.0183	- -
	3.0	.198	.0114	.0266	- -	.201	.0094	.0255	- -	.204	.0097	.0249	- -	.210	.0123	.0247	- -
	4.0	.269	.0155	.0348	- -	.273	.0133	.0340	- -	.278	.0142	.0352	- -	.285	.0178	.0368	- -
	5.0	.340	.0195	.0452	- -	.349	.0184	.0455	- -	.353	.0192	.0455	- -	.363	.0238	.0456	- -
	6.0	.412	.0237	.0586	- -	.424	.0243	.0594	- -	.429	.0254	.0597	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0118	- -	0	0	.0097	- -	0	0	.0090	- -	0	0	.0086	- -
	.5	.020	.0012	.0120	- -	.019	.0013	.0098	- -	.019	.0014	.0091	- -	.019	.0019	- - -	- -
	1.0	.040	.0021	.0124	- -	.038	.0019	.0105	- -	.039	.0022	.0095	- -	.036	.0029	.0090	- -
	1.5	.061	.0030	.0134	- -	.058	.0026	- - -	- -	.060	.0029	- - -	- -	.057	.0045	- - -	- -
	2.0	.081	.0034	.0145	- -	.079	.0031	.0126	- -	.080	.0034	.0118	- -	.076	.0050	.0110	- -
	3.0	.123	.0047	.0182	- -	.118	.0043	.0159	- -	.121	.0049	.0152	- -	.120	.0066	.0146	- -
	4.0	.165	.0064	.0230	- -	.160	.0059	.0208	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
	5.0	.207	.0080	.0292	- -	.203	.0072	.0270	- -	.205	.0080	.0264	- -	.203	.0098	.0259	- -
	6.0	.249	.0097	- - -	- -	.244	.0088	.0349	- -	.247	.0098	.0342	- -	.249	.0119	.0339	- -
	8.0	.334	.0135	.0576	- -	.327	.0122	- - -	- -	.330	.0136	- - -	- -	.329	.0159	- - -	- -
	10.0	.422	.0177	.0843	- -	.413	.0160	- - -	- -	.415	.0171	.0807	- -	.416	.0199	- - -	- -
	12.0	.511	.0223	.1184	- -	.499	.0198	.1143	- -	.503	.0211	.1146	- -	.514	.0244	.1162	- -
	14.0	.605	.0281	.1608	- -	.593	.0241	.1554	- -	.601	.0261	.1576	- -	.618	.0302	.1612	- -
	16.0	.708	.0351	.2122	- -	.693	.0311	- - -	- -	.712	.0339	- - -	- -	.725	.0382	- - -	- -
	18.0	.805	.0419	.2702	- -	.805	.0411	.2697	- -	.820	.0432	.2753	- -	.832	.0454	.2787	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(c) Basic airfoil: Biconvex to c/3, t/c = 0.06

(1) h/t = 1.0, b/c = 0

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0451	0.56	0	0	0.0414	0.53	0	0	0.0415	0.52	0	0	0.0417	0.54
	.5	.035	.0015	.0456	.55	.036	.0021	.0423	.52	.036	.0022	.0427	.51	.038	.0027	.0432	.53
	1.0	.070	.0032	.0466	.54	.072	.0040	.0436	.51	.071	.0042	.0441	.50	.075	.0046	.0445	.51
	1.5	.105	.0051	.0484	.53	.108	.0061	.0458	.50	.107	.0062	.0461	.49	.110	.0064	.0461	.52
	2.0	.139	.0060	.0502	.53	.142	.0076	.0477	.50	.143	.0077	.0479	.49	.149	.0080	.0481	.52
	3.0	.214	.0082	.0566	.53	.219	.0106	.0551	.50	.218	.0106	.0552	.49	.226	.0113	.0569	.53
	4.0	.289	.0108	.0651	.53	.293	.0137	.0643	.51	.296	.0140	.0646	.50	.308	.0148	.0624	.56
	5.0	.367	.0137	.0767	.54	.370	.0167	.0763	.51	.371	.0171	.0738	.56	- - -	- - -	- - -	- -
	6.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0286	.43	0	0	.0255	.40	0	0	.0255	.40	0	0	.0241	.48
	.5	.021	.0009	.0293	.41	.020	.0010	.0256	.40	.020	.0009	.0258	.40	.021	.0011	.0242	.48
	1.0	.042	.0017	.0301	.40	.040	.0017	.0267	.39	.041	.0017	.0264	.40	.042	.0016	.0245	.48
	1.5	.064	.0023	.0313	.40	.062	.0023	.0278	.38	.065	.0025	.0278	.39	.067	.0027	.0259	.47
	2.0	.085	.0029	.0324	.40	.084	- - -	- - -	.38	.086	.0028	.0290	.39	.089	.0030	.0271	.47
	3.0	.129	.0039	.0365	.40	.128	- - -	- - -	.39	.131	.0040	.0333	.39	.136	.0044	.0316	.46
	4.0	.176	.0053	.0420	.41	.173	.0047	.0384	.39	.177	.0052	.0387	.39	.182	.0058	.0371	.46
	5.0	.220	.0065	.0491	.41	.217	.0059	.0454	.40	.222	.0063	.0455	.40	.227	.0069	.0446	.45
	6.0	.266	.0079	.0581	.42	.262	.0071	.0542	.40	.268	.0076	.0546	.40	.277	.0085	.0540	.45
	8.0	.359	.0113	.0809	.43	.354	.0100	.0769	.40	.359	.0106	.0774	.41	.368	.0118	.0772	.45
	10.0	.451	.0156	.1109	.45	.446	.0134	.1067	.41	.451	.0140	.1076	.42	.463	.0156	.1085	.45
	12.0	.547	.0201	.1486	.47	.541	.0175	.1443	.43	.547	.0185	.1460	.43	.569	.0209	.1505	.45
	14.0	.640	.0227	.1928	.49	.642	.0229	.1915	.45	.653	.0242	.1949	.44	.678	.0269	.2015	.45
	16.0	.744	.0263	.2484	.51	.749	.0282	.2489	.43	.762	.0294	.2541	.42	.785	.0310	.2602	.43
	18.0	.855	.0301	.3154	.52	.859	.0313	.3167	.45	.876	.0319	.3235	.41	- - -	- - -	- - -	- -

(2) h/t = 0.6, b/c = 0.05

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0419	0.57	0	0	0.0397	0.57	0	0	0.0363	0.57	0	0	0.0381	0.61
	.5	.032	.0025	.0423	.56	.035	.0026	.0401	- -	.033	.0027	.0370	- -	.037	.0030	.0390	- -
	1.0	.067	.0048	.0433	.56	.069	.0053	.0415	- -	.065	.0053	.0382	- -	.073	.0059	.0395	- -
	1.5	.101	.0072	.0449	.55	.102	.0078	.0433	- -	.097	.0075	.0400	- -	.112	.0086	.0423	- -
	2.0	.136	.0089	.0470	.55	.137	.0097	.0457	.54	.130	.0093	.0421	.55	.150	.0106	.0444	.59
	3.0	.206	.0119	.0530	.55	.209	.0132	.0523	- -	.198	.0128	.0486	- -	.227	.0150	.0514	- -
	4.0	.280	.0154	.0613	.55	.282	.0172	.0611	.54	.268	.0168	.0569	.53	.305	.0195	.0597	.58
	5.0	.354	.0195	.0725	.56	.355	.0212	.0727	- -	.336	.0205	.0674	- -	- - -	- - -	- - -	- -
	6.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0265	.45	0	0	.0242	.46	0	0	.0239	.49	0	0	.0226	.56
	.5	.020	.0014	.0269	.44	.020	.0011	.0244	.45	.020	.0012	.0241	.49	.020	.0016	.0226	.56
	1.0	.040	.0025	.0277	.43	.042	.0023	.0251	.44	.041	.0022	.0247	.48	.043	.0030	.0229	.56
	1.5	.061	.0036	.0288	.43	.062	.0034	.0262	.44	.063	.0034	.0260	.48	.067	.0043	.0244	.55
	2.0	.082	.0043	.0300	.44	.084	.0041	.0276	.44	.084	.0038	.0272	.47	.087	.0051	.0256	.54
	3.0	.125	.0059	.0340	.44	.126	.0056	.0315	.44	.129	.0058	.0315	.46	.131	.0072	.0302	.53
	4.0	.170	.0077	.0392	.44	.171	.0073	.0369	.44	.173	.0075	.0370	.45	.178	.0091	.0354	.52
	5.0	.214	.0096	.0460	.44	.214	.0090	.0437	.44	.218	.0092	.0440	.44	.223	.0105	.0425	.51
	6.0	.258	.0117	.0545	.45	.258	.0108	.0523	.44	.264	.0111	.0527	.44	.270	.0126	.0521	.52
	8.0	.348	.0163	.0764	.47	.347	.0149	.0742	.44	.352	.0154	.0748	.44	.361	.0175	.0744	.52
	10.0	.439	.0218	.1055	.50	.439	.0195	.1035	.45	.443	.0200	.1040	.44	.455	.0222	.1044	.51
	12.0	.531	.0277	.1417	.52	.532	.0249	.1400	.45	.537	.0256	.1350	.44	.559	.0285	.1452	.51
	14.0	.624	.0321	.1847	.55	.630	.0315	.1854	.45	.639	.0324	.1884	.45	.665	.0354	.1945	.50
	16.0	.728	.0372	.2394	.57	.736	.0382	.2417	.44	.746	.0388	.2455	.43	.771	.0403	.2522	.46
	18.0	.837	.0425	.3049	.58	.843	.0430	.3072	.47	.855	.0431	.3122	.42	- - -	- - -	- - -	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(c) Basic airfoil: Biconvex to c/3, t/c = 0.06 - Continued

(3) h/t = 0.3, b/c = 0.05

M	α, deg	$R=3.5\times10^6$ Transition fixed				$R=3.5\times10^6$ Airfoil clean				$R=2.0\times10^6$ Airfoil clean				$R=1.0\times10^6$ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0369	0.58	0	0	0.0338	0.58	0	0	0.0333	0.60	0	0	0.0326	0.70
	.5	.033	.0029	.0373	.58	.034	.0029	.0342	.57	.033	.0027	.0338	.60	.038	.0039	.0328	.70
	1.0	.067	.0056	.0381	.57	.067	.0058	.0355	.57	.068	.0060	.0348	.60	.073	.0071	.0339	.70
	1.5	.100	.0081	.0396	.57	.101	.0085	.0371	.57	.102	.0086	.0366	.60	.110	.0105	.0361	.70
	2.0	.134	.0102	.0416	.57	.136	.0107	.0395	.57	.136	.0111	.0387	.60	.144	.0127	.0379	.70
	3.0	.203	.0139	.0472	.58	.206	.0149	.0460	.57	.209	.0153	.0457	.58	.220	.0178	.0451	.69
	4.0	.274	.0178	.0552	.59	.279	.0192	.0548	.57	.282	.0199	.0544	.57	.297	.0226	.0541	.68
	5.0	.346	.0223	.0660	.61	.351	.0239	.0659	.58	.354	.0243	.0658	.58	.373	.0281	.0654	.69
	6.0	.417	.0282	.0780	.69	.423	.0288	.0794	.61	.428	.0331	.0761	.78	- - -	- - -	- - -	- -
1.98	0	0	0	.0229	.44	0	0	.0205	.50	0	0	.0196	.61	0	0	.0186	.71
	.5	.021	.0014	.0232	.44	.020	.0016	.0206	.50	.022	.0015	.0199	.61	.020	.0016	.0188	.71
	1.0	.042	.0028	.0237	.43	.041	.0028	.0213	.49	.042	.0031	.0205	.60	.042	.0032	.0189	.71
	1.5	.061	.0041	.0249	.43	.061	.0039	.0225	.49	.062	.0044	.0218	.60	.064	.0045	.0209	.71
	2.0	.082	.0049	.0262	.43	.083	.0048	.0239	.49	.084	.0052	.0231	.59	.083	.0061	.0220	.70
	3.0	.125	.0068	.0301	.43	.125	.0065	.0278	.49	.127	.0072	.0272	.59	.128	.0084	.0262	.69
	4.0	.168	.0089	.0352	.43	.168	.0084	.0329	.48	.172	.0091	.0324	.58	.172	.0105	.0315	.68
	5.0	.211	.0110	.0418	.44	.212	.0103	.0396	.47	.215	.0114	.0391	.56	.217	.0129	.0386	.64
	6.0	.253	.0133	.0500	.43	.255	.0127	.0478	.48	.260	.0133	.0479	.56	.264	.0148	.0480	.65
	8.0	.341	.0186	.0710	.45	.342	.0175	.0691	.49	.347	.0186	.0693	.56	.350	.0208	.0694	.63
	10.0	.430	.0247	.0994	.51	.431	.0228	.0971	.50	.435	.0241	.0978	.53	.443	.0265	.0984	.57
	12.0	.525	.0317	.1356	.54	.522	.0290	.1332	.46	.526	.0305	.1340	.49	.542	.0338	.1375	.55
	14.0	.620	.0370	.1770	.58	.617	.0359	.1754	.43	.628	.0379	.1804	.44	.646	.0414	.1856	.52
	16.0	.714	.0431	.2295	.61	.719	.0431	.2307	.40	.732	.0450	.2359	.42	.750	.0472	.2405	.47
	18.0	.817	.0498	.2915	.60	.821	.0489	.2933	.45	.836	.0502	.2996	.39	.857	.0517	.3054	.44

(4) h/t = 0, b/c = 0.05

M	α, deg	$R=3.5\times10^6$ Transition fixed				$R=3.5\times10^6$ Airfoil clean				$R=2.0\times10^6$ Airfoil clean				$R=1.0\times10^6$ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0341	- -	0	0	0.0308	- -	0	0	0.0297	- -	0	0	0.0295	- -
	.5	.032	.0035	.0342	- -	.034	.0033	.0312	- -	.032	.0032	.0299	- -	.033	.0040	.0299	- -
	1.0	.065	.0066	.0348	- -	.065	.0065	.0322	- -	.065	.0066	.0309	- -	.068	.0074	.0305	- -
	1.5	.097	.0096	.0364	- -	.098	.0093	.0338	- -	.098	.0097	.0328	- -	.104	.0106	.0327	- -
	2.0	.129	.0120	.0383	- -	.131	.0117	.0358	- -	.132	.0121	.0352	- -	.138	.0135	.0348	- -
	3.0	.195	.0164	.0436	- -	.199	.0165	.0420	- -	.201	.0171	.0417	- -	.210	.0193	.0415	- -
	4.0	.263	.0213	.0514	- -	.268	.0218	.0505	- -	.274	.0226	.0503	- -	.283	.0254	.0504	- -
	5.0	.333	.0266	.0618	- -	.336	.0273	.0611	- -	.341	.0280	.0611	- -	.355	.0312	.0610	- -
	6.0	.400	.0318	.0742	- -	.405	.0332	.0742	- -	.406	.0354	.0721	- -	- - -	- - -	- - -	- -
2.0	0	0	0	.0217	- -	0	0	.0180	- -	0	0	.0176	- -	0	0	.0174	- -
	.5	.021	.0016	.0220	- -	.019	.0018	.0182	- -	.019	.0017	.0179	- -	.020	.0016	.0174	- -
	1.0	.041	.0032	.0225	- -	.038	.0034	.0187	- -	.039	.0033	.0184	- -	.039	.0032	.0175	- -
	1.5	.060	.0046	.0236	- -	.057	.0049	.0199	- -	.058	.0049	.0196	- -	.058	.0050	.0189	- -
	2.0	.081	.0059	.0248	- -	.077	.0060	.0211	- -	.078	.0059	.0208	- -	.079	.0064	.0200	- -
	3.0	.121	.0080	.0286	- -	.117	.0081	.0249	- -	.118	.0084	.0245	- -	.120	.0093	.0242	- -
	4.0	.163	.0104	.0335	- -	.157	.0104	.0298	- -	.159	.0111	.0296	- -	.162	.0127	.0291	- -
	5.0	.205	.0128	.0383	- -	.199	.0126	.0360	- -	.200	.0134	.0358	- -	.202	.0159	.0356	- -
	6.0	.247	.0155	.0479	- -	.240	.0152	.0439	- -	.243	.0161	.0438	- -	.247	.0180	.0441	- -
	8.0	.331	.0214	.0681	- -	.323	.0203	.0594	- -	.327	.0215	.0642	- -	.333	.0241	.0652	- -
	10.0	.419	.0277	.0953	- -	.410	.0257	.0909	- -	.412	.0268	.0911	- -	.421	.0299	.0929	- -
	12.0	.509	.0349	.1303	- -	.499	.0320	.1255	- -	.502	.0332	.1260	- -	.523	.0374	.1311	- -
	14.0	.598	.0404	.1706	- -	.592	.0392	.1676	- -	.600	.0412	.1701	- -	.625	.0453	.1771	- -
	16.0	.692	.0469	.2202	- -	.685	.0471	.2174	- -	.701	.0490	.2228	- -	.722	.0517	.2289	- -
	18.0	.790	.0543	.2791	- -	.787	.0534	.2781	- -	.803	.0549	.2834	- -	.823	.0572	.2893	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(c) Basic airfoil: Biconvex to c/3, t/c = 0.06 - Continued

(5) h/t = 0.6, b/c = 0.33

M	α, deg	$R=3.5\times10^6$ Transition fixed				$R=3.5\times10^6$ Airfoil clean				$R=2.0\times10^6$ Airfoil clean				$R=1.0\times10^6$ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0378	0.54	0	0	0.0334	0.57	0	0	0.0335	0.56	0	0	0.0330	0.61
	.5	.035	.0025	.0385	.53	.034	.0025	.0338	.56	.034	.0024	.0339	.56	.035	.0029	.0331	.61
	1.0	.069	.0049	.0395	.52	.070	.0049	.0348	.55	.068	.0051	.0351	.55	.072	.0055	.0340	.60
	1.5	.104	.0072	.0411	.51	.104	.0074	.0369	.55	.104	.0076	.0371	.54	.110	.0081	.0364	.60
	2.0	.139	.0090	.0431	.51	.139	.0092	.0393	.55	.140	.0095	.0393	.55	.147	.0098	.0387	.59
	3.0	.208	.0116	.0489	.50	.210	.0130	.0460	.55	.214	.0131	.0462	.54	.225	.0139	.0461	.60
	4.0	.281	.0147	.0573	.51	.281	.0167	.0550	.55	.287	.0171	.0551	.54	.301	.0182	.0549	.59
	5.0	.355	.0184	.0685	.51	.358	.0207	.0667	.56	.363	.0211	.0668	.55	.379	.0227	.0632	.73
	6.0	.429	.0225	.0809	.55	.425	.0246	.0785	.64	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0234	.43	0	0	.0206	.43	0	0	.0205	.48	0	0	.0194	.60
	.5	.021	.0011	.0237	.42	.021	.0011	.0209	.43	.022	.0011	.0207	.48	.026	.0011	.0198	.62
	1.0	.042	.0023	.0243	.42	.042	.0023	.0216	.42	.044	.0024	.0212	.48	.044	.0022	.0204	.61
	1.5	.063	.0034	.0256	.42	.062	.0032	.0227	.42	.064	.0034	.0225	.47	.062	.0033	.0217	.60
	2.0	.083	.0041	.0270	.41	.084	.0038	.0240	.43	.085	.0038	.0239	.47	.087	.0035	.0231	.59
	3.0	.127	.0056	.0309	.41	.127	.0051	.0279	.43	.130	.0051	.0280	.47	.130	.0055	.0273	.58
	4.0	.171	.0073	.0362	.41	.170	.0067	.0332	.44	.175	.0070	.0333	.47	.178	.0076	.0327	.57
	5.0	.215	.0089	.0429	.42	.214	.0083	.0399	.44	.217	.0086	.0400	.47	.223	.0093	.0400	.55
	6.0	.259	.0108	.0515	.42	.259	.0100	.0485	.44	.262	.0103	.0489	.47	.272	.0106	.0496	.57
	8.0	.348	.0150	.0732	.44	.347	.0140	.0701	.46	.350	.0143	.0708	.47	.360	.0156	.0716	.55
	10.0	.439	.0199	.1024	.46	.437	.0182	.0990	.47	.439	.0188	.1000	.48	.454	.0210	.1019	.53
	12.0	.533	.0263	.1392	.48	.529	.0238	.1355	.47	.534	.0246	.1369	.47	.554	.0278	.1416	.49
	14.0	.625	.0305	.1817	.53	.627	.0301	.1807	.44	.642	.0317	- - -	.44	- - -	- - -	- - -	.46
	16.0	.728	.0352	.2355	.57	.731	.0364	.2362	.43	.749	.0378	- - -	.40	.762	.0398	.2468	.43
	18.0	.833	.0407	.2988	.60	.837	.0413	.3009	.43	.857	.0420	- - -	.40	.875	.0434	.3156	.42

