TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 627

PRESSURE DISTRIBUTION OVER A CLARK Y-H AIRFOIL SECTION WITH A SPLIT FLAP

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SUMMARY

An investigation was made in the N.A.C.A. 7- by 10-foot wind tunnel of the distributions of air pressure over one chord section of a Clark Y-H airfoil with a split flap. The results obtained are given in the form of diagrams showing the chordwise distribution of pressure on both airfoil and flap and as plots of calculated aerodynamic coefficients for both airfoil and flap.

INTRODUCTION

The Clark Y-H airfoil section (frequently designated the N.A.C.A. CYH airfoil) is a development of the Clark Y section obtained by modifying the trailing-edge portion so as to reduce the center-of-pressure travel and the pitching moments. Aerodynamic characteristics of the Clark Y-H airfoil, obtained from force tests made several years ago in the variable-density wind tunnel, are given in references 1 and 2.

Because of numerous requests for pressure-distribution data for the Clark Y-H airfoil, a short series of tests to obtain such information was recently made in the 7- by 10-foot wind tunnel in connection with another project. The present report gives the results of the pressure-distribution tests at a single chord location on a rectangular Clark Y-H airfoil with a simple split flap for a few flap deflections and several angles of attack.

MODEL AND APPARATUS

The airfoil used for the present investigation was built of laminated mahogany to the Clark Y-H section

(table I) and has a span of 60 inches and a chord of 10 inches. The wooden trailing edge was cut off at 85 percent of the chord from the leading edge and was replaced by two strips of thin metal, one completing the upper surface and the other, the lower surface of the model. The strip on the lower surface was hinged at its leading edge, thus forming a simple split flap with a chord 15 percent of the airfoil chord.

A single row of pressure orifices was installed on both upper and lower surfaces of the airfoil and flap at a section 15 inches inboard of the right wing tip. The orifice locations on both the airfoil and the flap are shown in figure 1.

The model was mounted at the quarter-chord point on the standard force-test tripod in the N.A.C.A. 7- by 10-foot open-jet wind tunnel (reference 3). Small tubes from the orifices were brought out from the airfoil at midspan and down along the model support to the outside of the test section. These tubes were then connected to a photographic-recording multiple-tube manometer.

TESTS

The tests were all made at a dynamic pressure of 16.37 pounds per square foot, corresponding to an air speed of about 80 miles per hour at standard sea-level atmospheric conditions. The average Reynolds Number of the tests, based on the air speed and chord of the model, was 609,000.

The model was tested with flap deflections of 0°, 30°, and 60°. The range of angles of attack was chosen for each flap setting to include lift coefficients from below zero to approximately maximum lift. With the model set at a given angle of attack, a few minutes were allowed for all test conditions to become steady; a record was then taken of the pressures at the orifices by means of the photographic manometer.

RESULTS AND DISCUSSION

Pressure diagrams.- Diagrams of the pressures over the upper and lower surfaces of the airfoil with flap

neutral (or plain airfoil) are given in figure 2 as ratios of orifice point pressure p to dynamic pressure of the air stream q for the angles of attack investigated. Pressure diagrams for the airfoil with split flap deflected are given in figures 3 and 4 for the flap deflections and angles of attack tested. On the diagrams the pressures are all plotted normal to the airfoil chord, the pressure values being measured from the main chord for the airfoil pressures and from the deflected flap chord for the flap pressures.

These diagrams, which should be useful for application to rib and flap design, exhibit no unusual characteristics and are similar to those for other airfoils with split flaps as reported in references 4, 5, and 6. Some distributions of air loads along the span are given in reference 4 for a Clark Y airfoil with a partial-span split flap.

Section loads and moments.- The pressure diagrams were mechanically integrated and, from the data thus obtained, nondimensional coefficients were computed. The coefficients for the airfoil-and-flap combination include the loads of the flap projected onto the airfoil chord. The section coefficients are defined as follows:

$c_{n_w} = \frac{n_w}{q c_w}$, normal-force coefficient of airfoil with flap.

$c_{m_{w_{c/4}}} = \frac{m_{w_{c/4}}}{q c_w^2}$, pitching-moment coefficient about quarter-chord point of airfoil with flap.