(6) h/t = 0.3, b/c = 0.33

M	α, deg	$R=3.5\times10^6$ Transition fixed				$R=3.5\times10^6$ Airfoil clean				$R=2.0\times10^6$ Airfoil clean				$R=1.0\times10^6$ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0354	0.36	0	0	0.0314	0.54	0	0	0.0298	0.59	0	0	0.0302	0.67
	.5	.033	.0029	.0357	.36	.035	.0033	.0319	.54	.034	.0029	.0304	.59	.036	.0033	.0308	.67
	1.0	.066	.0055	.0365	.36	.068	.0057	.0326	.54	.067	.0058	.0315	.59	.074	.0064	.0317	.67
	1.5	.100	.0078	.0379	.37	.102	.0083	.0345	.55	.102	.0083	.0335	.59	.108	.0092	.0339	.66
	2.0	.134	.0097	.0396	.37	.136	.0106	.0364	.56	.138	.0106	.0356	.59	.145	.0111	.0359	.66
	3.0	.202	.0133	.0452	.38	.206	.0139	.0428	.57	.207	.0148	.0426	.58	.220	.0159	.0429	.65
	4.0	.273	.0170	.0530	.39	.278	.0191	.0514	.60	.281	.0194	.0512	.59	.295	.0206	.0515	.66
	5.0	.345	.0213	.0637	.41	.349	.0235	.0627	.59	.352	.0238	.0625	.60	.368	.0258	.0621	.68
	6.0	.417	.0262	.0766	.54	.416	.0282	.0759	.59	.421	.0303	.0737	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0214	.41	0	0	.0183	.46	0	0	.0182	.53	0	0	.0180	.69
	.5	.021	.0015	.0217	.41	.020	.0013	.0185	.46	.020	.0013	.0185	.53	.019	.0013	.0181	.69
	1.0	.042	.0028	.0223	.41	.041	.0026	.0191	.46	.040	.0026	.0188	.53	.042	.0029	.0182	.69
	1.5	.061	.0041	.0233	.40	.061	.0037	.0201	.46	.061	.0039	.0200	.53	.063	.0040	.0197	.69
	2.0	.083	.0049	.0246	.40	.081	.0045	.0214	.46	.082	.0046	.0214	.53	.085	.0051	.0203	.69
	3.0	.124	.0067	.0284	.40	.122	.0062	.0252	.46	.124	.0063	.0252	.51	.127	.0069	.0247	.68
	4.0	.168	.0087	.0336	.41	.164	.0080	.0302	.47	.168	.0085	.0304	.51	.173	.0099	.0297	.67
	5.0	.211	.0105	.0402	.42	.208	.0099	.0369	.47	.210	.0103	.0369	.51	.216	.0113	.0369	.62
	6.0	.253	.0128	.0483	.43	.250	.0119	.0451	.48	.254	.0125	.0454	.51	.262	.0136	.0457	.62
	8.0	.340	.0177	.0694	.46	.338	.0166	.0661	.49	.340	.0173	.0663	.52	.350	.0197	.0672	.57
	10.0	.429	.0235	.0976	.48	.425	.0219	.0938	.48	.425	.0229	.0940	.48	.438	.0256	.0961	.50
	12.0	.520	.0303	.1329	.53	.515	.0279	.1293	.44	.516	.0289	.1298	.43	.541	.0326	.1354	.47
	14.0	.608	.0352	.1738	.61	.608	.0351	.1723	.41	.616	.0366	.1751	.40	.645	.0406	.1827	.43
	16.0	.708	.0417	.2258	.63	.705	.0423	.2244	.41	.719	.0437	.2294	.38	.745	.0464	.2364	.40
	18.0	.808	.0485	.2865	.60	.808	.0482	.2866	.46	.821	.0493	.2911	.39	.851	.0518	.2998	.42

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(c) Basic airfoil: Biconvex to c/3, t/c = 0.06 - Concluded

(7) h/t = 0, b/c = 0.33

M	α, deg	R=3.5x10⁶ Transition fixed				R=3.5x10⁶ Airfoil clean				R=2.0x10⁶ Airfoil clean				R=1.0x10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0324	- -	0	0	0.0299	- -	- - -	- - -	- - -	- -	0	0	0.0301	- -
	.5	.032	.0034	.0326	- -	.032	.0029	.0302	- -	- - -	- - -	- - -	- -	.032	.0033	- - -	- -
	1.0	.067	.0063	.0335	- -	.067	.0061	.0315	- -	- - -	- - -	- - -	- -	.076	.0079	.0318	- -
	1.5	.097	.0088	.0348	- -	.098	.0087	.0332	- -	- - -	- - -	- - -	- -	.102	.0101	.0333	- -
	2.0	.129	.0111	.0367	- -	.130	.0113	.0352	- -	- - -	- - -	- - -	- -	.136	.0132	.0354	- -
	3.0	.195	.0151	.0422	- -	.199	.0159	.0415	- -	- - -	- - -	- - -	- -	.208	.0177	.0413	- -
	4.0	.262	.0195	.0500	- -	.267	.0210	.0500	- -	- - -	- - -	- - -	- -	.281	.0230	.0505	- -
	5.0	.332	.0247	.0605	- -	.337	.0259	.0608	- -	- - -	- - -	- - -	- -	.353	.0287	.0615	- -
	6.0	.400	.0303	.0735	- -	.404	.0311	.0739	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0204	- -	0	0	.0185	- -	0	0	0.0180	- -	0	0	.0177	- -
	.5	.020	.0014	.0208	- -	.019	.0015	.0186	- -	.018	.0016	.0180	- -	.015	.0021	- - -	- -
	1.0	.042	.0033	.0214	- -	.041	.0030	.0193	- -	.043	.0032	.0190	- -	.042	.0042	.0187	- -
	1.5	.058	.0044	.0223	- -	.058	.0041	.0202	- -	.059	.0043	.0198	- -	.052	.0052	.0193	- -
	2.0	.079	.0057	.0237	- -	.078	.0053	.0215	- -	.079	.0057	.0211	- -	.077	.0068	.0207	- -
	3.0	.119	.0076	.0273	- -	.119	.0071	.0251	- -	.119	.0075	.0248	- -	.116	.0084	.0240	- -
	4.0	.161	.0097	.0323	- -	.160	.0092	.0301	- -	.162	.0095	.0303	- -	.163	.0108	.0297	- -
	5.0	.203	.0120	.0387	- -	.202	.0112	.0366	- -	.204	.0119	.0362	- -	.204	.0134	.0355	- -
	6.0	.245	.0146	.0468	- -	.245	.0137	.0447	- -	.247	.0145	.0455	- -	.246	.0163	.0439	- -
	8.0	.330	.0199	.0673	- -	.331	.0185	.0655	- -	.331	.0192	.0650	- -	.337	.0218	.0649	- -
	10.0	.414	.0259	.0944	- -	.416	.0205	.0924	- -	.418	.0247	.0925	- -	.424	.0278	.0927	- -
	12.0	.502	.0332	.1286	- -	.504	.0299	.1269	- -	.506	.0309	.1209	- -	.522	.0342	.1296	- -
	14.0	.588	.0386	.1682	- -	.596	.0373	.1689	- -	.603	.0386	.1705	- -	.622	.0420	.1751	- -
	16.0	.684	.0454	.2178	- -	.695	.0453	.2207	- -	.703	.0405	.1230	- -	.723	.0489	.2276	- -
	18.0	.781	.0526	.2759	- -	.791	.0521	.2800	- -	.803	.0525	.2833	- -	.825	.0544	.2894	- -

(d) Basic airfoil: Biconvex to c/2, t/c = 0.04

(1) h/t = 1.0, b/c = 0

M	α, deg	R=3.5x10⁶ Transition fixed				R=3.5x10⁶ Airfoil clean				R=2.0x10⁶ Airfoil clean				R=1.0x10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0234	0.49	0	0	0.0217	0.50	0	0	0.0212	0.49	0	0	0.0198	0.53
	.5	.032	.0010	.0234	.50	.032	.0006	.0218	.50	.031	.0006	.0216	.49	.035	.0010	.0206	.55
	1.0	.067	.0012	.0245	.50	.066	.0010	.0226	.50	.067	.0011	.0222	.50	.070	.0010	.0211	.54
	1.5	.103	.0017	.0262	.50	.100	.0013	.0242	.50	.102	.0016	.0238	.50	.108	.0018	.0229	.53
	2.0	.137	.0021	.0284	.50	.135	.0016	.0263	.50	.138	.0018	.0262	.50	.144	.0024	.0252	.53
	3.0	.211	.0035	.0352	.50	.208	.0027	.0328	.50	.210	.0031	.0327	.50	.220	.0042	.0321	.53
	4.0	.289	.0056	.0445	.50	.282	.0043	.0420	.51	.286	.0046	.0416	.51	.302	.0063	.0403	.59
	5.0	.366	.0081	.0563	.51	.359	.0065	.0537	.51	.366	.0074	.0535	.52	- - -	- - -	- - -	- -
	6.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0164	.37	0	0	.0142	.36	0	0	.0138	.39	0	0	.0123	.46
	.5	.019	.0004	.0164	.36	.019	.0005	.0142	.36	.017	.0005	.0138	.39	.017	.0008	.0126	.46
	1.0	.040	.0004	.0168	.36	.040	.0005	.0147	.36	.037	.0005	.0138	.40	.035	.0008	- - -	.45
	1.5	.061	.0007	.0177	.37	.062	.0007	.0156	.36	.060	.0010	.0152	.40	.059	.0013	.0137	.44
	2.0	.084	.0008	.0189	.37	.082	.0007	.0168	.36	.081	.0010	.0161	.39	.081	.0008	.0148	.44
	3.0	.127	.0013	.0227	.37	.124	.0010	.0205	.36	.119	.0014	.0198	.39	.124	.0013	.0188	.45
	4.0	.172	.0023	.0281	.38	.167	.0015	.0257	.36	- - -	- - -	- - -	.42	.168	.0024	.0237	.45
	5.0	.217	.0034	.0350	.38	.210	.0019	.0326	.36	.207	.0026	.0316	.40	.212	.0024	.0307	.45
	6.0	.261	.0045	.0437	.39	.253	.0025	.0410	.36	.251	.0029	.0402	.40	.258	.0035	.0396	.45
	8.0	.349	.0064	.0652	.40	.343	.0039	.0627	.38	.340	.0046	.0617	.41	.347	.0056	.0608	.46
	10.0	.440	.0080	.0937	.42	.430	.0054	.0907	.39	.430	.0059	.0918	.41	.445	.0070	.0914	.48
	12.0	.531	.0101	.1293	.44	.521	.0072	.1259	.41	.522	.0074	.1262	.42	.543	.0093	.1288	.47
	14.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.618	.0102	.1703	.42	.650	.0122	.1768	.47
	16.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.740	.0139	.2306	.41	.767	.0165	.2370	.45
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(d) Basic airfoil: Biconvex to c/2, t/c = 0.04 - Continued

(2) h/t = 0.6, b/c = 0.05

M	α, deg	$R=3.5\times10^6$ Transition fixed				$R=3.5\times10^6$ Airfoil clean				$R=2.0\times10^6$ Airfoil clean				$R=1.0\times10^6$ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0206	0.52	0	0	0.0191	0.55	0	0	0.0176	0.59	0	0	0.0160	0.69
	.5	.030	.0017	.0215	.51	.033	.0015	.0196	.54	.033	.0013	.0185	.58	.035	.0021	.0173	.67
	1.0	.064	.0023	.0221	.50	.065	.0022	.0202	.54	.066	.0023	.0190	.58	.071	.0029	.0179	.66
	1.5	.099	.0029	.0239	.51	.099	.0024	.0217	.54	.102	.0030	.0208	.58	.106	.0034	.0201	.65
	2.0	.134	.0035	.0259	.51	.135	.0032	.0236	.54	.136	.0035	.0229	.58	.142	.0044	.0219	.64
	3.0	.208	.0056	.0326	.52	.205	.0045	.0302	.55	.209	.0052	.0294	.58	.215	.0052	.0289	.63
	4.0	.288	.0085	.0420	.54	.279	.0068	.0371	.55	.283	.0074	.0382	.58	.294	.0085	.0386	.63
	5.0	.364	.0123	.0533	.57	.357	.0100	.0509	.56	.362	.0105	.0507	.58	.376	.0133	.0504	.65
	6.0	.436	.0167	.0662	.61	.437	.0150	.0644	.63	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0146	.41	0	0	.0121	.48	0	0	.0120	.57	0	0	.0119	.65
	.5	.018	.0008	.0150	.40	.017	.0007	.0123	.47	.018	.0009	.0122	.56	.019	.0011	.0122	.65
	1.0	.039	.0010	.0151	.40	.038	.0010	.0124	.48	.038	.0013	.0124	.55	.039	.0013	.0124	.64
	1.5	.059	.0014	.0160	.41	.058	.0015	.0132	.48	.059	.0017	.0133	.55	.062	.0021	.0138	.64
	2.0	.081	.0015	.0172	.41	.080	.0017	.0145	.48	.081	.0021	.0144	.56	.084	.0021	.0148	.62
	3.0	.123	.0023	.0209	.41	.122	.0022	.0181	.48	.123	.0027	.0182	.55	.125	.0032	.0189	.61
	4.0	.167	.0031	.0262	.41	.165	.0031	.0234	.47	.167	.0036	.0235	.54	.171	.0048	.0241	.61
	5.0	.211	.0041	.0330	.42	.213	.0039	.0307	.47	.213	.0046	.0306	.53	.217	.0054	.0311	.59
	6.0	.256	.0052	.0413	.42	.253	.0048	.0391	.46	.255	.0055	.0390	.52	.261	.0064	.0400	.60
	8.0	.345	.0075	.0627	.44	.341	.0070	.0606	.44	.342	.0078	.0606	.50	.349	.0088	.0619	.58
	10.0	.435	.0100	.0909	.46	.431	.0093	.0888	.43	.432	.0086	.0888	.48	.443	.0115	.0910	.55
	12.0	.524	.0131	.1257	.49	.519	.0119	.1234	.43	.522	.0125	.1243	.48	.542	.0142	.1289	.54
	14.0	.621	.0164	.1694	.51	.618	.0148	.1667	.42	.626	.0164	.1702	.46	.650	.0182	.1771	.51
	16.0	.732	.0234	.2261	.53	.725	.0197	.2221	.42	.742	.0211	.2284	.43	.766	.0236	.2367	.46
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.869	.0305	.3001	.43	- - -	- - -	- - -	- -

(3) h/t = 0.3, b/c = 0.05

M	α, deg	$R=3.5\times10^6$ Transition fixed				$R=3.5\times10^6$ Airfoil clean				$R=2.0\times10^6$ Airfoil clean				$R=1.0\times10^6$ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0167	0.40	0	0	0.0136	0.56	0	0	0.0121	0.75	0	0	0.0120	0.80
	.5	.030	.0019	.0175	.41	.031	.0016	.0141	.56	.032	.0020	.0129	.74	.034	.0018	.0131	.80
	1.0	.062	.0027	.0181	.41	.064	.0023	.0147	.56	.065	.0029	.0137	.73	.068	.0031	.0137	.79
	1.5	.096	.0035	.0195	.40	.097	.0030	.0164	.56	- - -	.0039	.0169	.71	.104	.0044	.0158	.78
	2.0	.130	.0044	.0215	.41	.131	.0038	.0182	.57	.132	.0045	.0176	.70	.139	.0049	.0177	.76
	3.0	.201	.0068	.0275	.41	.200	.0057	.0242	.59	.204	.0066	.0241	.68	.211	.0078	.0244	.75
	4.0	.274	.0103	.0362	.44	.272	.0085	.0327	.60	.269	.0092	.0325	.65	.289	.0111	.0339	.72
	5.0	.349	.0141	.0472	.56	.347	.0121	.0440	.60	.352	.0132	.0448	.64	.368	.0158	.0460	.70
	6.0	.426	.0186	.0614	.60	.425	.0169	.0588	.60	.431	.0185	.0594	.64	- - -	- - -	- - -	- -
1.98	0	0	0	.0119	.45	0	0	.0090	.58	0	0	.0093	.73	0	0	.0106	.79
	.5	.019	.0009	.0122	.46	.018	.0009	.0093	.58	.020	.0012	.0098	.73	.022	.0011	.0110	.79
	1.0	.039	.0013	.0124	.46	.037	.0012	.0097	.57	.039	.0018	.0101	.72	.041	.0016	.0119	.79
	1.5	.060	.0018	.0133	.46	.058	.0017	.0105	.57	.061	.0023	.0111	.71	.062	.0024	.0128	.79
	2.0	.080	.0017	.0144	.46	.078	.0019	.0118	.56	.081	.0029	.0124	.71	.082	.0032	.0138	.78
	3.0	.122	.0026	.0181	.46	.119	.0028	.0153	.56	.122	.0037	.0161	.69	.124	.0040	.0177	.77
	4.0	.164	.0038	.0231	.46	.160	.0040	.0203	.55	.164	.0050	.0210	.67	.167	.0056	.0228	.74
	5.0	.206	.0051	.0295	.46	.201	.0049	.0266	.53	.206	.0061	.0279	.65	.209	.0065	.0294	.72
	6.0	.248	.0061	.0376	.47	.243	.0061	.0347	.53	.248	.0072	.0360	.64	.253	.0080	.0379	.72
	8.0	.334	.0089	.0581	.47	.328	.0087	.0552	.49	.333	.0101	.0570	.61	.337	.0112	.0657	.68
	10.0	.419	.0122	.0849	.48	.413	.0112	.0839	.48	.418	.0125	.0858	.57	.426	.0139	.0822	.61
	12.0	.508	.0153	.1187	.51	.499	.0142	.1153	.46	.506	.0153	.1182	.52	.522	.0174	.1230	.57
	14.0	.604	.0193	.1611	.55	.596	.0173	.1581	.44	.605	.0188	.1621	.46	.625	.0214	.1684	.50
	16.0	.708	.0265	.2147	.57	.703	.0222	.2115	.42	.716	.0240	.1947	.43	.736	.0262	.2324	.49
	18.0	.822	.0340	.2791	.61	.823	.0311	.2790	.47	.837	.0334	.2855	.45	.864	.0360	.2950	.46

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(d) Basic airfoil: Biconvex to c/2, t/c = 0.04 - Continued

(4) h/t = 0, b/c = 0.05

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0128	- -	0	0	0.0125	- -	0	0	0.0117	- -	0	0	0.0102	- -
	.5	.030	.0022	.0131	- -	.031	.0022	.0128	- -	.032	.0021	.0121	- -	.030	.0021	.0111	- -
	1.0	.061	.0036	.0138	- -	.062	.0031	.0134	- -	.062	.0035	.0130	- -	.065	.0041	.0114	- -
	1.5	.094	.0046	.0151	- -	.094	.0041	.0147	- -	.095	.0047	.0141	- -	.097	.0059	.0140	- -
	2.0	.128	.0057	.0171	- -	.128	.0051	.0167	- -	.129	.0056	.0161	- -	.134	.0075	.0151	- -
	3.0	.196	.0086	.0228	- -	.195	.0075	.0223	- -	.198	.0081	.0218	- -	.202	.0108	.0206	- -
	4.0	.268	.0123	.0314	- -	.266	.0107	.0305	- -	.268	.0115	.0299	- -	.276	.0143	.0295	- -
	5.0	.341	.0167	.0421	- -	.340	.0143	.0415	- -	.342	.0157	.0411	- -	.357	.0191	.0418	- -
	6.0	.417	.0213	.0560	- -	.418	.0193	.0559	- -	.420	.0211	.0554	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0098	- -	0	0	.0083	- -	0	0	.0069	- -	0	0	.0067	- -
	.5	.019	.0013	.0099	- -	.019	.0014	.0085	- -	.018	.0010	.0072	- -	.018	.0013	.0065	- -
	1.0	.039	.0019	.0101	- -	.039	.0023	.0088	- -	.039	.0021	.0076	- -	.039	.0021	.0077	- -
	1.5	.059	.0025	.0109	- -	.059	.0026	.0094	- -	.058	.0033	.0083	- -	.060	.0032	.0085	- -
	2.0	.078	.0030	.0120	- -	.079	.0029	.0106	- -	.078	.0038	.0094	- -	.080	.0043	.0100	- -
	3.0	.120	.0042	.0154	- -	.119	.0041	.0139	- -	.120	.0051	.0129	- -	.120	.0062	.0131	- -
	4.0	.161	.0055	.0203	- -	.160	.0055	.0190	- -	.160	.0067	.0177	- -	.163	.0080	.0179	- -
	5.0	.202	.0067	.0265	- -	.202	.0066	.0250	- -	.202	.0079	.0241	- -	.206	.0094	.0246	- -
	6.0	.244	.0083	.0345	- -	.244	.0080	.0328	- -	.246	.0094	.0321	- -	.251	.0107	.0328	- -
	8.0	.329	.0117	.0544	- -	.328	.0110	.0529	- -	- - -	- - -	- - -	- -	.333	.0144	.0526	- -
	10.0	.414	.0151	.0806	- -	.412	.0141	.0793	- -	- - -	- - -	- - -	- -	.422	.0175	.0799	- -
	12.0	.501	.0189	.1138	- -	.500	.0174	.1126	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -
	14.0	.594	.0230	.1551	- -	.593	.0211	.1540	- -	- - -	- - -	- - -	- -	.625	.0254	.1612	- -
	16.0	.700	.0295	.2078	- -	.694	.0262	.2048	- -	- - -	- - -	- - -	- -	.736	.0313	.2169	- -
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -

(5) h/t = 0.6, b/c = 0.50

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0195	0.46	0	0	0.0150	0.53	0	0	0.0145	0.56	0	0	0.0141	0.63
	.5	.037	.0014	.0202	.45	.033	.0012	.0156	.53	.032	.0015	.0151	.56	.033	.0016	.0153	.61
	1.0	.070	.0019	.0210	.45	.066	.0016	.0164	.53	.067	.0019	.0159	.56	.070	.0016	.0160	.58
	1.5	.105	.0026	.0228	.45	.101	.0019	.0182	.53	.102	.0023	.0177	.56	.109	.0024	.0183	.56
	2.0	.141	.0031	.0250	.45	.135	.0029	.0202	.53	.137	.0028	.0198	.55	.145	.0029	.0204	.54
	3.0	.215	.0051	.0318	.44	.208	.0034	.0267	.53	.209	.0040	.0264	.56	.221	.0047	.0273	.55
	4.0	.289	.0079	.0408	.45	.281	.0054	.0354	.54	.285	.0060	.0353	.56	.300	.0072	.0365	.56
	5.0	.368	.0108	.0528	.43	.358	.0081	.0474	.54	.362	.0088	.0476	.57	.381	.0102	.0484	.62
	6.0	.446	.0135	.0669	.47	.440	.0123	.0626	.55	.444	.0134	.0619	.64	- - -	- - -	- - -	.71