$(c.p.)_w = \left(0.25 - \frac{c_{m_{w_{c/4}}}}{c_{n_w}}\right) \times 100$, center of pressure of airfoil with flap in percentage of airfoil chord from leading edge.

$c_{n_f} = \frac{n_f}{q c_f}$, normal-force coefficient of flap.

$c_{h_f} = \frac{h_f}{q c_f^2}$, hinge-moment coefficient of flap about flap leading edge.

$(c.p.)_f = \left(-\frac{c_{h_f}}{c_{n_f}}\right) \times 100$, center of pressure of flap in percentage of flap chord from hinge.

where n_w is the airfoil section normal force per unit span.

$m_{w_{c/4}}$, airfoil section pitching moment about the quarter-chord point per unit span.

n_f, flap section normal force per unit span.

h_f, flap section hinge moment per unit span about the flap hinge.

q, dynamic pressure.

c_w, chord of airfoil with flap.

c_f, chord of flap.

No corrections have been applied to the data for the effects of the wind-tunnel jet boundaries.

Normal-force and pitching-moment coefficients and centers of pressure are plotted in figure 5 for the airfoil with flap neutral. The same characteristics are given in figures 6 and 7 for the airfoil with split flap deflected 30° and 60°, respectively. In addition, flap normal-force and hinge-moment coefficients and centers of pressure are included on these two figures.

The results given in figures 5, 6, and 7 do not differ greatly from those obtained with a Clark Y airfoil in other tests (reference 4). Aside from the lower pitching moments of the airfoil with flap neutral, mention may also be made of the flap loads. The maximum normal-force coefficient of the split flap has a value of about 1.3, which is practically the same as that of split flaps on a Clark Y airfoil; hinge-moment coefficients of the flap are also of about equal magnitude with either airfoil.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., November 10, 1937.

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1. Higgins, George J.: The N.A.C.A. CYH Airfoil Section. T.N. No. 240, N.A.C.A., 1926.

2. Jacobs, Eastman N., and Anderson, Raymond F.: Large-Scale Aerodynamic Characteristics of Airfoils as Tested in the Variable-Density Wind Tunnel. T.R. No. 352, N.A.C.A., 1930.

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CLARK Y-H AIRFOIL SECTION

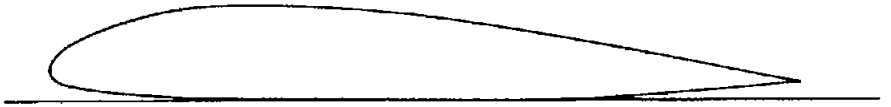


TABLE I

(Ordinates in percent of chord)

Station	Upper	Lower
0.	3.50	3.50
1.25	5.45	1.93
2.5	6.50	1.47
5.	7.90	.93
7.5	8.85	.63
10	9.60	.42
15	10.69	.15
20	11.36	.03
30	11.70	0
40	11.40	0
50	10.52	0
60	9.15	0
65	8.30	0
70	7.41	.06
80	5.82	.38
90	3.84	1.02
95	2.93	1.40
100	2.05	1.85
L.E. Rad.: 1.50		

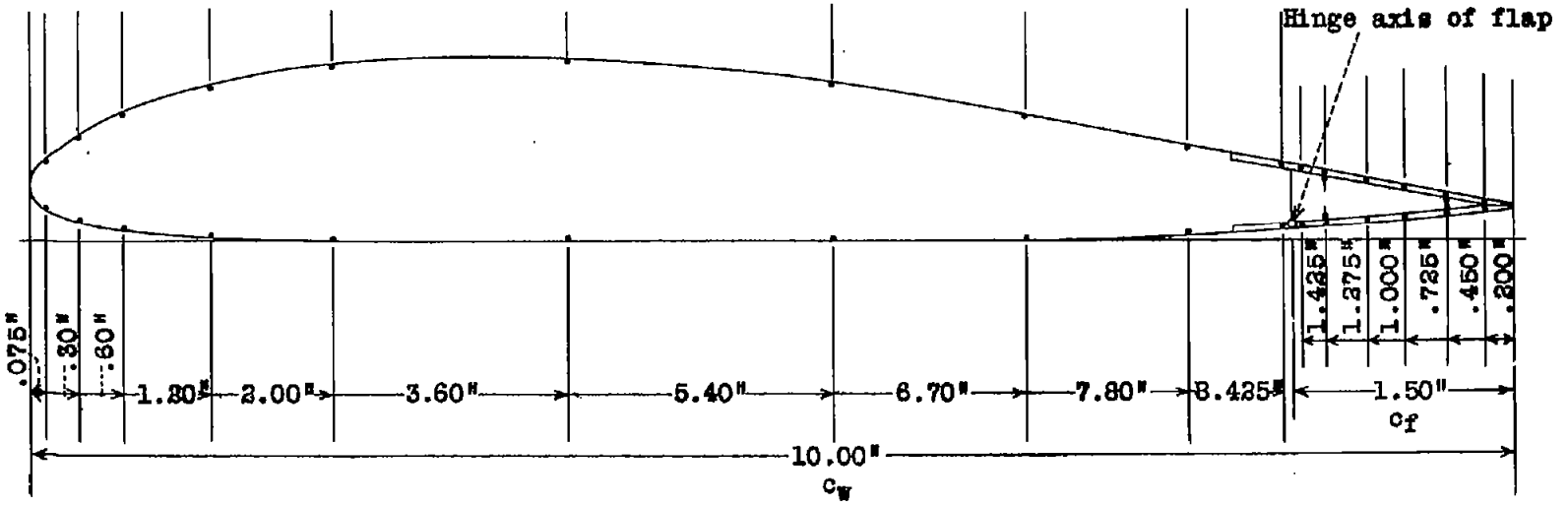


Figure 1.- Clark Y-H model showing location of pressure orifices on airfoil and on split flap.