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(d) Basic airfoil: Biconvex to c/2, t/c = 0.04 - Concluded

(6) h/t = 0.3, b/c = 0.50

M	α, deg	R=3.5x10^6 Transition fixed				R=3.5x10^6 Airfoil clean				R=2.0x10^6 Airfoil clean				R=1.0x10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0157	0.43	0	0	0.0142	0.49	0	0	0.0133	0.52	0	0	0.0127	0.53
	.5	.030	.0017	.0160	.43	.030	.0014	.0148	.49	.032	.0014	.0139	.52	.034	.0016	.0134	.52
	1.0	.063	.0025	.0167	.43	.062	.0019	.0155	.49	.065	.0022	.0147	.52	.069	.0026	.0143	.52
	1.5	.097	.0033	.0184	.43	.095	.0024	.0170	.49	.100	.0030	.0164	.53	.103	.0036	- - -	.53
	2.0	.130	.0039	.0201	.44	.129	.0030	.0188	.49	.132	.0034	.0182	.53	.140	.0037	.0179	.55
	3.0	- - -	.0064	- - -	.44	.198	.0047	.0250	.49	.203	.0054	.0246	.54	.213	.0060	.0244	.56
	4.0	.274	.0098	.0351	.45	.272	.0070	.0333	.49	.277	.0076	.0333	.54	.290	.0092	.0330	.62
	5.0	.348	.0131	.0462	.46	.343	.0102	.0445	.49	.351	.0108	.0448	.55	.369	.0130	.0450	.64
	6.0	.424	.0167	.0603	.46	.420	.0145	.0589	.49	.430	.0155	.0593	.56	- - -	- - -	- - -	- -
1.98	0	0	0	.0112	.43	0	0	.0092	.37	0	0	.0089	.43	0	0	.0081	.66
	.5	.017	.0010	.0113	.43	.018	.0007	.0095	.37	.020	.0009	.0090	.43	.019	.0008	.0084	.65
	1.0	.037	.0013	.0116	.43	.039	.0010	.0097	.37	.039	.0012	.0095	.43	.039	.0014	.0091	.65
	1.5	.058	.0016	.0125	.43	.060	- - -	- - -	.37	.060	.0018	- - -	.43	.062	.0016	.0099	.64
	2.0	.078	.0019	.0136	.43	.079	.0016	.0119	.37	.081	.0018	- - -	.43	.081	.0019	.0110	.65
	3.0	.118	.0025	.0171	.43	.121	.0022	.0155	.37	.123	.0029	.0151	.45	.126	.0030	.0150	.65
	4.0	.160	.0036	.0220	.43	.162	.0031	.0204	.37	.165	.0038	.0201	.47	.167	.0041	.0197	.65
	5.0	.202	.0045	.0273	.44	.205	.0038	.0268	.37	.209	.0043	.0264	.49	.213	.0050	.0262	.65
	6.0	.244	.0057	.0363	.44	.247	.0049	.0349	.40	.251	.0055	.0348	.50	.254	.0063	.0343	.66
	8.0	.328	.0083	.0565	.44	.330	.0071	- - -	.42	.335	.0079	.0557	.49	.339	.0098	.0554	.65
	10.0	.414	.0108	.0831	.47	.420	.0093	.0826	.44	.422	.0100	.0828	.49	.431	.0121	.0833	.57
	12.0	.499	.0140	.1161	.48	.503	.0123	.1159	.43	.507	.0133	.1167	.47	.526	.0150	.1195	.55
	14.0	.594	.0166	.1584	.54	.597	.0152	.1579	.42	.604	.0164	.1601	.44	.629	.0191	.1654	.50
	16.0	.701	.0235	.2117	.59	.701	.0196	.2179	.42	- - -	- - -	- - -	- -	.738	.0237	.2214	.46
	18.0	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	- - -	- - -	- - -	- -	.862	.0344	.2907	.43

(7) h/t = 0, b/c = 0.50

M	α, deg	R=3.5x10^6 Transition fixed				R=3.5x10^6 Airfoil clean				R=2.0x10^6 Airfoil clean				R=1.0x10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0119	- -	0	0	0.0105	- -	0	0	0.0095	- -	0	0	0.0093	- -
	.5	.029	.0019	.0122	- -	.029	.0018	.0106	- -	.027	.0018	.0098	- -	.027	.0020	.0094	- -
	1.0	.063	.0034	.0129	- -	.063	.0031	.0112	- -	.063	.0033	.0104	- -	.068	.0038	.0100	- -
	1.5	.093	.0042	.0141	- -	.092	.0039	.0126	- -	.092	.0040	.0119	- -	.094	.0043	.0117	- -
	2.0	.126	.0054	.0162	- -	.125	.0047	.0146	- -	.125	.0050	.0140	- -	.130	.0064	.0138	- -
	3.0	.195	.0079	.0222	- -	.193	.0068	.0205	- -	.195	.0072	.0198	- -	.200	.0090	.0197	- -
	4.0	.266	.0113	.0310	- -	.263	.0095	.0288	- -	.268	.0103	.0284	- -	.276	.0122	.0288	- -
	5.0	.338	.0154	.0419	- -	.336	.0131	.0400	- -	.340	.0141	.0396	- -	.352	.0169	.0407	- -
	6.0	.413	.0198	.0556	- -	.411	.0179	.0540	- -	.419	.0197	.0542	- -	.444	.0194	.0553	- -
1.98	0	0	0	.0093	- -	0	0	.0067	- -	0	0	.0062	- -	0	0	.0064	- -
	.5	.019	.0011	.0095	- -	.019	.0012	.0070	- -	.018	.0009	.0063	- -	.018	.0008	.0065	- -
	1.0	.039	.0017	.0097	- -	.040	.0018	.0073	- -	.042	.0021	.0067	- -	- - -	.0024	.0071	- -
	1.5	.059	.0023	.0106	- -	.057	.0020	.0079	- -	.056	.0026	.0072	- -	.054	.0029	- - -	- -
	2.0	.079	.0027	.0116	- -	.077	.0028	.0091	- -	.076	.0033	.0085	- -	.077	.0040	.0092	- -
	3.0	.119	.0039	.0150	- -	.117	.0036	.0124	- -	.119	.0043	.0121	- -	.119	.0050	.0123	- -
	4.0	.160	.0051	.0199	- -	.159	.0048	.0175	- -	.160	.0052	.0170	- -	.160	.0058	.0175	- -
	5.0	.200	.0063	.0261	- -	.199	.0059	.0237	- -	.200	.0065	.0233	- -	.203	.0078	.0237	- -
	6.0	.242	.0076	.0341	- -	.240	.0071	.0316	- -	.241	.0078	.0313	- -	.243	.0095	.0311	- -
	8.0	.325	.0107	.0538	- -	.325	.0097	.0517	- -	.328	.0105	.0517	- -	.329	.0119	.0550	- -
	10.0	.409	.0142	.0798	- -	.402	.0123	.0777	- -	.412	.0131	.0784	- -	.419	.0151	.0790	- -
	12.0	.492	.0160	.1119	- -	.492	.0151	.1105	- -	.500	.0157	.1116	- -	.516	.0177	.1151	- -
	14.0	.587	.0216	.1532	- -	.584	.0183	.1513	- -	.597	.0190	.1546	- -	.616	.0214	.1588	- -
	16.0	.693	.0313	.2057	- -	.688	.0231	.2027	- -	.705	.0247	.2080	- -	.728	.0275	.2216	- -
	18.0	.799	.0401	.2660	- -	.800	.0361	.2663	- -	.824	.0347	.2742	- -	.850	.0370	.2818	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Continued

(e) Basic airfoil: Biconvex, t/c = 0.04

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0121	- -	0	0	0.0114	- -	0	0	0.0108	- -	0	0	0.0095	- -
	.5	.030	.0015	.0122	- -	.030	.0014	.0116	- -	.028	.0016	.0110	- -	.027	.0023	.0105	- -
	1.0	.065	.0028	.0131	- -	.064	.0027	.0123	- -	.064	.0032	.0116	- -	.069	.0046	.0110	- -
	1.5	.096	.0054	.0144	- -	.094	.0036	.0136	- -	.094	.0039	.0129	- -	.093	.0056	.0124	- -
	2.0	.128	.0052	.0164	- -	.128	.0048	.0156	- -	.126	.0053	.0150	- -	.129	.0074	.0146	- -
	3.0	.196	.0079	.0223	- -	.196	.0072	.0213	- -	.196	.0080	.0249	- -	.201	.0097	.0204	- -
	4.0	.268	.0114	.0309	- -	.267	.0104	.0299	- -	.268	.0111	.0283	- -	.277	.0130	.0294	- -
	5.0	.341	.0156	.0420	- -	.331	.0144	.0402	- -	.343	.0152	.0409	- -	.345	.0182	.0406	- -
	6.0	.416	.0205	.0560	- -	.416	.0192	.0553	- -	.420	.0212	.0555	- -	- - -	- - -	- - -	- -
1.98	0	0	.0001	.0095	- -	0	0	.0071	- -	0	0	.0071	- -	0	0	.0068	- -
	.5	.018	.0008	.0095	- -	.019	.0011	.0074	- -	.019	.0012	.0071	- -	.016	.0011	- - -	- -
	1.0	.041	.0017	.0100	- -	.040	.0019	.0077	- -	.040	.0025	.0075	- -	.033	.0026	- - -	- -
	1.5	.059	.0020	.0107	- -	.058	.0023	.0083	- -	.057	.0029	.0081	- -	.055	.0032	.0080	- -
	2.0	.078	.0027	.0117	- -	.078	.0030	.0095	- -	.078	.0038	.0092	- -	.075	.0045	.0096	- -
	3.0	.120	.0040	.0152	- -	.118	.0041	.0131	- -	.118	.0044	.0128	- -	.117	.0056	.0128	- -
	4.0	.159	.0050	.0200	- -	.160	.0052	.0178	- -	.161	.0059	.0179	- -	.161	.0066	.0181	- -
	5.0	.201	.0063	.0263	- -	.202	.0064	.0243	- -	.201	.0073	.0239	- -	.204	.0083	.0241	- -
	6.0	.242	.0081	.0342	- -	.241	.0080	.0320	- -	.243	.0090	.0322	- -	.246	.0106	.0321	- -
	8.0	.327	.0111	.0544	- -	.324	.0108	.0522	- -	.329	.0119	.0523	- -	.333	.0135	.0527	- -
	10.0	.410	.0142	.0805	- -	.406	.0136	.0781	- -	.409	.0151	.0785	- -	.421	.0173	.0790	- -
	12.0	.495	.0177	.1134	- -	.492	.0168	.1113	- -	.495	.0177	.1116	- -	.512	.0201	.1145	- -
	14.0	.586	.0217	.1541	- -	.583	.0203	.1519	- -	.595	.0215	.1547	- -	.617	.0243	.1596	- -
	16.0	.692	.0268	.2059	- -	.688	.0256	.2037	- -	.703	.0273	.2082	- -	.728	.0302	.2151	- -
	18.0	.802	.0345	.2678	- -	.802	.0356	.2680	- -	.823	.0376	.2750	- -	.847	.0405	.2822	- -

(f) Basic airfoil: NACA 16-004

(1) h/t = 0

M	α, deg	R=3.5×10⁶ Transition fixed				R=3.5×10⁶ Airfoil clean				R=2.0×10⁶ Airfoil clean				R=1.0×10⁶ Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0179	- -	0	0	0.0153	- -	0	0	0.0150	- -	0	0	0.0145	- -
	.5	.034	.0018	.0182	- -	.030	.0017	.0160	- -	.029	.0021	.0156	- -	.031	.0024	.0156	- -
	1.0	.064	.0034	.0193	- -	.063	.0031	.0168	- -	.061	.0036	.0164	- -	.063	.0042	.0161	- -
	1.5	.095	.0047	.0207	- -	.092	.0036	.0181	- -	.094	.0048	.0177	- -	.093	.0053	.0174	- -
	2.0	- - -	- - -	- - -	- -	.125	.0053	.0199	- -	.126	.0061	.0196	- -	.127	.0075	.0194	- -
	3.0	.194	.0088	.0282	- -	.192	.0073	.0258	- -	.193	.0085	.0252	- -	.196	.0097	.0252	- -
	4.0	- - -	- - -	- - -	- -	.261	.0099	.0338	- -	.262	.0112	.0335	- -	.270	.0123	.0339	- -
	5.0	- - -	- - -	- - -	- -	.331	.0133	.0442	- -	.334	.0141	.0439	- -	.342	.0160	.0444	- -
	6.0	.405	.0217	.0589	- -	.402	.0170	.0576	- -	.408	.0175	.0576	- -	- - -	- - -	- - -	- -
1.98	0	0	0	.0144	- -	0	0	.0116	- -	0	0	.0115	- -	0	0	.0123	- -
	.5	.020	.0009	.0147	- -	.020	.0013	.0120	- -	.019	.0018	.0123	- -	.021	.0032	.0135	- -
	1.0	.040	.0017	.0152	- -	.040	.0022	.0124	- -	.037	.0024	.0125	- -	.041	.0032	.0140	- -
	1.5	.059	.0025	.0160	- -	.058	.0029	.0132	- -	.058	.0037	.0133	- -	.061	.0048	.0149	- -
	2.0	.080	.0031	.0171	- -	.078	.0034	.0143	- -	.078	.0046	.0148	- -	.080	.0064	.0157	- -
	3.0	.121	.0046	.0206	- -	.119	.0050	.0178	- -	.120	.0059	.0183	- -	.123	.0069	.0196	- -
	4.0	.163	.0062	.0255	- -	.160	.0064	.0230	- -	.163	.0072	.0234	- -	.170	.0093	.0259	- -
	5.0	.205	.0078	.0316	- -	.201	.0081	.0292	- -	.203	.0085	.0297	- -	.207	.0101	.0315	- -
	6.0	.246	.0097	.0394	- -	.243	.0096	.0373	- -	.246	.0103	.0380	- -	.256	.0124	.0408	- -
	8.0	.324	.0131	.0608	- -	.325	.0133	.0568	- -	.328	.0139	.0576	- -	.338	.0167	.0615	- -
	10.0	.413	.0168	.0853	- -	.423	.0164	.0851	- -	.410	.0165	.0838	- -	.422	.0178	.0875	- -
	12.0	.499	.0207	.1179	- -	.492	.0197	.1147	- -	.497	.0198	.1170	- -	.520	.0222	.1228	- -
	14.0	.586	.0250	.1615	- -	.586	.0228	.1556	- -	.594	.0238	.1583	- -	.619	.0257	.1658	- -
	16.0	.705	.0250	.2121	- -	.682	.0275	.2049	- -	.699	.0282	.2107	- -	.721	.0312	.2183	- -
	18.0	.814	.0298	.2736	- -	.801	.0271	.2692	- -	.812	.0345	.2739	- -	.851	.0328	.2892	- -

TABLE II.- LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS AND BASE PRESSURE RATIO FOR AIRFOILS TESTED - Concluded

(f) Basic airfoil: NACA 16-004 - Concluded

(2) h/t = 0.3

M	α, deg	R=3.5×10^6 Transition fixed				R=3.5×10^6 Airfoil clean				R=2.0×10^6 Airfoil clean				R=1.0×10^6 Airfoil clean			
		c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p	c_l	c_m	c_d	p_b/p
1.45	0	0	0	0.0207	0.45	0	0	0.0174	- -	0	0	0.0169	0.58	0	0	0.0168	0.61
	.5	.033	.0017	.0210	.45	.033	.0013	.0178	- -	.033	.0015	.0174	- -	.033	.0010	.0174	- -
	1.0	.065	.0026	.0216	.45	.065	.0021	.0185	- -	.064	.0025	.0179	.59	.067	.0020	.0179	.58
	1.5	.097	.0036	.0232	.46	.097	.0029	.0199	- -	.098	.0034	.0194	.50	.101	.0033	.0196	- -
	2.0	.131	.0046	.0252	.46	.129	.0032	.0216	- -	.131	.0038	.0212	.59	.137	.0038	.0214	.60
	3.0	.199	.0064	.0311	.46	.196	.0051	.0274	- -	.198	.0055	.0272	.60	.208	.0059	.0275	- -
	4.0	.268	.0085	.0388	.46	.266	.0072	.0355	- -	.269	.0078	.0350	.65	.281	.0084	.0356	.71
	5.0	.339	.0104	.0493	.47	.338	.0097	.0467	- -	.340	.0102	.0459	- -	.358	.0113	.0470	- -
	6.0	.413	.0128	.0623	.48	.413	.0127	.0606	- -	.416	.0132	.0598	.67	- - -	- - -	- - -	- -
1.98	0	0	0	.0154	.43	0	0	.0125	.46	0	0	.0124	.56	0	0	.0124	.67
	.5	.020	.0009	.0155	.43	.021	.0008	.0127	.46	.022	.0009	.0128	.51	.021	.0016	.0126	.66
	1.0	.040	.0016	.0158	.43	.041	.0014	.0129	.48	.042	.0014	.0130	.51	.042	.0016	.0129	.69
	1.5	.059	.0020	.0166	.43	.061	.0020	.0138	.48	.062	.0021	.0140	.52	.064	.0021	.0137	.70
	2.0	.081	.0027	.0178	.43	.082	.0023	.0149	.48	.083	.0026	.0148	.59	.084	.0026	.0147	.71
	3.0	.121	.0037	.0213	.44	.122	.0034	.0186	.50	.123	.0037	.0184	.65	.126	.0047	.0182	.70
	4.0	.162	.0050	.0262	.44	.165	.0047	.0235	.52	.166	.0051	.0234	.65	.171	.0063	.0233	.71
	5.0	.206	.0063	.0326	.45	.206	.0058	.0298	.56	.206	.0063	.0297	.65	.211	.0071	.0299	.69
	6.0	.248	.0076	.0407	.45	.249	.0071	.0380	.60	.250	.0077	.0381	.65	.255	.0084	.0382	.70
	8.0	.333	.0105	.0609	.47	.333	.0100	.0583	.59	.333	.0111	.0583	.61	.338	.0121	.0586	.65
	10.0	.418	.0135	.0874	.49	.416	.0130	.0846	.53	.415	.0139	.0845	.55	.425	.0156	.0858	.57
	12.0	.506	.0166	.1208	.52	.504	.0158	.1183	.47	.502	.0166	.1181	.49	.521	.0189	.1216	.55
	14.0	.597	.0202	.1619	.57	.595	.0186	.1594	.43	.598	.0199	.1604	.44	.622	.0226	.1660	.53
	16.0	.692	.0235	.2108	.62	.693	.0224	.2100	.42	.703	.0241	.2134	.41	.727	.0268	.2202	.49
	18.0	.796	.0280	.2708	.62	.803	.0277	.2721	.42	.816	.0294	.2770	.40	.840	.0328	.2847	.47