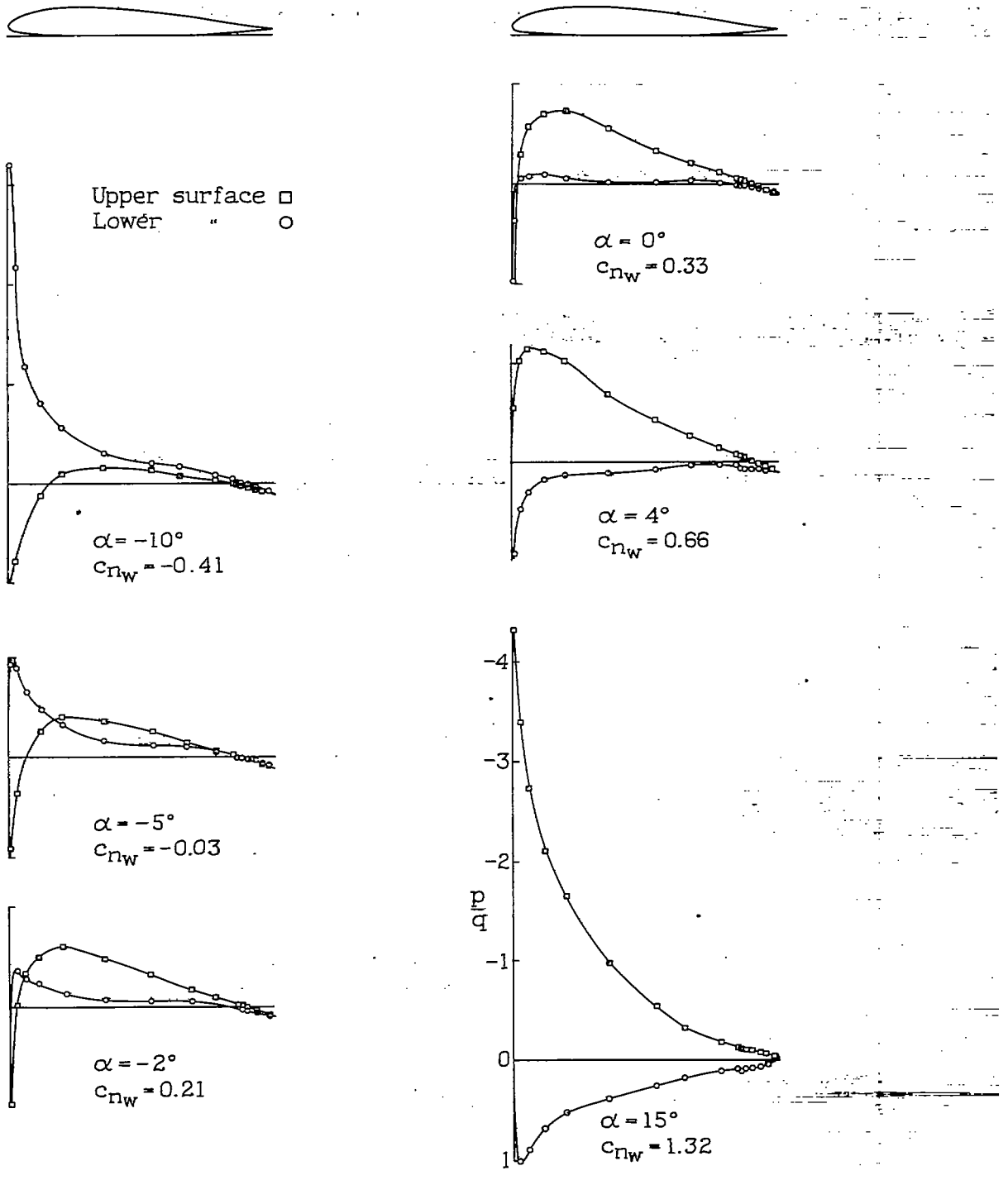
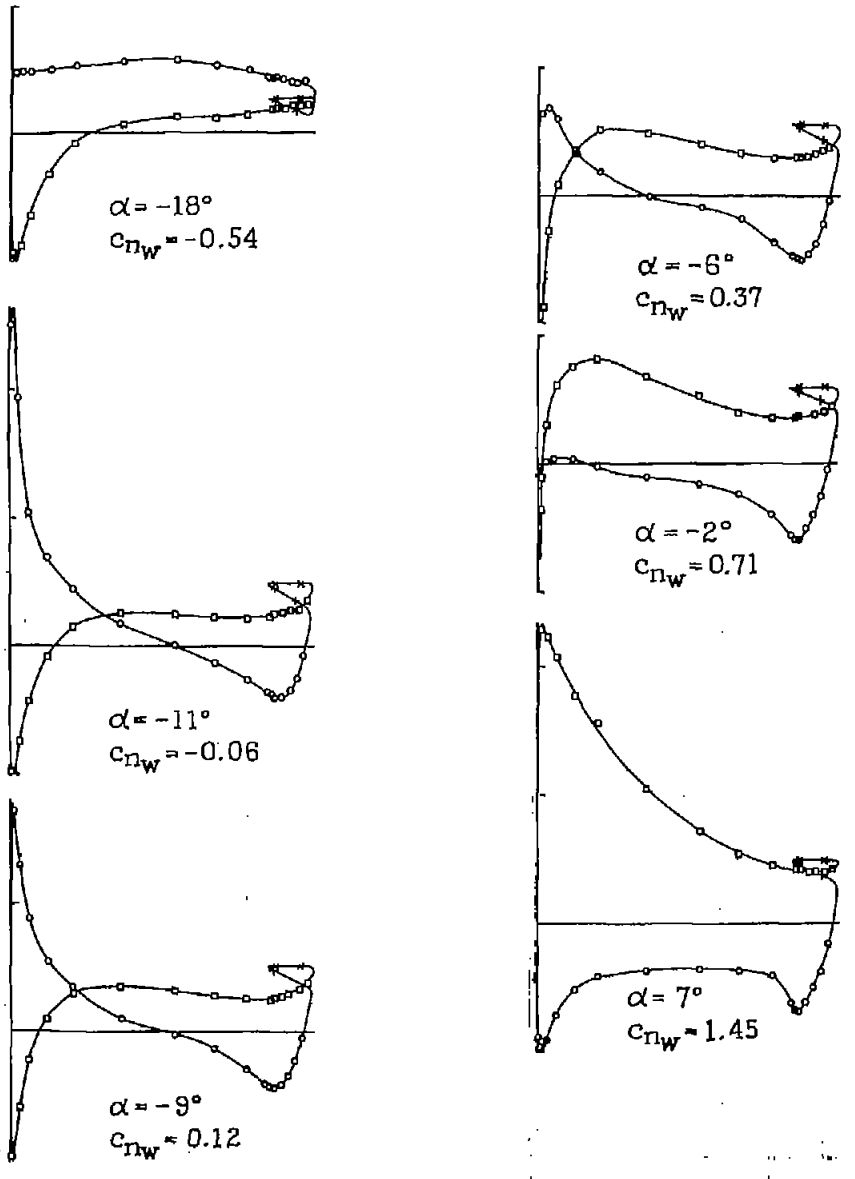


Figure 2.- Pressure distribution on the Clark Y-H airfoil at various angles of attack. Split flap neutral.



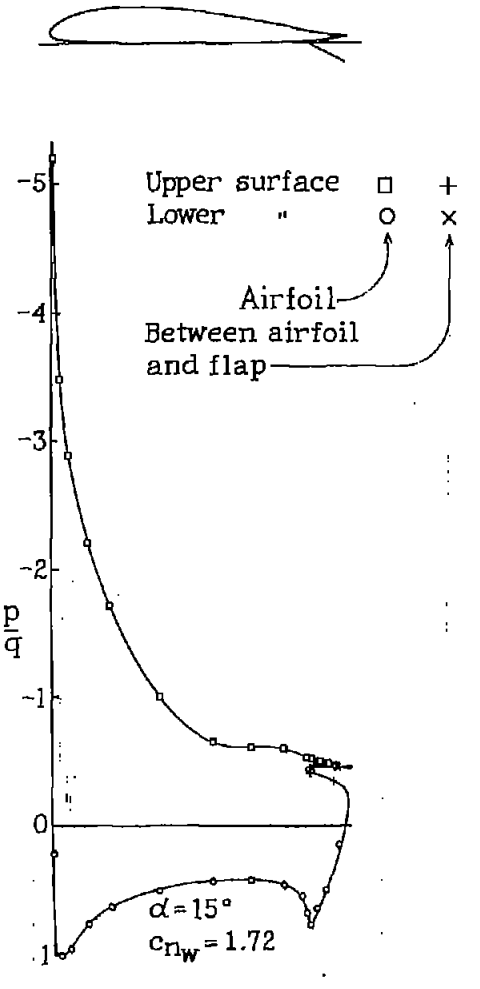


Figure 3.- Pressure distribution on the Clark Y-H airfoil at various angles of attack. 0.15 c_w split flap deflected 30°.