TABLE III.- SUMMARY OF RESULTS

Configuration	Basic airfoil: biconvex to c/3, t/c = 0.02	M	Roughness	R, million	βc_{l_α}		$\frac{dc_m}{dc_l}$		$c_{d_{min}}$		$\left(\frac{l}{d}\right)_{max}$		$c_{l_{opt}}$	
	h/t = 1.0, b/c = 0	1.45	Salt	3.5	4.03	(4.11)	0.004	(0.010)	0.0139	(0.0139)	8.8	(8.3)	0.26	(0.23)
		1.45	Clean	3.5	4.20	(4.11)	.004	(.010)	.0120	- - -	9.2	- - -	.23	- - -
		1.45	Clean	2.0	4.23	(4.11)	0	(.010)	.0113	- - -	9.3	- - -	.21	- - -
2		1.45	Clean	1.0	4.27	(4.11)	.001	(.010)	.0102	(.0077)	9.8	(11.3)	.21	(.17)
		1.98	Salt	3.5	3.97	(4.10)	.001	(.010)	.0104	(.0104)	7.6	(7.5)	.17	(.16)
		1.98	Clean	3.5	4.11	(4.10)	0	(.010)	.0082	- - -	8.6	- - -	.14	- - -
	A = 0.643 in.^{2}	1.98	Clean	2.0	4.02	(4.10)	.001	(.010)	.0071	- - -	9.1	- - -	.13	- - -
	I/(t/2) = 0.0118 in.^{3}	1.98	Clean	1.0	4.13	(4.10)	.002	(.010)	.0064	(.0054)	10.0	(10.5)	.12	(.11)
	h/t = 0.6, b/c = 0.05	1.45	Salt	3.5	3.88	(4.06)	.010	(.015)	.0117	(.0122)	9.2	(8.8)	.22	(.22)
		1.45	Clean	3.5	3.90	(4.06)	.006	(.015)	.0096	- - -	10.1	- - -	.20	- - -
		1.45	Clean	2.0	3.98	(4.06)	.007	(.015)	.0098	- - -	10.0	- - -	.20	- - -
7		1.45	Clean	1.0	4.07	(4.06)	.003	(.015)	.0099	(.0069)	10.7	(11.9)	.20	(.16)
		1.98	Salt	3.5	3.97	(4.06)	.006	(.014)	.0082	(.0092)	8.7	(8.0)	.15	(.15)
		1.98	Clean	3.5	3.76	(4.06)	.007	(.014)	.0064	- - -	9.7	- - -	.12	- - -
	A = 0.635 in.^{2}	1.98	Clean	2.0	3.97	(4.06)	.007	(.014)	.0057	- - -	10.6	- - -	.12	- - -
	I/(t/2) = 0.0115 in.^{3}	1.98	Clean	1.0	4.02	(4.06)	.011	(.014)	.0050	(.0052)	11.6	(10.7)	.11	(.11)
	h/t = 0.3, b/c = 0.05	1.45	Salt	3.5	4.00	(4.03)	.021	(.018)	.0095	(.0100)	10.6	(9.7)	.22	(.19)
		1.45	Clean	3.5	3.95	(4.03)	.015	(.018)	.0075	- - -	11.8	- - -	.15	- - -
		1.45	Clean	2.0	4.03	(4.03)	.016	(.018)	.0070	- - -	11.7	- - -	.17	- - -
8		1.45	Clean	1.0	4.13	(4.03)	.014	(.018)	.0077	(.0060)	12.5	(12.7)	.16	(.15)
		1.98	Salt	3.5	4.02	(4.03)	.011	(.017)	.0077	(.0078)	9.0	(8.6)	.13	(.13)
		1.98	Clean	3.5	4.02	(4.03)	.011	(.017)	.0053	- - -	11.3	- - -	.11	- - -
	A = 0.589 in.^{2}	1.98	Clean	2.0	4.00	(4.03)	.013	(.017)	.0041	- - -	12.4	- - -	.09	- - -
	I/(t/2) = 0.0096 in.^{3}	1.98	Clean	1.0	4.02	(4.03)	.018	(.017)	.0041	(.0046)	12.3	(11.3)	.10	(.10)
	h/t = 0, b/c = 0.05	1.45	Salt	3.5	4.06	(4.00)	.021	(.020)	.0075	(.0087)	11.3	(10.4)	.18	(.18)
		1.45	Clean	3.5	3.90	(4.00)	.019	(.020)	.0071	- - -	11.8	- - -	.17	- - -
		1.45	Clean	2.0	3.96	(4.00)	.021	(.020)	.0058	- - -	12.8	- - -	.14	- - -
9		1.45	Clean	1.0	3.79	(4.00)	.024	(.020)	.0052	(.0056)	13.4	(13.1)	.15	(.15)
		1.98	Salt	3.5	4.03	(4.00)	.018	(.020)	.0064	(.0069)	9.9	(9.1)	.12	(.13)
		1.98	Clean	3.5	3.92	(4.00)	.015	(.020)	.0047	- - -	11.6	- - -	.11	- - -
	A = 0.553 in.^{2}	1.98	Clean	2.0	3.96	(4.00)	.019	(.020)	.0040	- - -	12.7	- - -	.10	- - -
	I/(t/2) = 0.0087 in.^{3}	1.98	Clean	1.0	3.95	(4.00)	.024	(.020)	.0041	(.0044)	13.8	(11.5)	.09	(.10)
	h/t = 0.6, b/c = 0.33	1.45	Salt	3.5	4.00	(4.06)	.014	(.014)	.0109	(.0113)	9.6	(9.2)	.21	(.21)
		1.45	Clean	3.5	4.05	(4.06)	.011	(.014)	.0090	- - -	10.4	- - -	.18	- - -
		1.45	Clean	2.0	4.08	(4.06)	.010	(.014)	.0084	- - -	11.0	- - -	.18	- - -
10		1.45	Clean	1.0	4.11	(4.06)	.009	(.014)	.0082	(.0060)	11.4	(12.7)	.19	(.15)
		1.98	Salt	3.5	4.08	(4.06)	.008	(.013)	.0081	(.0086)	8.7	(8.2)	.14	(.14)
		1.98	Clean	3.5	4.05	(4.06)	.009	(.013)	.0063	- - -	9.9	- - -	.11	- - -
	A = 0.595 in.^{2}	1.98	Clean	2.0	4.11	(4.06)	.005	(.013)	.0056	- - -	10.6	- - -	.11	- - -
	I/(t/2) = 0.0096 in.^{3}	1.98	Clean	1.0	4.05	(4.06)	.009	(.013)	.0052	(.0046)	11.2	(11.4)	.11	(.10)
	h/t = 0.3, b/c = 0.33	1.45	Salt	3.5	3.95	(4.03)	.020	(.016)	.0084	(.0095)	10.9	(10.0)	.18	(.19)
		1.45	Clean	3.5	3.92	(4.03)	.015	(.016)	.0082	- - -	10.9	- - -	.18	- - -
		1.45	Clean	2.0	3.99	(4.03)	.015	(.016)	.0071	- - -	11.7	- - -	.15	- - -
11		1.45	Clean	1.0	4.01	(4.03)	.011	(.016)	.0064	(.0055)	12.5	(13.3)	.16	(.15)
		1.98	Salt	3.5	3.96	(4.03)	.013	(.016)	.0070	(.0074)	9.3	(8.9)	.12	(.13)
		1.98	Clean	3.5	3.86	(4.03)	.013	(.016)	.0053	- - -	10.6	- - -	.11	- - -
	A = 0.559 in.^{2}	1.98	Clean	2.0	3.98	(4.03)	.012	(.016)	.0050	- - -	11.3	- - -	.11	- - -
	I/(t/2) = 0.0087 in.^{3}	1.98	Clean	1.0	4.05	(4.03)	.016	(.016)	.0050	(.0043)	11.6	(11.7)	.13	(.10)
	h/t = 0, b/c = 0.33	1.45	Salt	3.5	3.99	(4.00)	.025	(.019)	.0068	(.0084)	11.9	(10.6)	.17	(.18)
		1.45	Clean	3.5	3.99	(4.00)	.020	(.019)	.0061	- - -	12.3	- - -	.15	- - -
		1.45	Clean	2.0	3.99	(4.00)	.021	(.019)	.0055	- - -	13.4	- - -	.14	- - -
12		1.45	Clean	1.0	4.00	(4.00)	.021	(.019)	.0042	(.0052)	14.4	(13.6)	.13	(.14)
		1.98	Salt	3.5	4.12	(4.00)	.016	(.018)	.0062	(.0067)	10.1	(9.3)	.13	(.12)
		1.98	Clean	3.5	4.00	(4.00)	.015	(.018)	.0046	- - -	11.5	- - -	.10	- - -
	A = 0.523 in.^{2}	1.98	Clean	2.0	4.10	(4.00)	.018	(.018)	.0042	- - -	11.8	- - -	.10	- - -
	I/(t/2) = 0.0082 in.^{3}	1.98	Clean	1.0	4.09	(4.00)	.018	(.018)	.0040	(.0042)	12.1	(11.8)	.09	(.10)

Note: Parentheses indicate theoretical values; upper half of airfoils shown.

TABLE III.- SUMMARY OF RESULTS - Continued

Configuration	Basic airfoil: biconvex to c/3 t/c = 0.04	M	Roughness	R, million	βc_{l_α}		$\frac{dc_m}{dc_l}$		$c_{d_{min}}$		$\left(\frac{l}{d}\right)_{max}$		$c_{l_{opt}}$	
	h/t = 1.0, b/c = 0	1.45	Salt	3.5	4.15	(4.21)	0.026	(0.020)	0.0258	(0.0261)	6.2	(6.1)	- - -	(0.32)
		1.45	Clean	3.5	4.17	(4.21)	.020	(.020)	.0235	- - -	6.6	- - -	0.31	- - -
		1.45	Clean	2.0	4.24	(4.21)	.025	(.020)	.0230	- - -	6.6	- - -	.32	- - -
3		1.45	Clean	1.0	4.39	(4.21)	.022	(.020)	.0222	(.0207)	6.9	(6.4)	- - -	(.29)
		1.98	Salt	3.5	4.03	(4.20)	.012	(.019)	.0179	(.0182)	5.8	(5.7)	.22	(.21)
		1.98	Clean	3.5	4.08	(4.20)	.012	(.019)	.0147	- - -	6.3	- - -	.19	- - -
	A = 1.285 in.^{2}	1.98	Clean	2.0	4.01	(4.20)	.012	(.019)	.0144	- - -	6.4	- - -	.19	- - -
	I/(t/2) = 0.0473 in.^{3}	1.98	Clean	1.0	4.00	(4.20)	.017	(.019)	.0140	(.0121)	6.4	(7.0)	.21	(.17)
	h/t = 0.6, b/c = 0.05	1.45	Salt	3.5	4.26	(4.13)	.035	(.030)	.0233	(.0245)	6.6	(6.2)	.35	(.31)
		1.45	Clean	3.5	4.20	(4.13)	.032	(.030)	.0210	- - -	6.8	- - -	.28	- - -
		1.45	Clean	2.0	4.07	(4.13)	.032	(.030)	.0192	- - -	6.9	- - -	.29	- - -
13		1.45	Clean	1.0	4.19	(4.13)	.039	(.030)	.0184	(.0181)	7.2	(7.4)	.30	(.27)
		1.98	Salt	3.5	4.00	(4.12)	.025	(.029)	.0159	(.0168)	6.1	(5.9)	.19	(.20)
		1.98	Clean	3.5	4.09	(4.12)	.021	(.029)	.0135	- - -	6.5	- - -	.18	- - -
	A = 1.271 in.^{2}	1.98	Clean	2.0	4.06	(4.12)	.024	(.029)	.0123	- - -	6.6	- - -	.18	- - -
	I/(t/2) = 0.0459 in.^{3}	1.98	Clean	1.0	4.11	(4.12)	.028	(.029)	.0114	(.0116)	7.1	(7.2)	.18	(.17)
	h/t = 0.3, b/c = 0.05	1.45	Salt	3.5	4.25	(4.06)	.041	(.035)	.0204	(.0207)	7.0	(6.8)	.32	(.28)
		1.45	Clean	3.5	4.16	(4.06)	.036	(.035)	.0178	- - -	7.5	- - -	.27	- - -
		1.45	Clean	2.0	4.15	(4.06)	.038	(.035)	.0161	- - -	7.6	- - -	.27	- - -
14		1.45	Clean	1.0	4.27	(4.06)	.048	(.035)	.0147	(.0151)	7.9	(8.0)	.28	(.24)
		1.98	Salt	3.5	4.13	(4.06)	.029	(.033)	.0137	(.0140)	6.6	(6.5)	.19	(.18)
		1.98	Clean	3.5	4.17	(4.06)	.025	(.033)	.0112	- - -	7.3	- - -	.17	- - -
	A = 1.178 in.^{2}	1.98	Clean	2.0	4.05	(4.06)	.030	(.033)	.0102	- - -	7.6	- - -	.17	- - -
	I/(t/2) = 0.0383 in.^{3}	1.98	Clean	1.0	3.99	(4.06)	.036	(.033)	.0089	(.0100)	8.0	(7.7)	.17	(.15)
	h/t = 0, b/c = 0.05	1.45	Salt	3.5	3.99	(4.00)	.058	(.041)	.0168	(.0187)	7.6	(7.1)	.28	(.27)
		1.45	Clean	3.5	3.98	(4.00)	.051	(.041)	.0156	- - -	7.8	- - -	.27	- - -
		1.45	Clean	2.0	3.99	(4.00)	.055	(.041)	.0146	- - -	8.0	- - -	.25	- - -
15		1.45	Clean	1.0	4.09	(4.00)	.063	(.041)	.0137	(.0152)	8.4	(8.0)	.25	(.24)
		1.98	Salt	3.5	4.02	(4.00)	.041	(.039)	.0121	(.0126)	7.0	(6.8)	.17	(.17)
		1.98	Clean	3.5	3.94	(4.00)	.038	(.039)	.0100	- - -	7.8	- - -	.16	- - -
	A = 1.106 in.^{2}	1.98	Clean	2.0	3.92	(4.00)	.041	(.039)	.0093	- - -	8.0	- - -	.15	- - -
	I/(t/2) = 0.0348 in.^{3}	1.98	Clean	1.0	3.92	(4.00)	.047	(.039)	.0088	(.0101)	8.4	(7.6)	.15	(.15)
	h/t = 0.6, b/c = 0.33	1.45	Salt	3.5	4.27	(4.13)	.035	(.027)	.0213	(.0211)	6.4	(6.7)	.33	(.29)
		1.45	Clean	3.5	4.01	(4.13)	.030	(.027)	.0181	- - -	7.3	- - -	.29	- - -
		1.45	Clean	2.0	4.16	(4.13)	.030	(.027)	.0175	- - -	7.4	- - -	.28	- - -
16		1.45	Clean	1.0	4.36	(4.13)	.033	(.027)	.0159	(.0147)	7.7	(8.2)	.30	(.24)
		1.98	Salt	3.5	4.25	(4.12)	.021	(.026)	.0147	(.0149)	6.0	(6.3)	.21	(.19)
		1.98	Clean	3.5	4.23	(4.12)	.019	(.026)	.0124	- - -	7.0	- - -	.19	- - -
	A = 1.189 in.^{2}	1.98	Clean	2.0	4.20	(4.12)	.021	(.026)	.0112	- - -	7.2	- - -	.17	- - -
	I/(t/2) = 0.0385 in.^{3}	1.98	Clean	1.0	4.24	(4.12)	.023	(.026)	.0102	(.0096)	7.5	(7.9)	.18	(.15)
	h/t = 0.3, b/c = 0.33	1.45	Salt	3.5	4.05	(4.06)	.044	(.033)	.0180	(.0184)	7.3	(7.2)	.29	(.27)
		1.45	Clean	3.5	3.95	(4.06)	.034	(.033)	.0165	- - -	7.6	- - -	.26	- - -
		1.45	Clean	2.0	4.10	(4.06)	.036	(.033)	.0157	- - -	7.6	- - -	.26	- - -
17		1.45	Clean	1.0	4.20	(4.06)	.037	(.033)	.0160	(.0133)	8.0	(8.6)	.26	(.23)
		1.98	Salt	3.5	4.05	(4.06)	.027	(.031)	.0126	(.0129)	6.9	(6.7)	.18	(.17)
		1.98	Clean	3.5	3.98	(4.06)	.024	(.031)	- - -	- - -	7.3	- - -	.18	- - -
	A = 1.117 in.^{2}	1.98	Clean	2.0	4.03	(4.06)	.027	(.031)	- - -	- - -	7.4	- - -	.17	- - -
	I/(t/2) = 0.0349 in.^{3}	1.98	Clean	1.0	4.16	(4.06)	.031	(.031)	- - -	(.0089)	7.7	(8.2)	.16	(.15)
	h/t = 0, b/c = 0.33	1.45	Salt	3.5	3.97	(4.00)	.058	(.038)	.0157	(.0165)	7.7	(7.5)	.27	(.25)
		1.45	Clean	3.5	3.97	(4.00)	.049	(.038)	.0149	- - -	8.0	- - -	.25	- - -
		1.45	Clean	2.0	4.06	(4.00)	.050	(.038)	.0139	- - -	8.3	- - -	.25	- - -
18		1.45	Clean	1.0	3.89	(4.00)	.065	(.038)	.0131	(.0136)	8.6	(8.4)	.24	(.23)
		1.98	Salt	3.5	4.07	(4.00)	.039	(.037)	.0118	(.0117)	7.2	(7.0)	.18	(.16)
		1.98	Clean	3.5	3.96	(4.00)	.035	(.037)	.0097	- - -	7.7	- - -	.16	- - -
	A = 1.045 in.^{2}	1.98	Clean	2.0	3.95	(4.00)	.040	(.037)	.0090	- - -	8.2	- - -	.16	- - -
	I/(t/2) = 0.0329 in.^{3}	1.98	Clean	1.0	3.67	(4.00)	.048	(.037)	.0086	(.0092)	8.3	(8.0)	.15	(.15)

Note: Parentheses indicate theoretical values; upper half of airfoils shown.

TABLE III.- SUMMARY OF RESULTS - Continued

Configur-ation	Basic airfoil: biconvex to c/3 t/c = 0.06	M	Rough-ness	R, million	βc_{l_α}		$\frac{dc_m}{dc_l}$		$c_{d_{min}}$		$\left(\frac{l}{d}\right)_{max}$		$c_{l_{opt}}$	
4	h/t = 1.0, b/c = 0	1.45	Salt	3.5	4.32	(4.32)	0.038	(0.029)	0.0451	(0.0428)	- - -	(4.8)	- - -	(0.42)
		1.45	Clean	3.5	4.29	(4.32)	.050	(.029)	.0414	- - -	- - -	- - -	- - -	- - -
		1.45	Clean	2.0	4.32	(4.32)	.049	(.029)	.0415	- - -	- - -	- - -	- - -	- - -
		1.45	Clean	1.0	4.42	(4.32)	.049	(.029)	.0417	(.0398)	- - -	(5.0)	- - -	(.41)
		1.98	Salt	3.5	4.30	(4.30)	.032	(.028)	.0286	(.0286)	4.4	(4.6)	0.28	(.27)
		1.98	Clean	3.5	4.17	(4.30)	.025	(.028)	.0255	- - -	4.8	- - -	.25	- - -
	A = 1.928 in.^{2}	1.98	Clean	2.0	4.21	(4.30)	.028	(.028)	.0255	- - -	4.8	- - -	.25	- - -
	I/(t/2) = 0.1063 in.^{3}	1.98	Clean	1.0	4.36	(4.30)	.030	(.028)	.0241	(.0230)	5.0	(5.1)	.25	(.24)
19	h/t = 0.6, b/c = 0.05	1.45	Salt	3.5	4.10	(4.20)	.055	(.044)	.0419	(.0424)	4.9	(4.8)	- - -	(.41)
		1.45	Clean	3.5	4.24	(4.20)	.061	(.044)	.0397	- - -	4.8	- - -	- - -	- - -
		1.45	Clean	2.0	4.03	(4.20)	.062	(.044)	.0363	- - -	4.9	- - -	- - -	- - -
		1.45	Clean	1.0	4.39	(4.20)	.066	(.044)	.0381	(.0370)	- - -	(5.2)	- - -	(.39)
		1.98	Salt	3.5	4.01	(4.18)	.046	(.042)	.0265	(.0276)	4.8	(4.6)	.26	(.26)
		1.98	Clean	3.5	4.06	(4.18)	.042	(.042)	.0242	- - -	5.2	- - -	.24	- - -
	A = 1.906 in.^{2}	1.98	Clean	2.0	4.18	(4.18)	.042	(.042)	.0239	- - -	4.9	- - -	.25	- - -
	I/(t/2) = 0.1033 in.^{3}	1.98	Clean	1.0	4.27	(4.18)	.049	(.042)	.0226	(.0220)	4.9	(5.2)	.26	(.23)
20	h/t = 0.3, b/c = 0.05	1.45	Salt	3.5	4.12	(4.10)	.073	(.052)	.0369	(.0362)	5.3	(5.1)	- - -	(.37)
		1.45	Clean	3.5	4.16	(4.10)	.073	(.052)	.0338	- - -	5.3	- - -	.37	- - -
		1.45	Clean	2.0	4.15	(4.10)	.077	(.052)	.0333	- - -	5.6	- - -	- - -	- - -
		1.45	Clean	1.0	4.29	(4.10)	.086	(.052)	.0326	(.0307)	5.6	(5.6)	- - -	(.35)
		1.98	Salt	3.5	4.08	(4.09)	.051	(.050)	.0229	(.0235)	5.1	(5.0)	.25	(.24)
		1.98	Clean	3.5	4.12	(4.09)	.049	(.050)	.0205	- - -	5.3	- - -	.23	- - -
	A = 1.767 in.^{2}	1.98	Clean	2.0	4.21	(4.09)	.052	(.050)	.0196	- - -	5.4	- - -	.21	- - -
	I/(t/2) = 0.0862 in.^{3}	1.98	Clean	1.0	4.17	(4.09)	.059	(.050)	.0186	(.0190)	5.5	(5.6)	.21	(.21)
21	h/t = 0, b/c = 0.05	1.45	Salt	3.5	3.90	(4.00)	.080	(.061)	.0341	(.0340)	5.4	(5.3)	- - -	(.36)
		1.45	Clean	3.5	3.95	(4.00)	.080	(.061)	.0308	- - -	5.5	- - -	- - -	- - -
		1.45	Clean	2.0	4.02	(4.00)	.082	(.061)	.0297	- - -	5.6	- - -	- - -	- - -
		1.45	Clean	1.0	4.10	(4.00)	.095	(.061)	.0295	(.0315)	5.8	(5.5)	- - -	(.35)
		1.98	Salt	3.5	3.99	(4.00)	.063	(.059)	.0217	(.0219)	5.2	(5.1)	- - -	(.22)
		1.98	Clean	3.5	3.74	(4.00)	.062	(.059)	.0180	- - -	5.5	- - -	- - -	- - -
	A = 1.659 in.^{2}	1.98	Clean	2.0	3.74	(4.00)	.064	(.059)	.0176	- - -	5.5	- - -	.21	- - -
	I/(t/2) = 0.0783 in.^{3}	1.98	Clean	1.0	3.85	(4.00)	.071	(.059)	.0174	(.0196)	5.7	(5.5)	.20	(.21)
22	h/t = 0.6, b/c = 0.33	1.45	Salt	3.5	4.18	(4.20)	.052	(.040)	.0378	(.0358)	5.3	(5.2)	- - -	(.38)
		1.45	Clean	3.5	4.18	(4.20)	.060	(.040)	.0334	- - -	5.5	- - -	- - -	- - -
		1.45	Clean	2.0	4.14	(4.20)	.062	(.040)	.0335	- - -	5.4	- - -	- - -	- - -
		1.45	Clean	1.0	4.27	(4.20)	.063	(.040)	.0330	(.0303)	- - -	(5.7)	- - -	(.35)
		1.98	Salt	3.5	4.15	(4.18)	.041	(.038)	.0234	(.0237)	5.0	(5.0)	.24	(.24)
		1.98	Clean	3.5	4.17	(4.18)	.038	(.038)	.0206	- - -	5.3	- - -	.23	- - -
	A = 1.784 in.^{2}	1.98	Clean	2.0	4.35	(4.18)	.037	(.038)	.0205	- - -	5.3	- - -	.22	- - -
	I/(t/2) = 0.0867 in.^{3}	1.98	Clean	1.0	4.30	(4.18)	.039	(.038)	.0194	(.0180)	5.5	(5.8)	.22	(.21)
23	h/t = 0.3, b/c = 0.33	1.45	Salt	3.5	4.08	(4.10)	.065	(.048)	.0354	(.0326)	5.4	(5.4)	- - -	(.35)
		1.45	Clean	3.5	4.15	(4.10)	.073	(.048)	.0314	- - -	5.5	- - -	- - -	- - -
		1.45	Clean	2.0	4.12	(4.10)	.073	(.048)	.0298	- - -	5.6	- - -	- - -	- - -
		1.45	Clean	1.0	4.35	(4.10)	.078	(.048)	.0302	(.0271)	- - -	(6.0)	- - -	(.33)
		1.98	Salt	3.5	4.12	(4.09)	.049	(.047)	.0214	(.0214)	5.3	(5.2)	.24	(.22)
		1.98	Clean	3.5	4.05	(4.09)	.046	(.047)	.0183	- - -	5.6	- - -	.21	- - -
	A = 1.676 in.^{2}	1.98	Clean	2.0	4.16	(4.09)	.049	(.047)	.0182	- - -	5.5	- - -	.21	- - -
	I/(t/2) = 0.0785 in.^{3}	1.98	Clean	1.0	4.11	(4.09)	.056	(.047)	.0180	(.0168)	5.8	(5.9)	.21	(.20)
24	h/t = 0, b/c = 0.33	1.45	Salt	3.5	3.97	(4.00)	.075	(.058)	.0324	(.0310)	5.5	(5.5)	- - -	(.34)
		1.45	Clean	3.5	4.04	(4.00)	.076	(.058)	.0299	- - -	5.6	- - -	- - -	- - -
		1.45	Clean	2.0	- - -	(4.00)	- - -	(.058)	- - -	- - -	- - -	- - -	- - -	- - -
		1.45	Clean	1.0	4.09	(4.00)	.095	(.058)	.0301	(.0284)	5.8	(5.8)	- - -	(.33)
		1.98	Salt	3.5	3.94	(4.00)	.063	(.055)	.0204	(.0202)	5.2	(5.3)	.22	(.22)
		1.98	Clean	3.5	4.01	(4.00)	.055	(.055)	.0185	- - -	5.6	- - -	.22	- - -
	A = 1.568 in.^{2}	1.98	Clean	2.0	3.93	(4.00)	.058	(.055)	.0180	- - -	5.5	- - -	.21	- - -
	I/(t/2) = 0.0740 in.^{3}	1.98	Clean	1.0	3.83	(4.00)	.065	(.055)	.0177	(.0178)	5.8	(5.7)	.22	(.20)

Note: Parentheses indicate theoretical values; upper half of airfoils shown.

TABLE III.- SUMMARY OF RESULTS - Continued

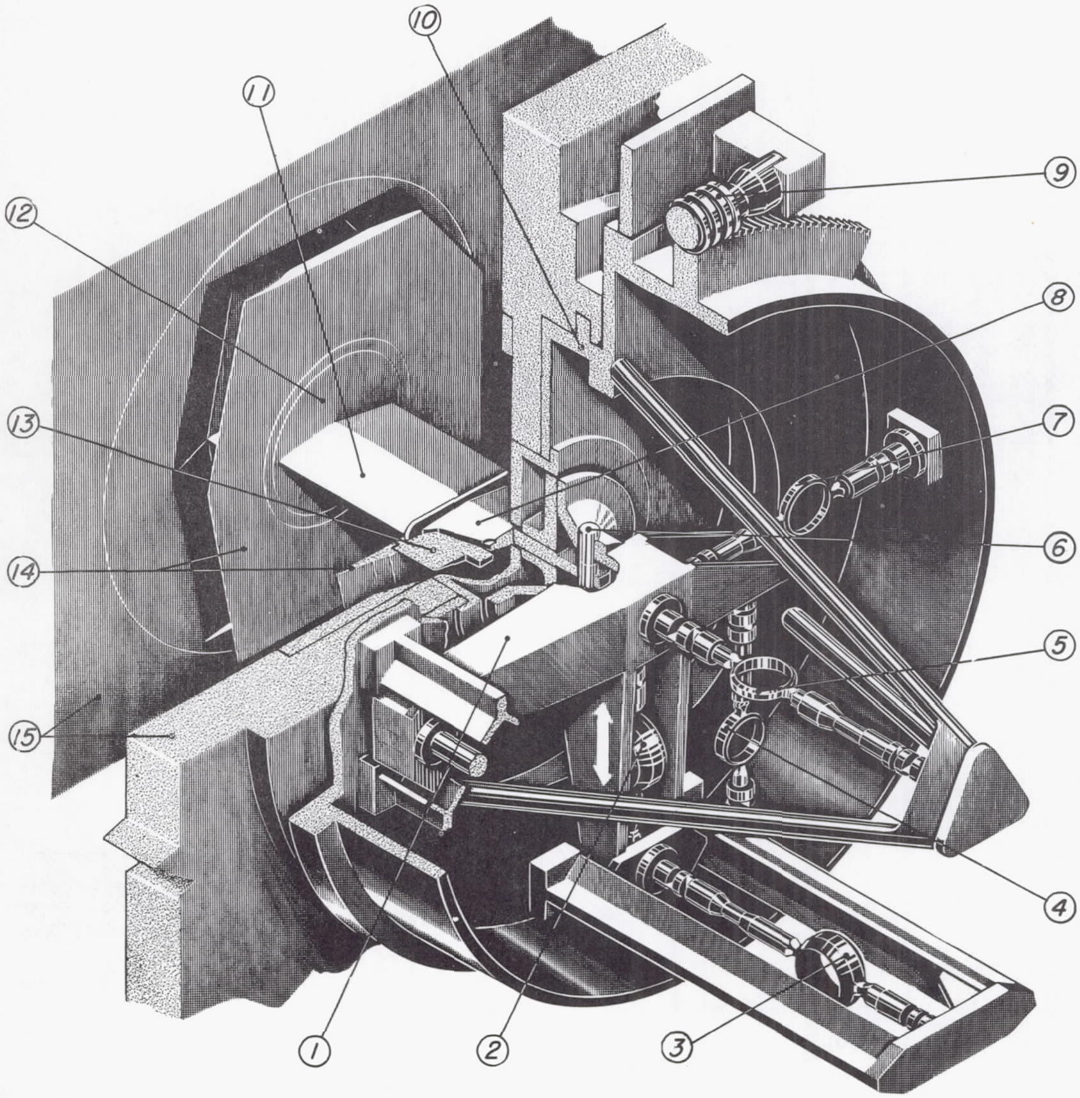
Configuration	Basic airfoil: biconvex to c/2 t/c = 0.04	M	Roughness	R, million	βc_{l_α}		$\frac{dc_m}{dc_l}$		$c_{d_{min}}$		$\left(\frac{l}{d}\right)_{max}$		$c_{l_{opt}}$	
5	h/t = 1.0, b/c = 0	1.45	Salt	3.5	4.24	(4.21)	0.015	(0.017)	0.0234	(0.0235)	6.5	(6.4)	0.35	(0.31)
		1.45	Clean	3.5	4.10	(4.21)	.009	(.017)	.0218	- - -	6.8	- - -	.31	- - -
		1.45	Clean	2.0	4.02	(4.21)	.012	(.017)	.0212	- - -	6.9	- - -	.32	(.27)
		1.45	Clean	1.0	4.22	(4.21)	.016	(.017)	.0198	(.0180)	- - -	(7.4)	- - -	- - -
		1.98	Salt	3.5	4.17	(4.20)	.009	(.016)	.0164	(.0168)	6.2	(5.9)	.21	(.20)
		1.98	Clean	3.5	4.15	(4.20)	.008	(.016)	.0142	- - -	6.3	- - -	.19	- - -
	A = 1.202 in.^{2}	1.98	Clean	2.0	4.07	(4.20)	.012	(.016)	.0138	- - -	6.5	- - -	.19	- - -
	I/(t/2) = 0.0421 in.^{3}	1.98	Clean	1.0	4.03	(4.20)	.014	(.016)	.0123	(.0106)	6.8	(7.5)	.19	(.16)
25	h/t = 0.6, b/c = 0.05	1.45	Salt	3.5	4.18	(4.13)	.028	(.027)	.0206	(.0220)	6.8	(6.6)	.32	(.29)
		1.45	Clean	3.5	4.12	(4.13)	.021	(.027)	.0191	- - -	7.1	- - -	.28	- - -
		1.45	Clean	2.0	4.08	(4.13)	.023	(.027)	.0176	- - -	7.3	- - -	.27	- - -
		1.45	Clean	1.0	4.20	(4.13)	.026	(.027)	.0160	(.0155)	7.6	(7.9)	.28	(.25)
		1.98	Salt	3.5	4.14	(4.12)	.019	(.026)	.0146	(.0154)	6.4	(6.2)	.21	(.19)
		1.98	Clean	3.5	4.09	(4.12)	.021	(.026)	.0121	- - -	7.0	- - -	.17	- - -
	A = 1.188 in.^{2}	1.98	Clean	2.0	4.05	(4.12)	.021	(.026)	.0120	- - -	6.9	- - -	.17	- - -
	I/(t/2) = 0.0407 in.^{3}	1.98	Clean	1.0	4.06	(4.12)	.024	(.026)	.0119	(.0101)	7.0	(7.7)	.18	(.16)
26	h/t = 0.3, b/c = 0.05	1.45	Salt	3.5	3.94	(4.06)	.034	(.030)	.0167	(.0172)	7.6	(7.4)	.30	(.26)
		1.45	Clean	3.5	3.96	(4.06)	.028	(.030)	.0136	- - -	8.4	- - -	.24	- - -
		1.45	Clean	2.0	3.98	(4.06)	.031	(.030)	.0121	- - -	8.4	- - -	.23	- - -
		1.45	Clean	1.0	4.05	(4.06)	.034	(.030)	.0120	(.0121)	8.6	(9.0)	.24	(.22)
		1.98	Salt	3.5	3.96	(4.06)	.022	(.029)	.0119	(.0123)	7.1	(6.9)	.19	(.17)
		1.98	Clean	3.5	3.86	(4.06)	.023	(.029)	.0090	- - -	7.8	- - -	.15	- - -
	A = 1.047 in.^{2}	1.98	Clean	2.0	4.02	(4.06)	.031	(.029)	.0093	- - -	7.8	- - -	.14	- - -
	I/(t/2) = 0.0286 in.^{3}	1.98	Clean	1.0	4.02	(4.06)	.031	(.029)	.0106	(.0082)	7.3	(8.5)	.16	(.14)
27	h/t = 0, b/c = 0.05	1.45	Salt	3.5	3.91	(4.00)	.044	(.035)	.0128	(.0144)	8.6	(8.1)	.22	(.23)
		1.45	Clean	3.5	3.88	(4.00)	.037	(.035)	.0125	- - -	8.8	- - -	.22	- - -
		1.45	Clean	2.0	3.94	(4.00)	.042	(.035)	.0117	- - -	9.1	- - -	.20	- - -
		1.45	Clean	1.0	4.08	(4.00)	.053	(.035)	.0102	(.0115)	9.8	(9.2)	.19	(.21)
		1.98	Salt	3.5	3.88	(4.00)	.036	(.033)	.0098	(.0104)	8.0	(7.4)	.15	(.15)
		1.98	Clean	3.5	3.96	(4.00)	.033	(.033)	.0083	- - -	8.6	- - -	.13	- - -
	A = 0.939 in.^{2}	1.98	Clean	2.0	3.95	(4.00)	.037	(.033)	.0069	- - -	9.3	- - -	.12	- - -
	I/(t/2) = 0.0234 in.^{3}	1.98	Clean	1.0	3.89	(4.00)	- - -	(.033)	.0067	(.0079)	9.3	(8.6)	.14	(.14)
28	h/t = 0.6, b/c = 0.50	1.45	Salt	3.5	4.22	(4.13)	.024	(.022)	.0195	(.0184)	6.6	(7.2)	.33	(.27)
		1.45	Clean	3.5	4.10	(4.13)	.023	(.022)	.0150	- - -	8.0	- - -	.25	- - -
		1.45	Clean	2.0	4.14	(4.13)	.021	(.022)	.0145	- - -	8.0	- - -	.25	- - -
		1.45	Clean	1.0	4.22	(4.13)	.022	(.022)	.0141	(.0119)	8.2	(9.1)	.28	(.22)
		1.98	Salt	3.5	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
		1.98	Clean	3.5	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
	A = 1.058 in.^{2}	1.98	Clean	2.0	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
	I/(t/2) = 0.0289 in.^{3}	1.98	Clean	1.0	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
29	h/t = 0.3, b/c = 0.50	1.45	Salt	3.5	3.91	(4.06)	.032	(.027)	.0157	(.0152)	7.8	(7.9)	.27	(.24)
		1.45	Clean	3.5	3.85	(4.06)	.027	(.027)	.0142	- - -	8.1	- - -	.25	- - -
		1.45	Clean	2.0	4.02	(4.06)	.030	(.027)	.0133	- - -	8.4	- - -	.24	- - -
		1.45	Clean	1.0	4.10	(4.06)	.032	(.027)	.0127	(.0101)	8.8	(9.8)	- - -	(.20)
		1.98	Salt	3.5	3.92	(4.06)	.020	(.025)	.0112	(.0111)	7.3	(7.2)	.18	(.16)
		1.98	Clean	3.5	4.01	(4.06)	.018	(.025)	.0092	- - -	7.9	- - -	.15	- - -
	A = 0.950 in.^{2}	1.98	Clean	2.0	4.09	(4.06)	.020	(.025)	.0089	- - -	8.3	- - -	.15	- - -
	I/(t/2) = 0.0235 in.^{3}	1.98	Clean	1.0	4.01	(4.06)	.022	(.025)	.0081	(.0071)	8.5	(9.1)	.15	(.13)
30	h/t = 0, b/c = 0.50	1.45	Salt	3.5	3.87	(4.00)	.042	(.031)	.0119	(.0129)	8.8	(8.5)	.21	(.22)
		1.45	Clean	3.5	3.76	(4.00)	.036	(.031)	.0105	- - -	9.4	- - -	.20	- - -
		1.45	Clean	2.0	3.77	(4.00)	.036	(.031)	.0095	- - -	9.9	- - -	.20	- - -
		1.45	Clean	1.0	3.79	(4.00)	.045	(.031)	.0093	(.0099)	10.1	(9.9)	.19	(.20)
		1.98	Salt	3.5	3.91	(4.00)	.031	(.030)	.0093	(.0095)	8.1	(7.8)	.14	(.15)
		1.98	Clean	3.5	3.89	(4.00)	.026	(.030)	.0067	- - -	9.4	- - -	.12	- - -
	A = 0.842 in.^{2}	1.98	Clean	2.0	3.94	(4.00)	.030	(.030)	.0062	- - -	9.8	- - -	.11	- - -
	I/(t/2) = 0.0204 in.^{3}	1.98	Clean	1.0	3.75	(4.00)	.035	(.030)	.0064	(.0070)	9.6	(9.1)	.12	(.13)

Note: Parentheses indicate theoretical values; upper half of airfoils shown.

TABLE III.- SUMMARY OF RESULTS - Concluded

Configuration	Airfoil	M	Roughness	R, million	βc_{l_α}		$\frac{dc_m}{dc_l}$		$c_{d_{min}}$		$\left(\frac{l}{d}\right)_{max}$		$c_{l_{opt}}$	
	Biconvex, t/c = 0.04,	1.45	Salt	3.5	3.96	(4.00)	0.040	(0.035)	0.0121	(0.0138)	8.8	(8.2)	0.22	(0.23)
		1.45	Clean	3.5	3.92	(4.00)	.038	(.035)	.0114	- - -	9.1	- - -	.21	- - -
		1.45	Clean	2.0	3.86	(4.00)	.041	(.035)	.0108	- - -	9.3	- - -	.20	- - -
1		1.45	Clean	1.0	3.80	(4.00)	.045	(.035)	.0095	- - -	9.7	(9.4)	.20	(.20)
		1.98	Salt	3.5	3.92	(4.00)	.031	(.034)	.0095	(.0101)	8.0	(7.6)	.15	(.15)
		1.98	Clean	3.5	3.96	(4.00)	.032	(.034)	.0071	- - -	9.1	- - -	.13	- - -
	A = 0.964 in.^{2}	1.98	Clean	2.0	3.96	(4.00)	.035	(.034)	.0071	- - -	9.4	- - -	.13	- - -
	I/(t/2) = 0.0265 in.^{3}	1.98	Clean	1.0	3.87	(4.00)	.039	(.034)	.0068	(.0076)	9.7	(8.8)	.13	(.13)
	NACA 16-004, h/t = 0	1.45	Salt	3.5	3.92	(4.00)	.044	(.039)	.0179	(.0184)	7.2	(7.1)	.32	(.26)
		1.45	Clean	3.5	3.83	(4.00)	.039	(.039)	.0153	- - -	7.7	- - -	.26	- - -
		1.45	Clean	2.0	3.92	(4.00)	.042	(.039)	.0150	- - -	7.8	- - -	.26	- - -
6		1.45	Clean	1.0	3.73	(4.00)	.047	(.039)	.0145	(.0155)	8.0	(7.9)	.27	(.24)
		1.98	Salt	3.5	3.87	(4.00)	.036	(.038)	.0144	(.0155)	6.4	(6.1)	.20	(.19)
		1.98	Clean	3.5	3.95	(4.00)	.040	(.038)	.0116	- - -	7.0	- - -	.16	- - -
	A = 1.069 in.^{2}	1.98	Clean	2.0	3.93	(4.00)	.040	(.038)	.0115	- - -	6.9	- - -	.17	- - -
	I/(t/2) = 0.0311 in.^{3}	1.98	Clean	1.0	4.13	(4.00)	.043	(.038)	.0123	(.0130)	6.6	(6.7)	.19	(.17)
	NACA 16-004, h/t = 0.3	1.45	Salt	3.5	4.06	(4.06)	.030	(.032)	.0207	(.0196)	6.9	(6.9)	.34	(.27)
		1.45	Clean	3.5	3.91	(4.06)	.026	(.032)	.0174	- - -	7.5	- - -	.26	- - -
		1.45	Clean	2.0	4.04	(4.06)	.028	(.032)	.0169	- - -	7.6	- - -	.27	- - -
31		1.45	Clean	1.0	4.06	(4.06)	.030	(.032)	.0168	(.0146)	7.8	(8.1)	.28	(.24)
		1.98	Salt	3.5	3.96	(4.06)	.030	(.031)	.0154	(.0168)	6.3	(5.9)	.20	(.20)
		1.98	Clean	3.5	4.01	(4.06)	.028	(.031)	.0125	- - -	7.0	- - -	.17	- - -
	A = 1.102 in.^{2}	1.98	Clean	2.0	4.08	(4.06)	.030	(.031)	.0124	- - -	7.0	- - -	.17	- - -
	I/(t/2) = 0.0313 in.^{3}	1.98	Clean	1.0	4.05	(4.06)	.033	(.031)	.0124	(.0128)	7.3	(6.8)	.17	(.17)

Note: Parentheses indicate theoretical values; upper half of airfoils shown.



1.- Floating beam
2.- Normal-force gage
3.- Rolling-moment gage
4.- Pitching-moment gage
5.- Side-force gage
6.- Pin connecting model Shank to floating beam
7.- Chord-force gage
8.- Model shank
9.- Worm-gear drive mechanism
10.- Balance housing
11.- Two-dimensional model
12.- Rotating circular plate
13.- Fairing
14.- Boundary-layer plates
15.- Main tunnel walls

Figure 1.- Side-support balance with a typical two-dimensional model installation.

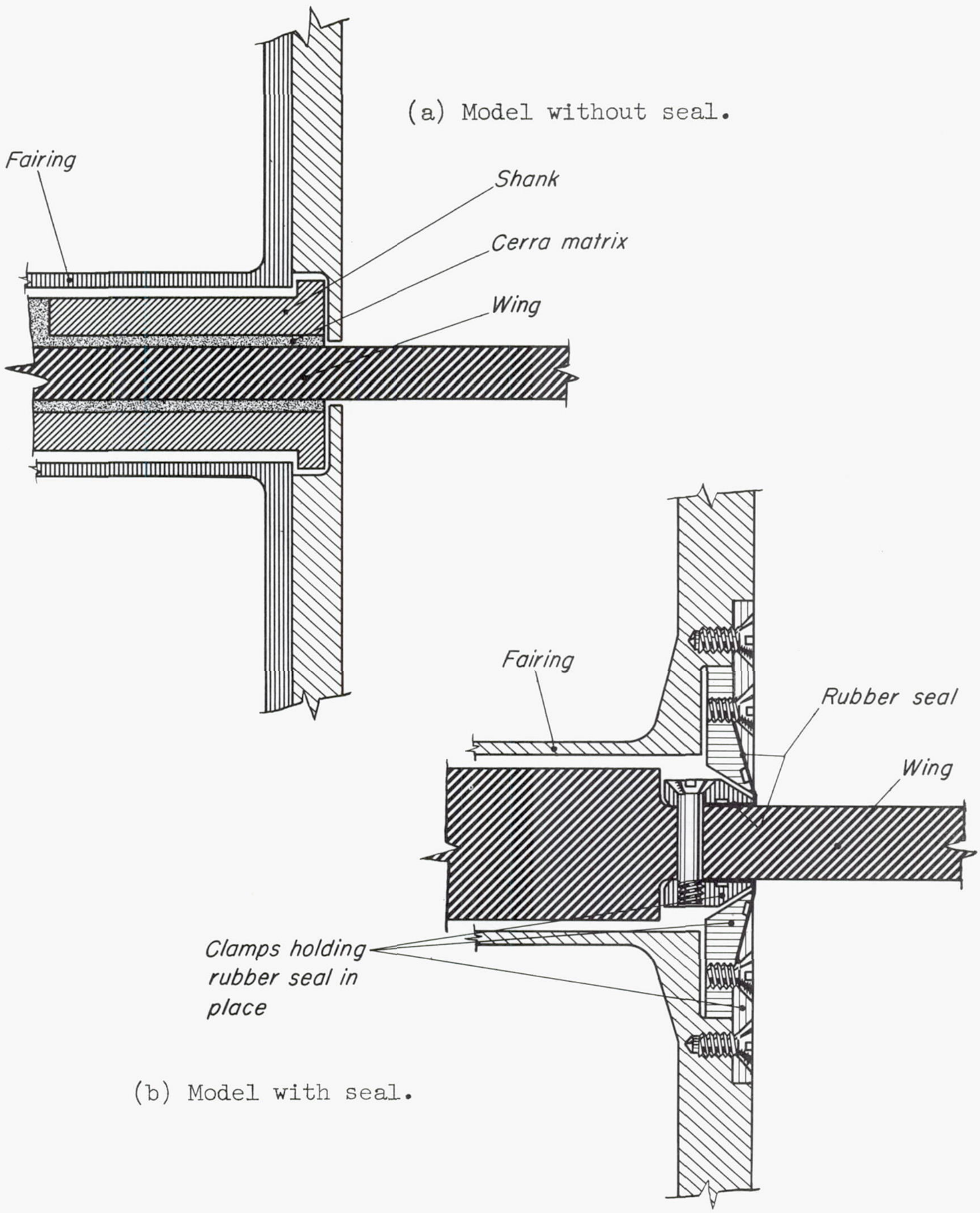


Figure 2.- Details of the junction between the wing and the boundary-layer plate.

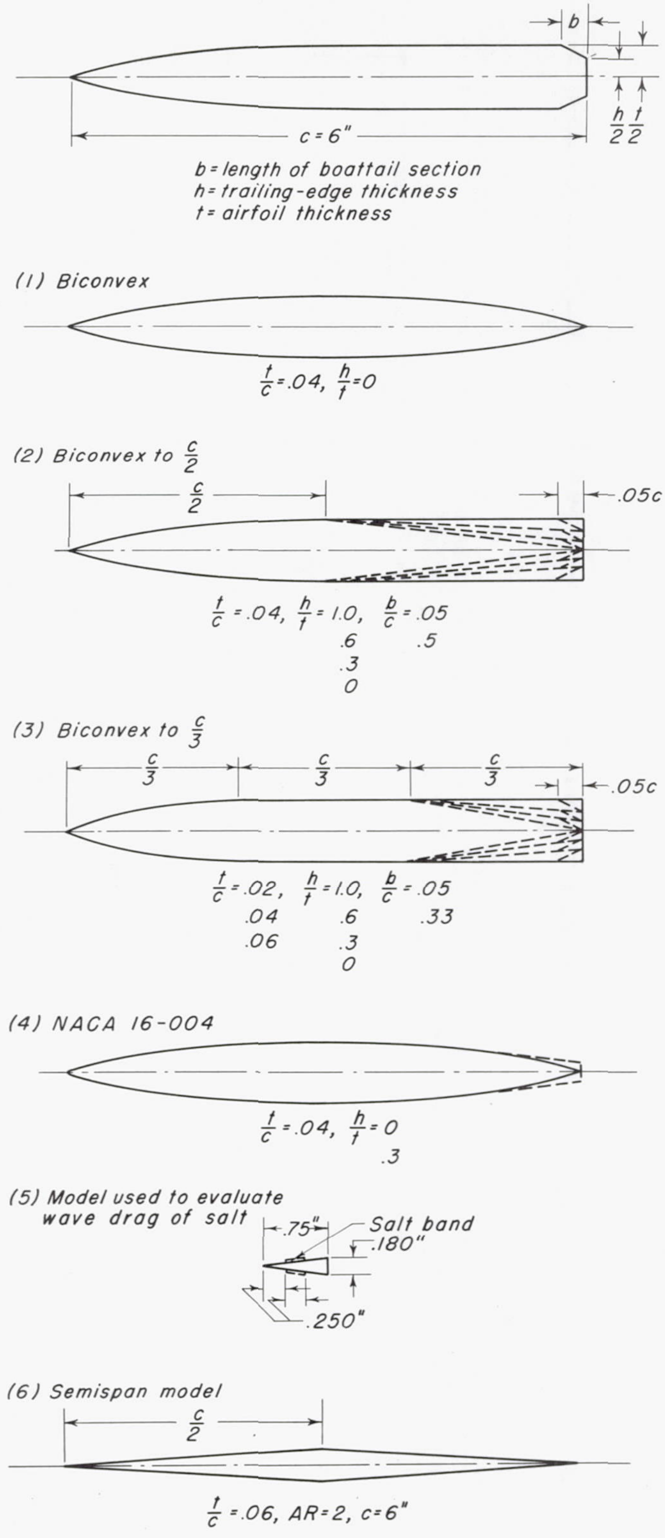
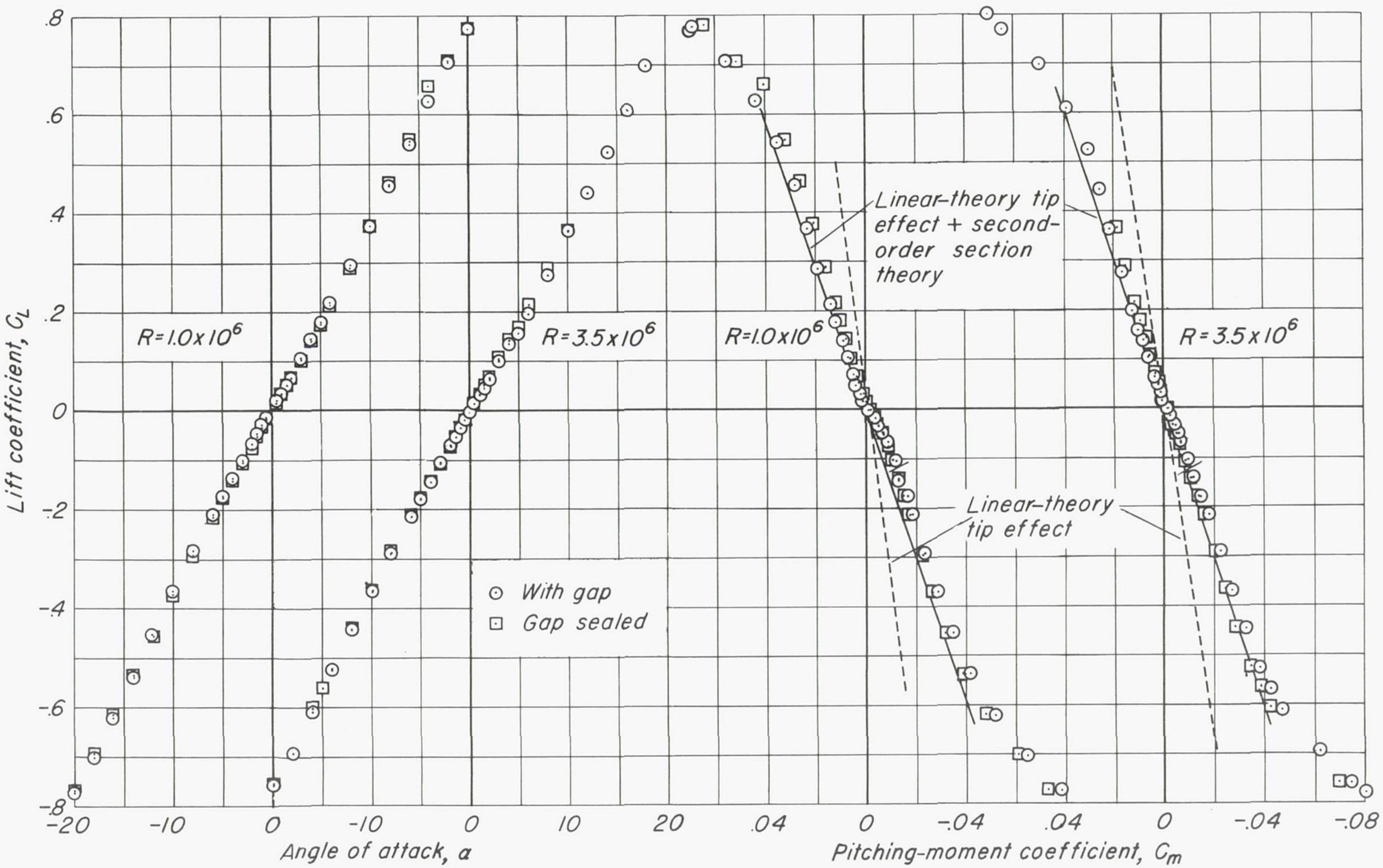
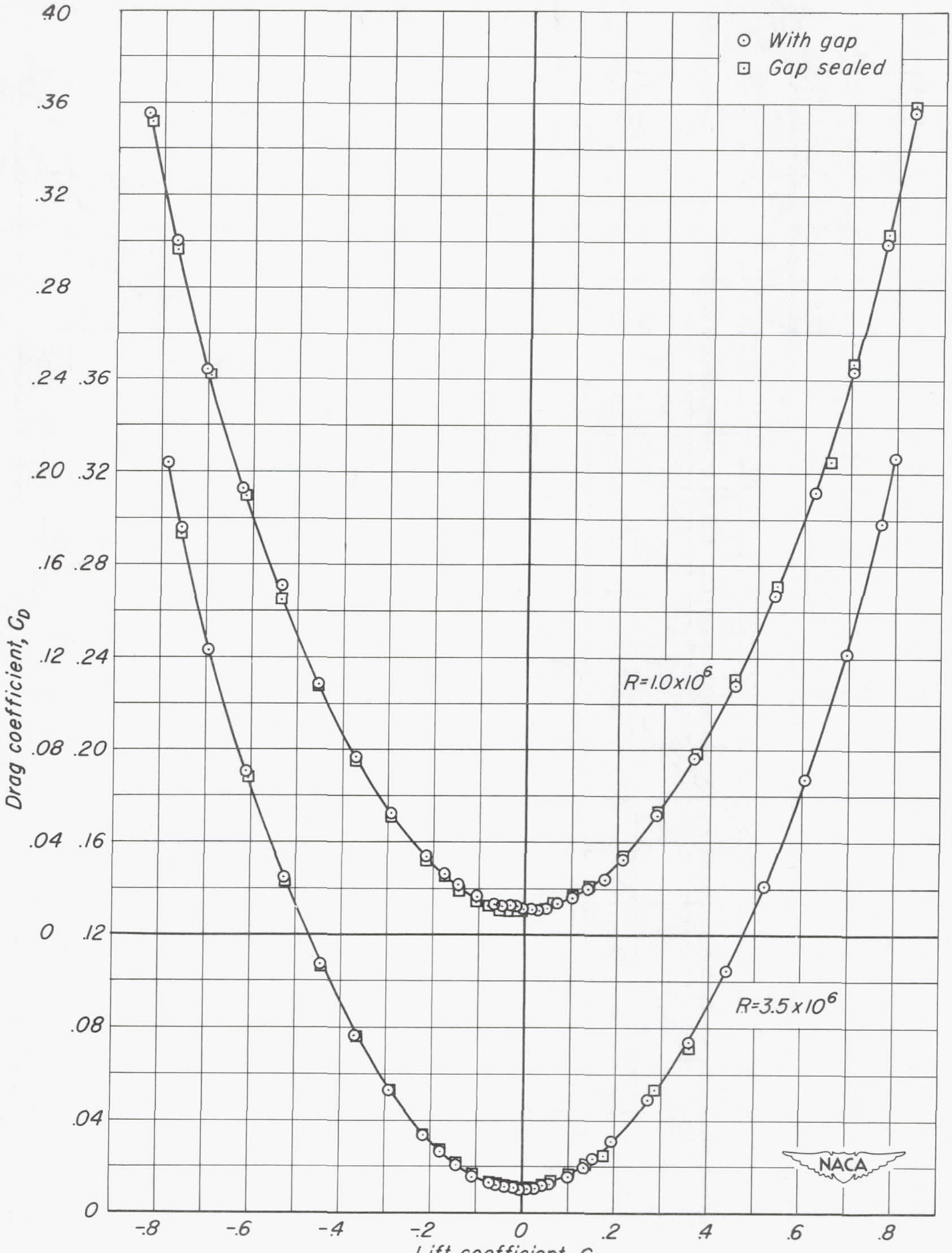


Figure 3.- Method of designating airfoils and summary sketch of models (not to scale).



(a) Effect of gap on lift and pitching moment.

Figure 4.- Effect of gap on lift, drag, and pitching moment of semispan model; M = 1.98.



(b) Effect of gap on drag.

Figure 4.- Concluded.

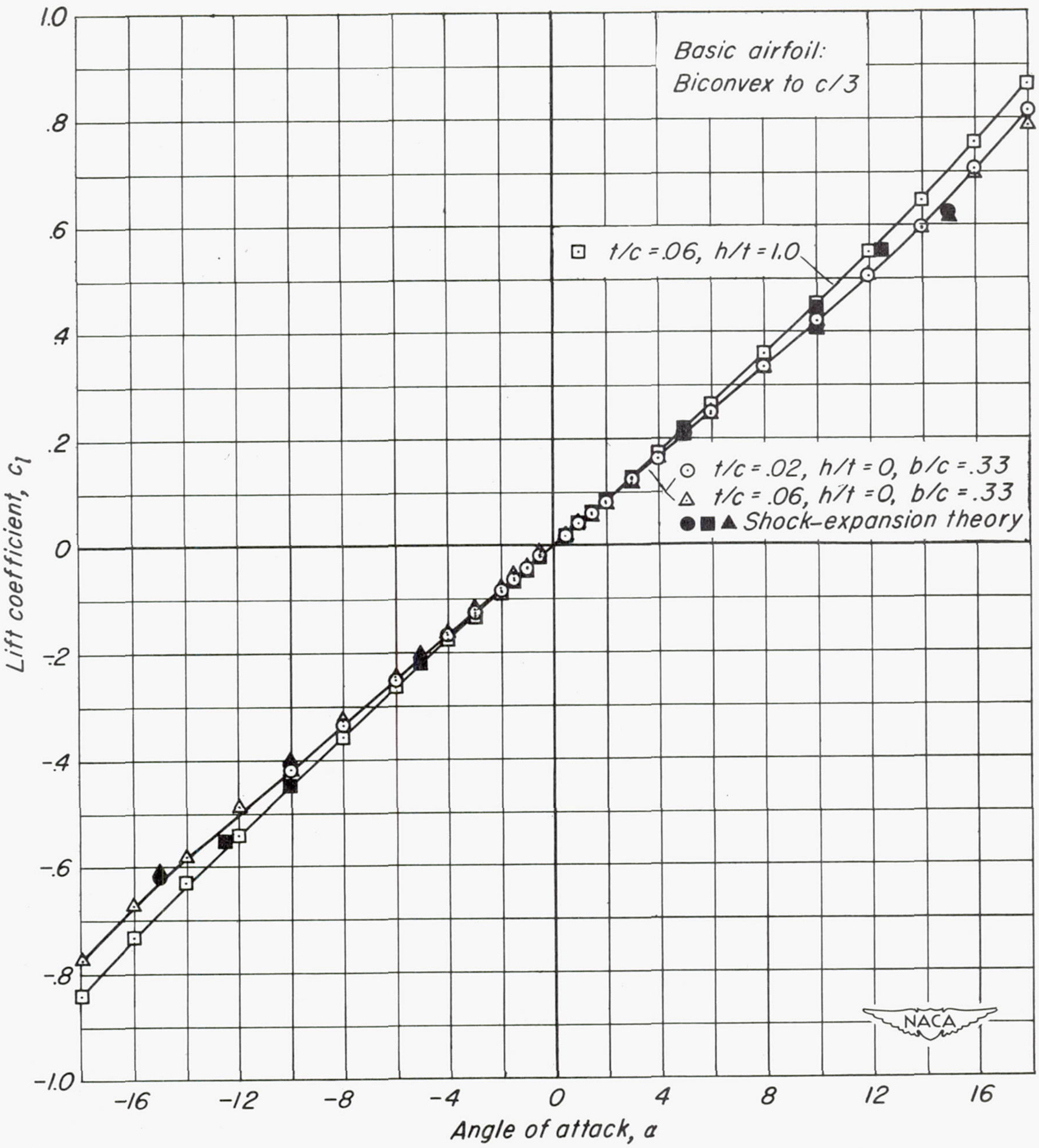
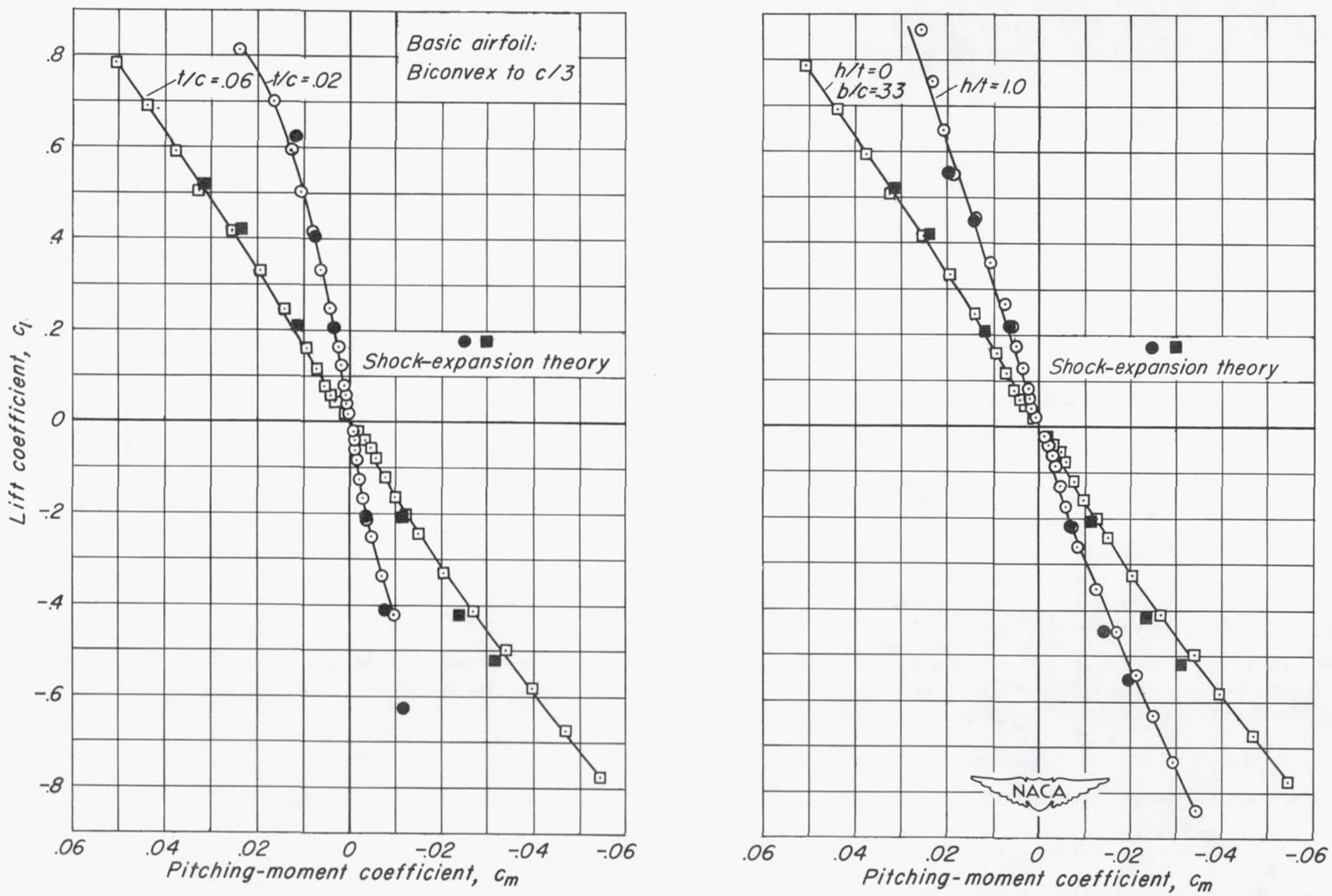


Figure 5.- Typical variations of lift coefficient with angle of attack; M = 1.98, transition fixed, R=3.5×10^6.



(a) Thickness effect; h/t = 0, b/c = 0.33. (b) Trailing-edge bluntness effect; t/c = 0.06.

Figure 6.- Typical variations of pitching-moment coefficient with lift coefficient; M = 1.98, transition fixed, $R=3.5 \times 10^6$.

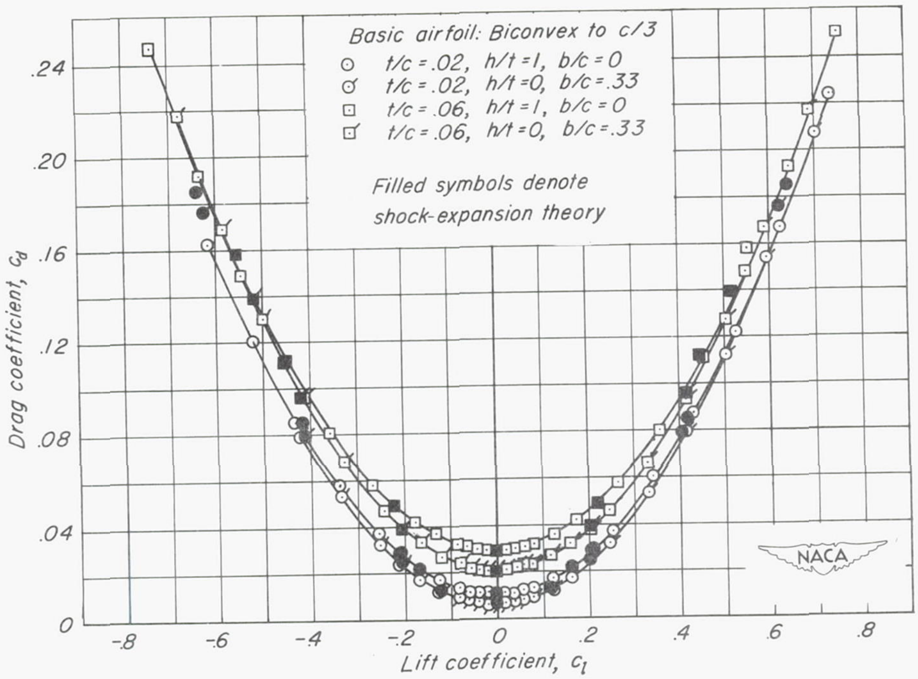


Figure 7.- Typical drag curves; M = 1.98, transition fixed, $R=3.5\times10^6$.

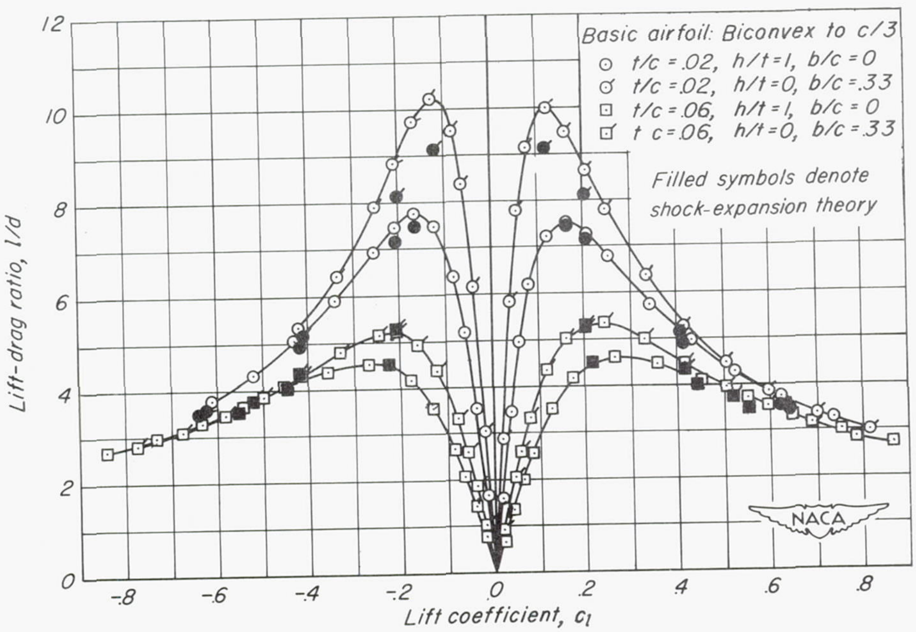


Figure 8.- Typical lift-drag ratio curves; M = 1.98, transition fixed, $R=3.5\times10^6$.

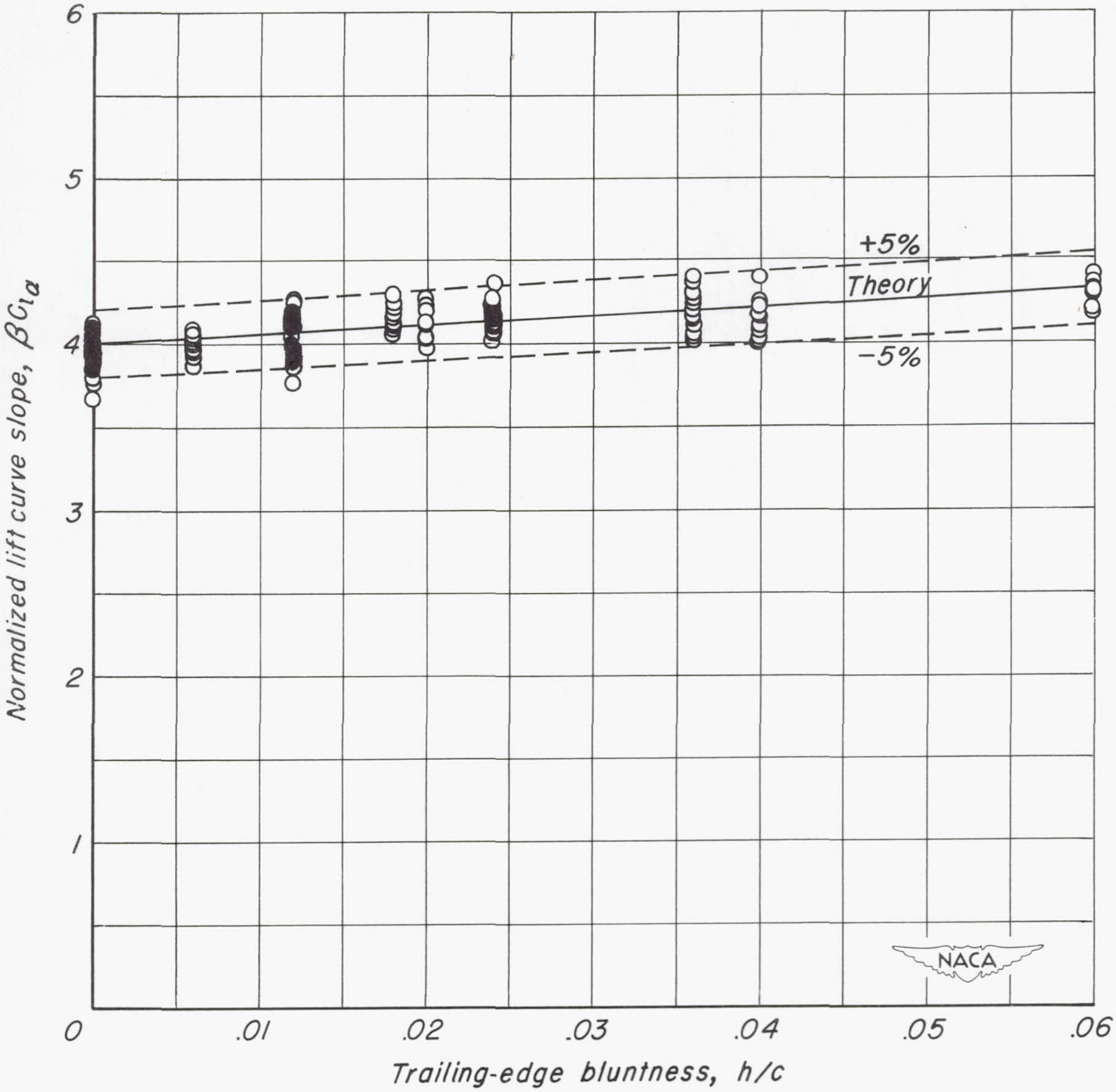
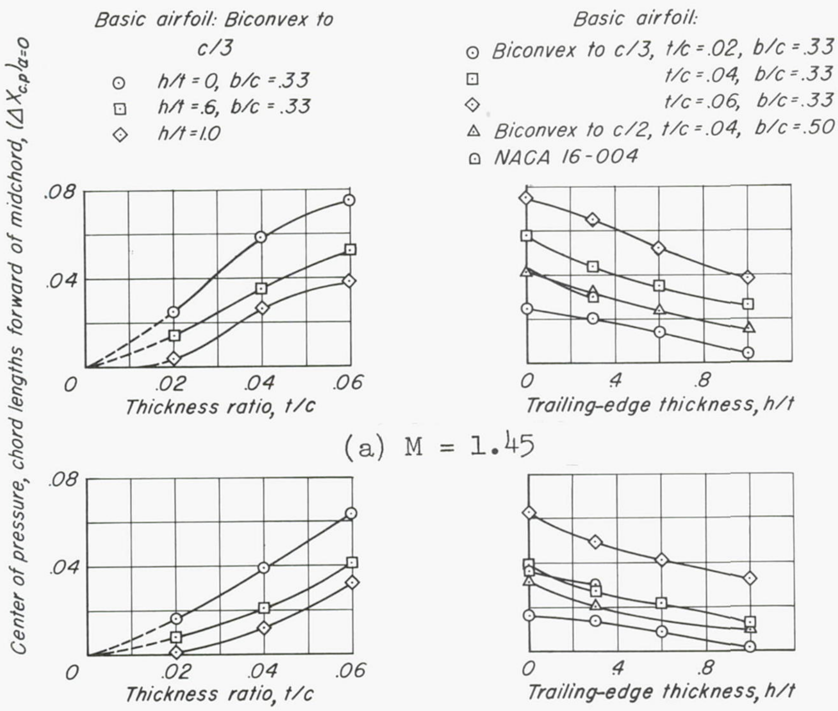


Figure 9.- Variation of lift-curve slope with trailing-edge bluntness for all models tested; R = 1.0, 2.0, and 3.5 million, M = 1.45 and 1.98.



(a) M = 1.45

(b) M = 1.98

Figure 10.- Variation of center-of-pressure location with thickness ratio and trailing-edge thickness; transition fixed, $R=3.5\times10^6$.

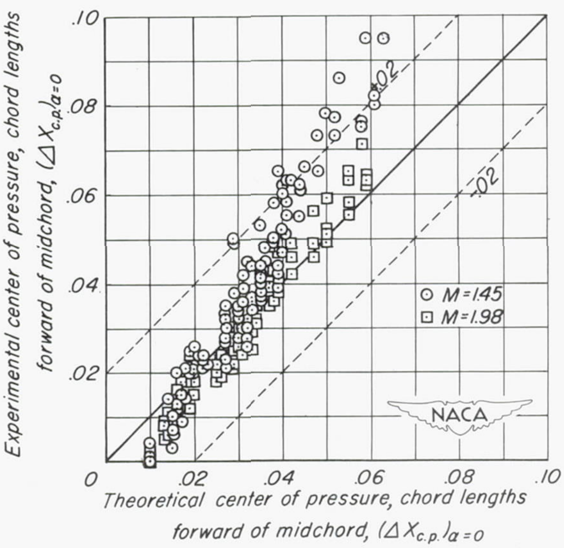
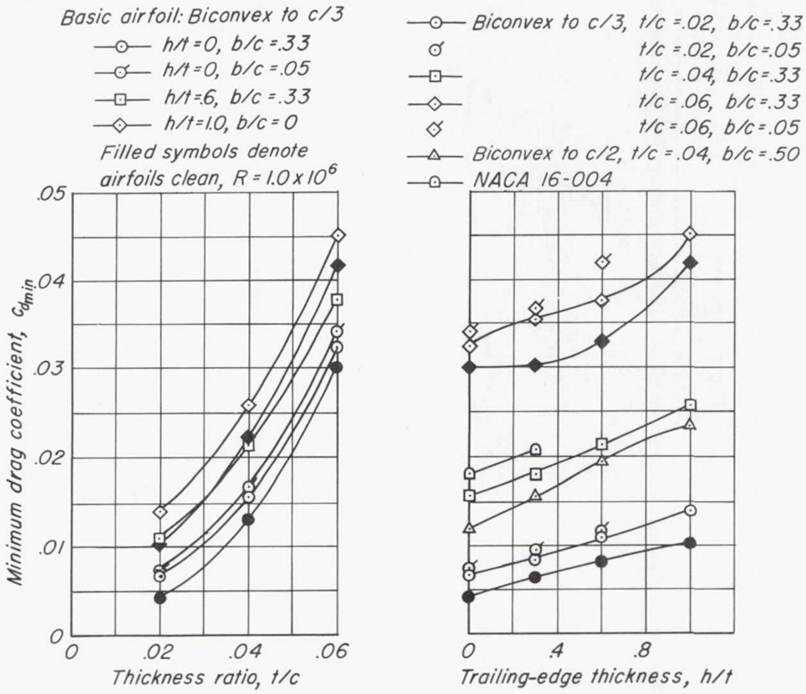
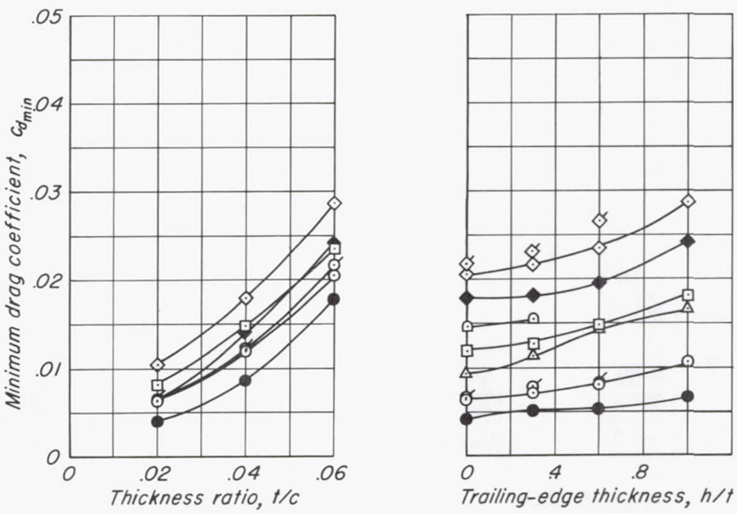


Figure 11.- Correlation between theoretical and experimental center-of-pressure locations for all the airfoils and Reynolds numbers.

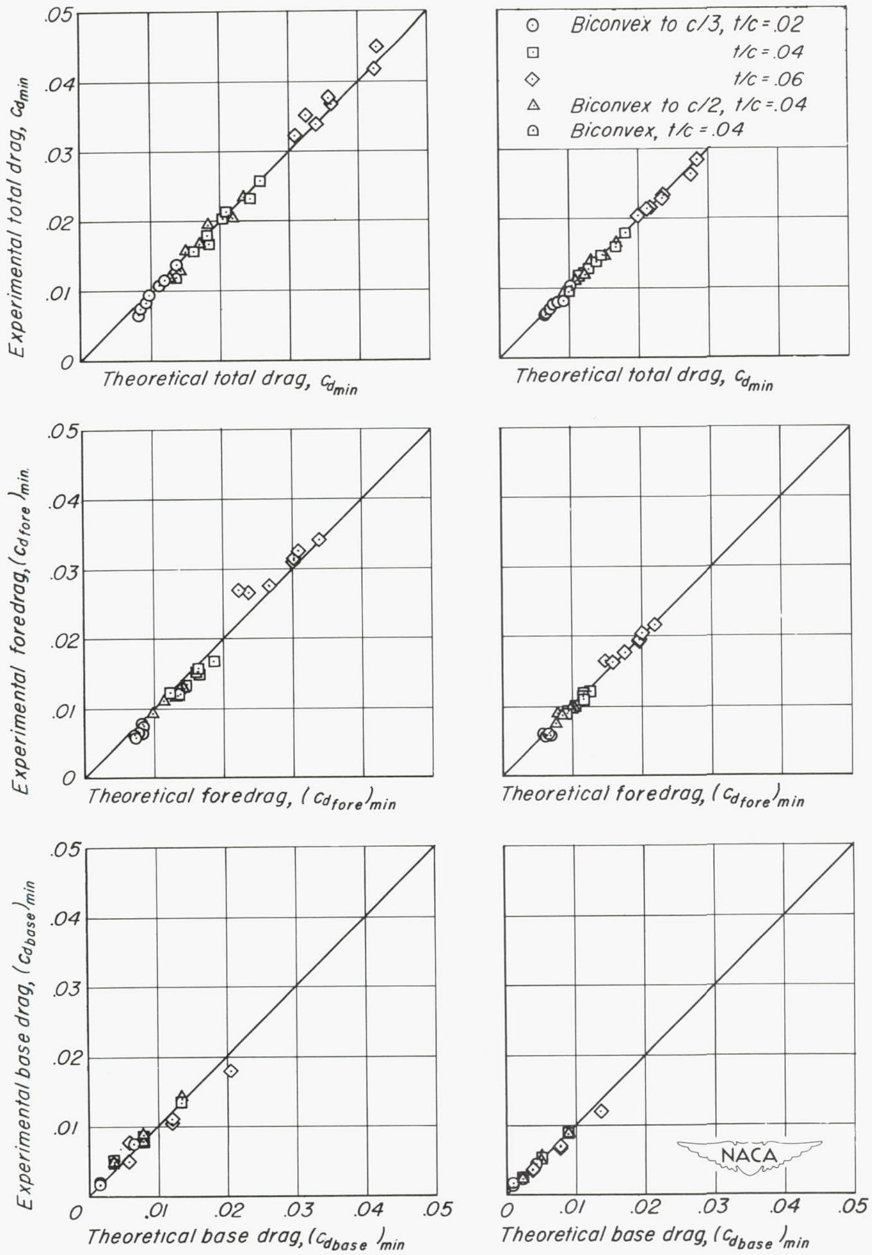


(a) M = 1.45



(b) M = 1.98

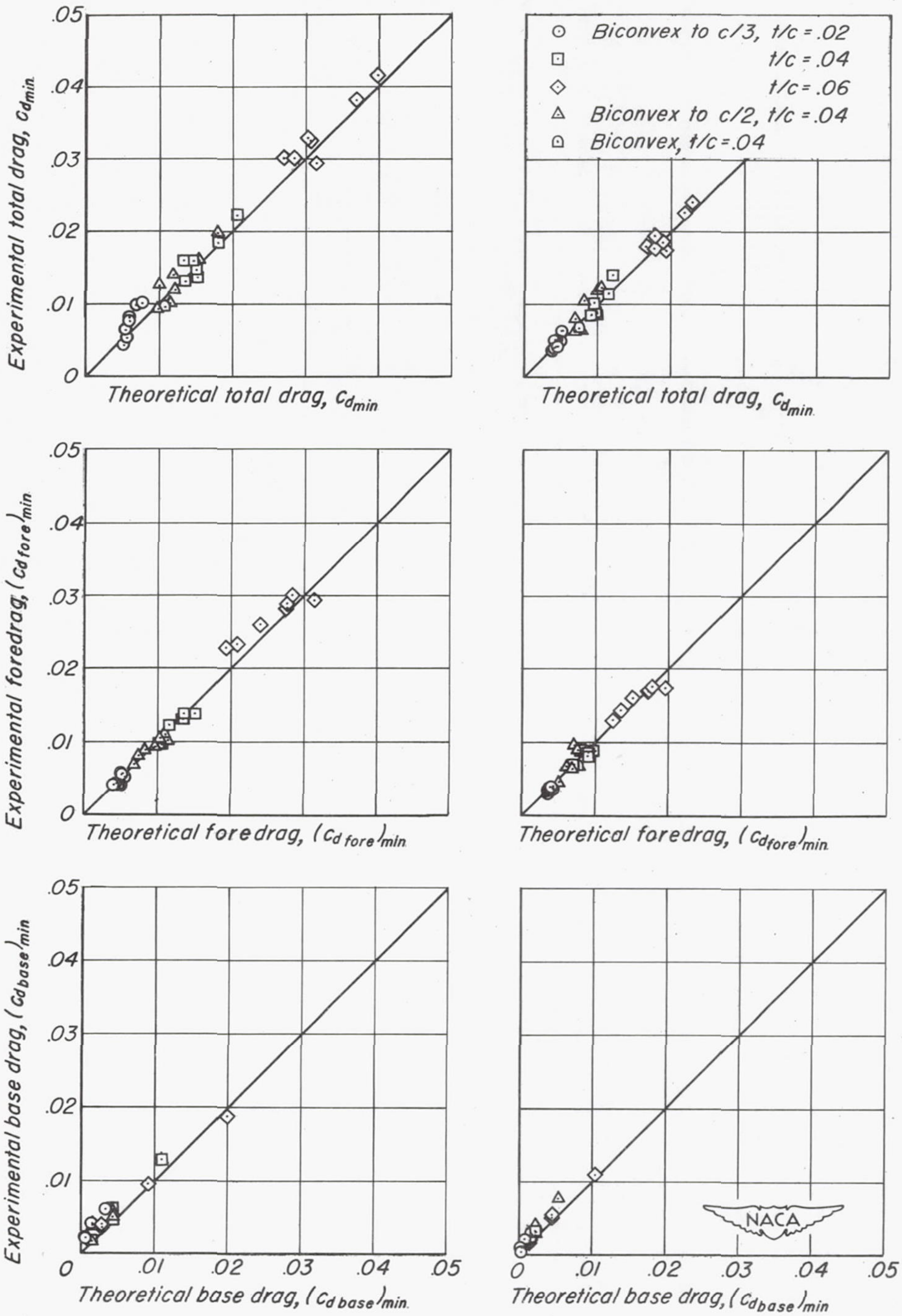
Figure 12.- Variation of minimum drag coefficient with airfoil thickness ratio and trailing-edge thickness ratio; transition fixed, $R=3.5\times10^6$ unless noted otherwise.



(a) M = 1.45, transition fixed, R=3.5×10^{6}.

(b) M = 1.98, transition fixed, R=3.5×10^{6}.

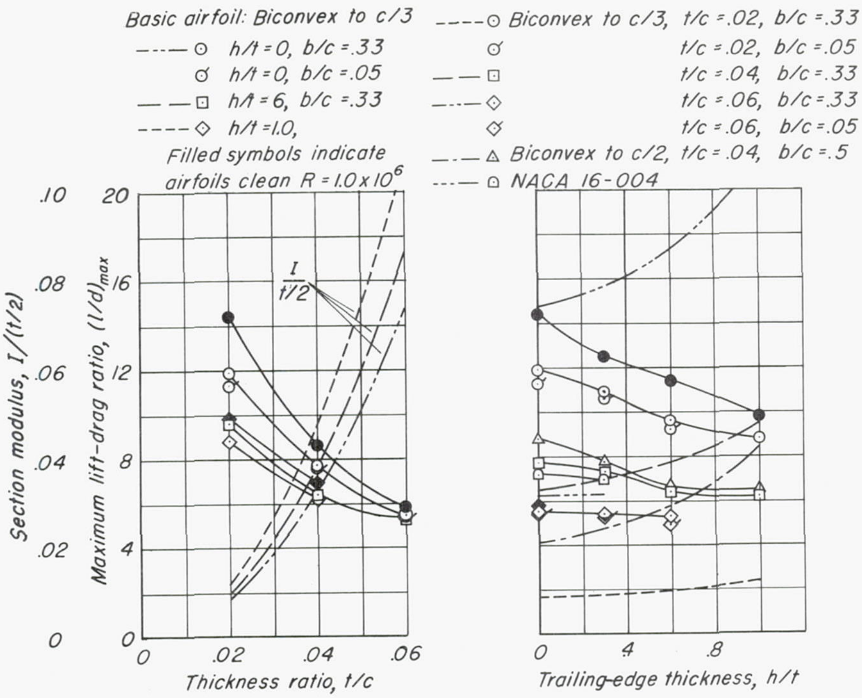
Figure 13.- Correlation between theoretical and experimental minimum drag coefficients.



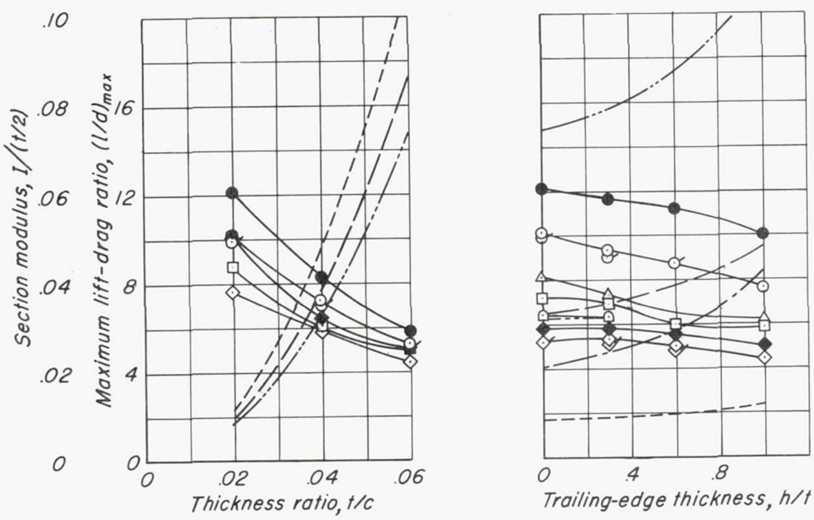
(c) M = 1.45, model clean, R=1.0×10^{6}.

(d) M = 1.98, model clean, R=1.0×10^{6}.

Figure 13.- Concluded.

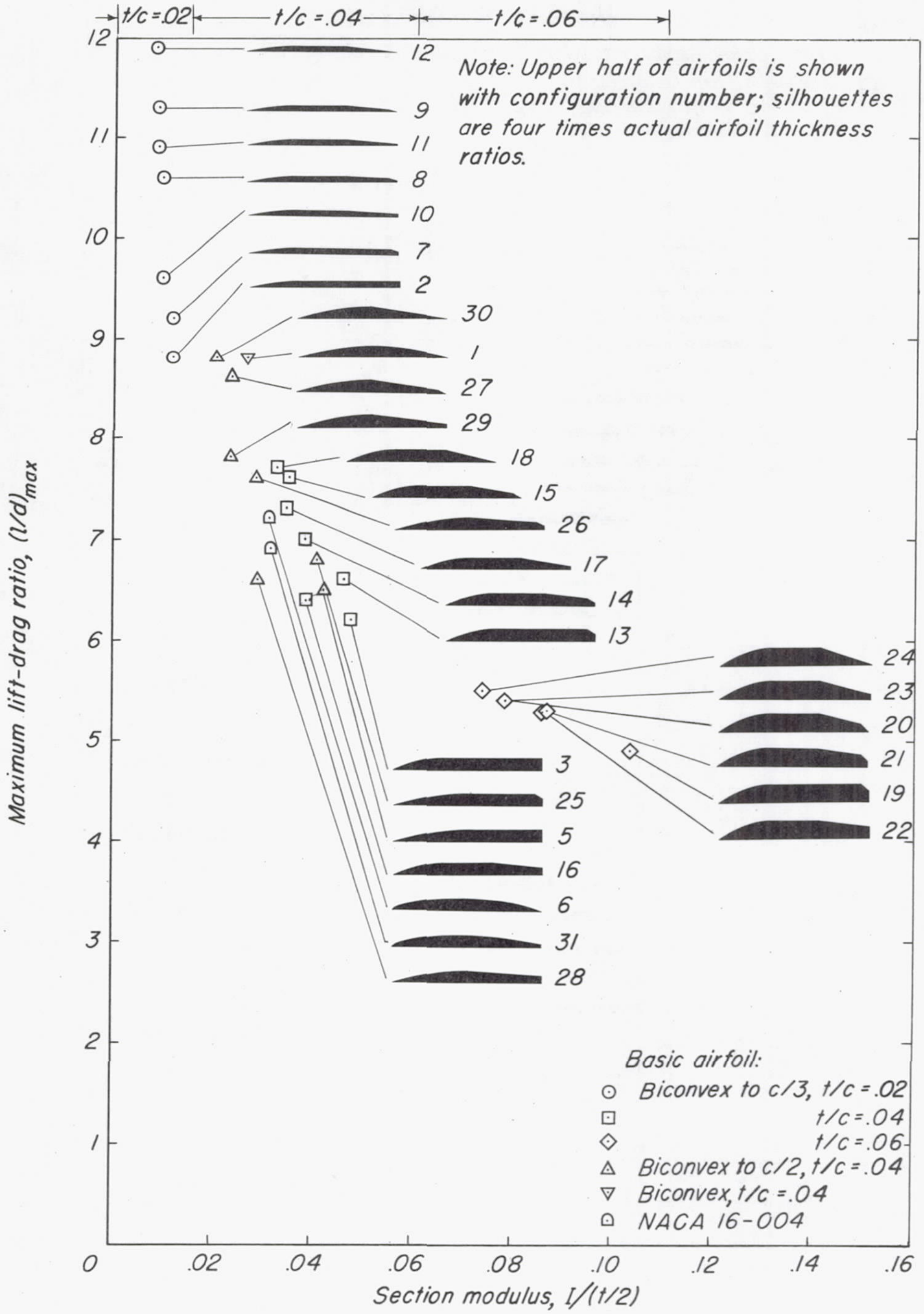


(a) M = 1.45



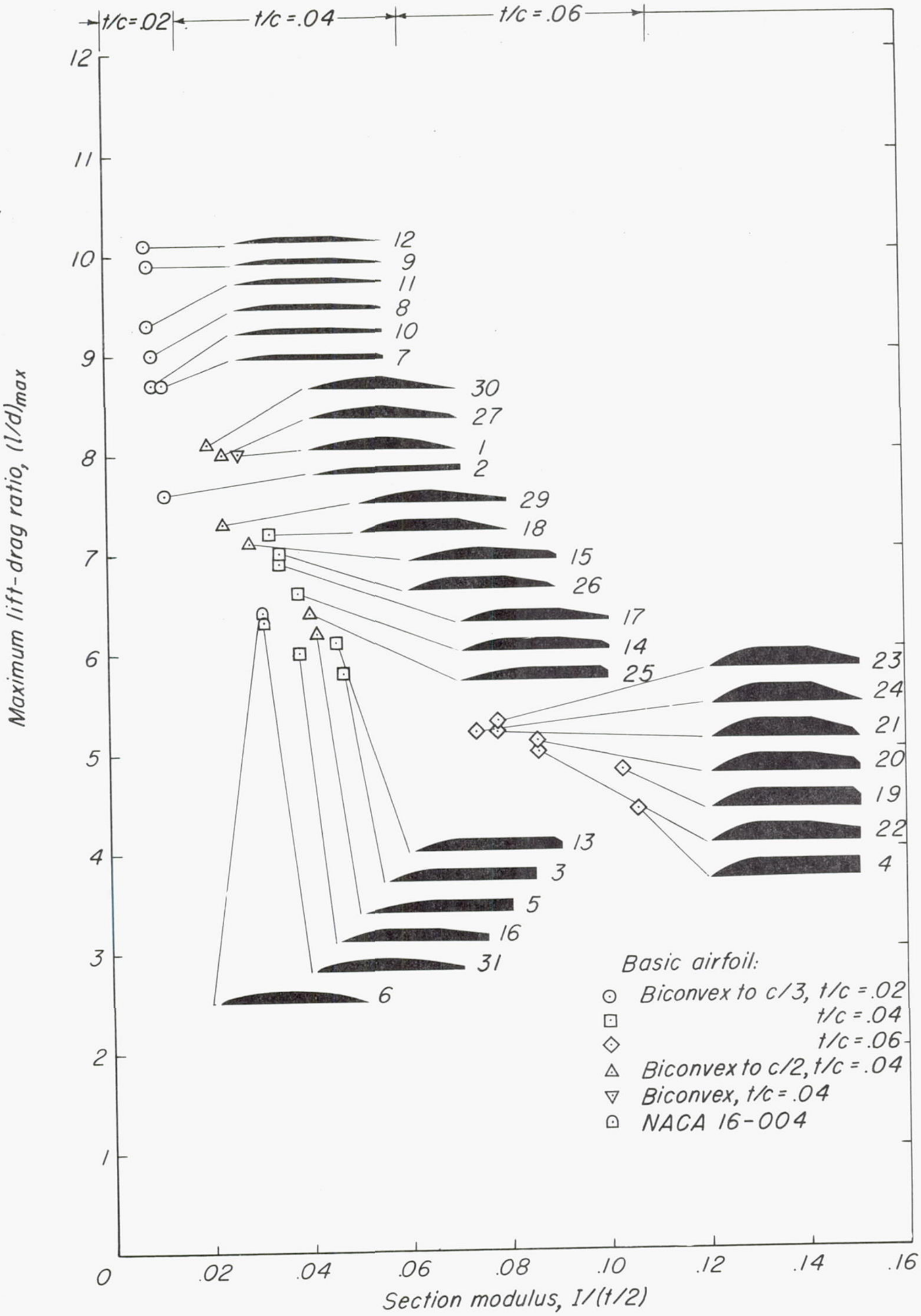
(b) M = 1.98

Figure 14.- Variation of maximum lift-drag ratio and airfoil section modulus with thickness ratio and trailing-edge thickness; transition fixed, $R=3.5\times10^{6}$.



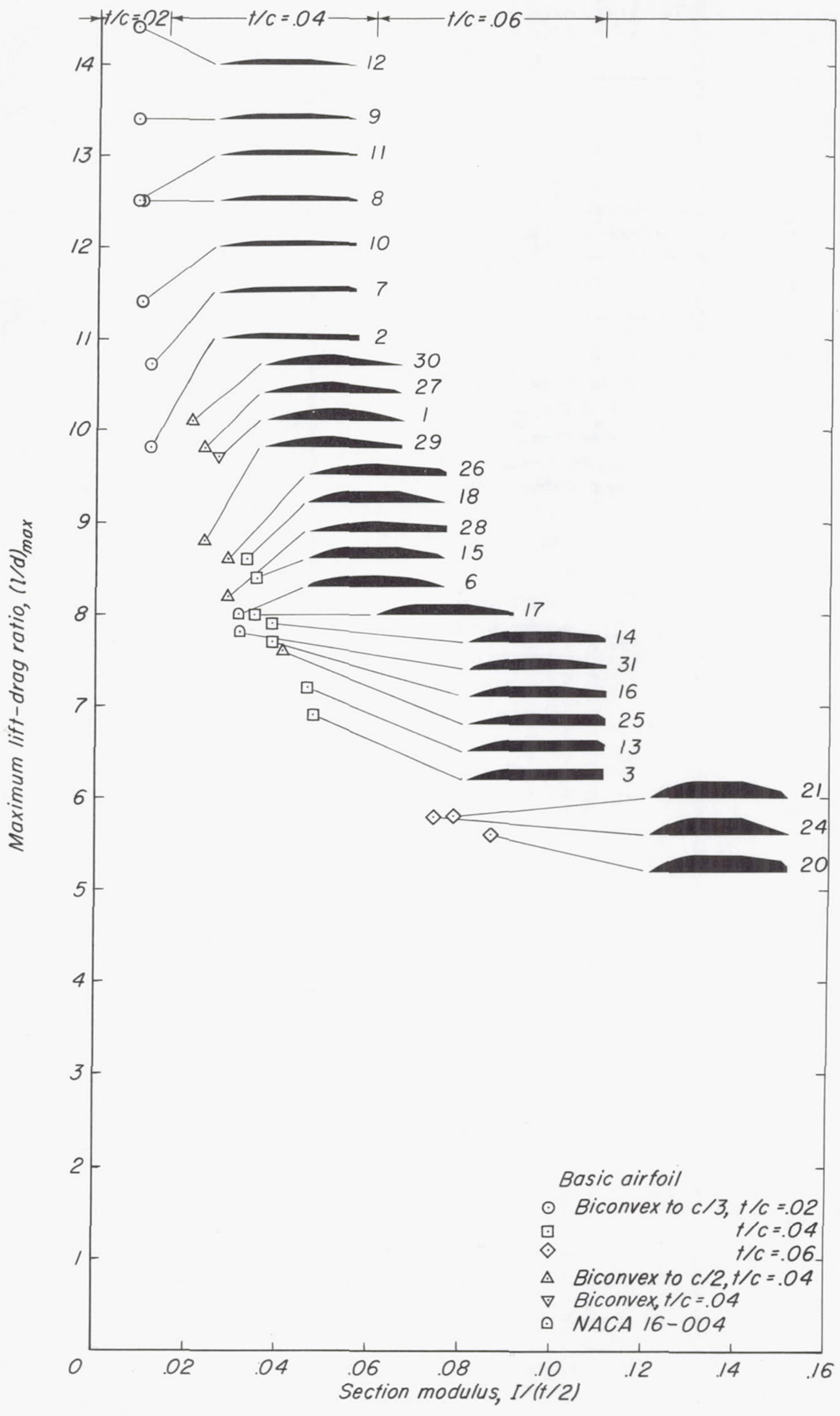
(a) M = 1.45, transition fixed, $R=3.5 \times 10^6$.

Figure 15.- Variation of airfoil maximum lift-drag ratio with section modulus.



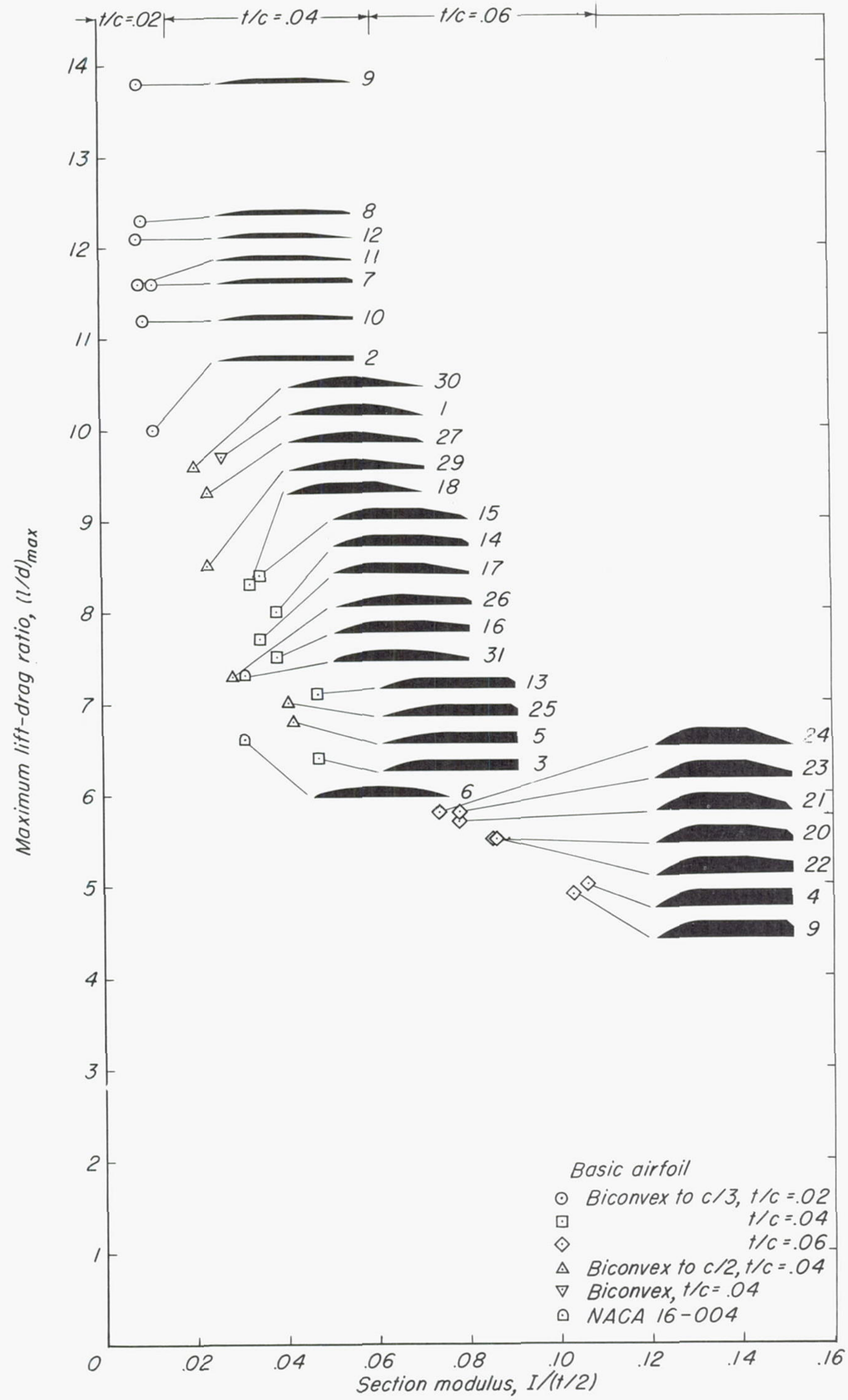
(b) $M = 1.98$, transition fixed, $R=3.5\times10^6$.

Figure 15.- Continued.



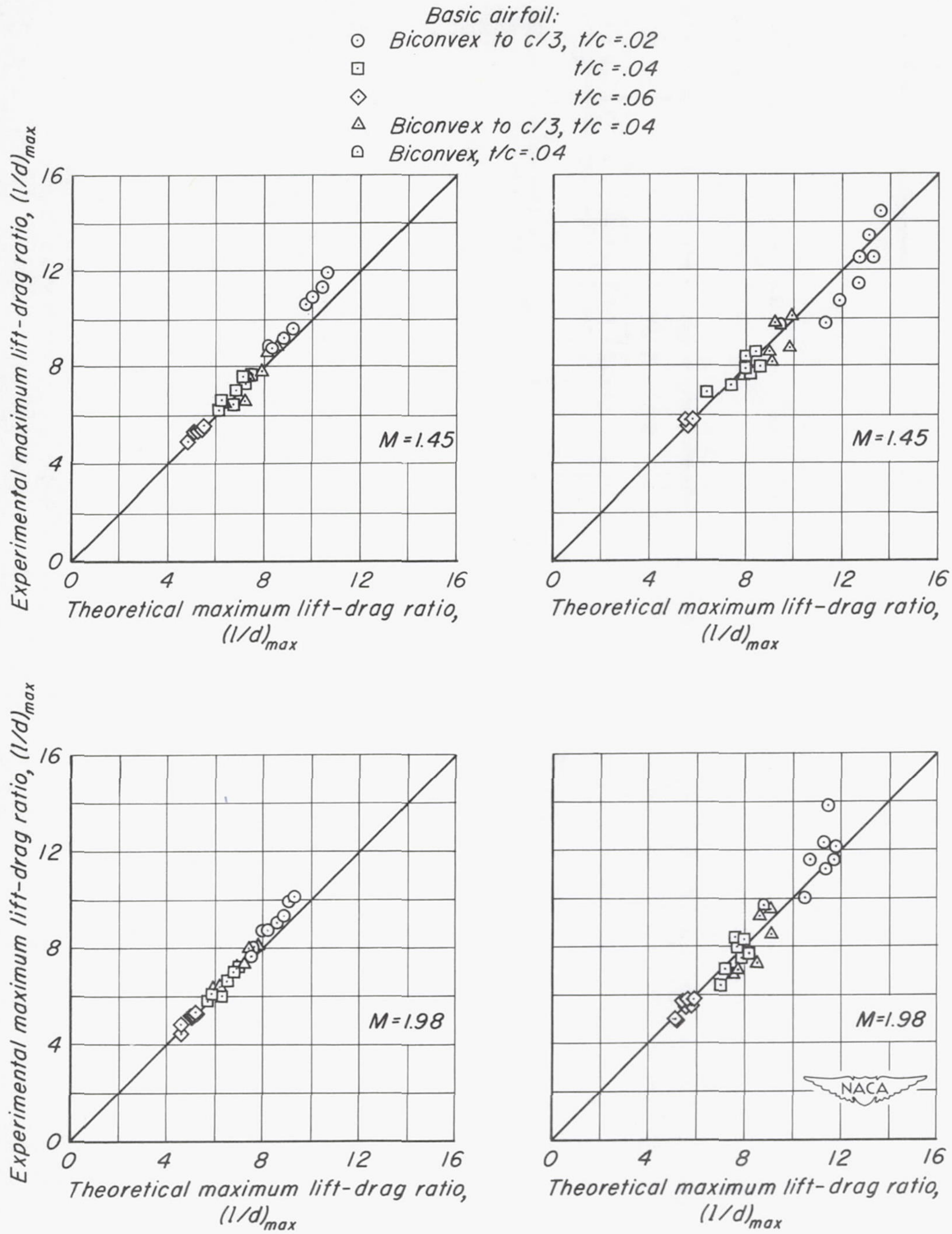
(c) M = 1.45, airfoils clean, $R=1.0\times10^6$.

Figure 15.- Continued.



(d) M = 1.98, airfoils clean, $R=1.0\times10^6$.

Figure 15.- Concluded.



(a) Transition fixed, $R=3.5\times10^6$.
(b) Airfoils clean, $R=1.0\times10^6$.

Figure 16.- Correlation between theoretical and experimental maximum lift-drag ratios.

NACA-Langley