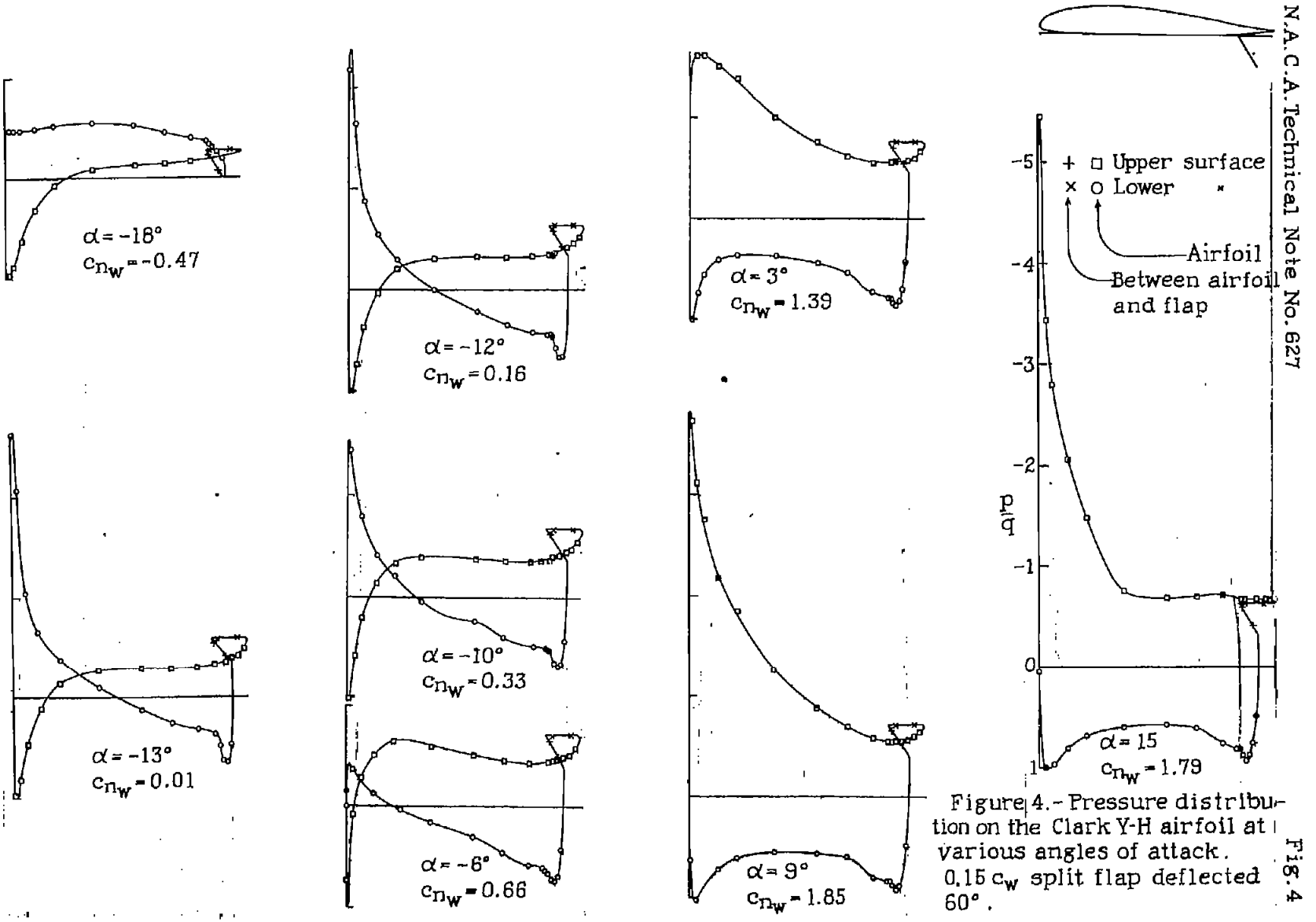


Figure 4.- Pressure distribution on the Clark Y-H airfoil at various angles of attack. 0.15 c_w split flap deflected 60°.

Fig. 4

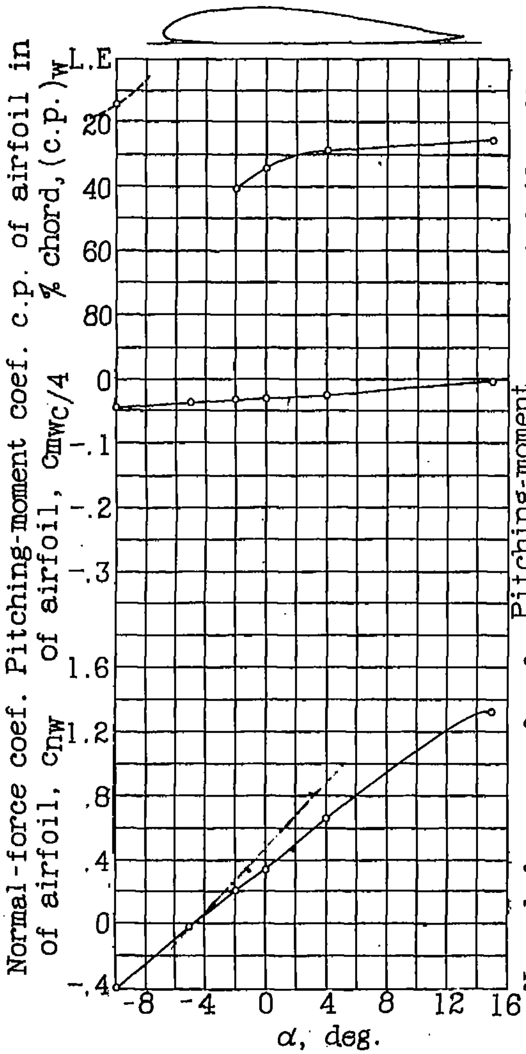


Figure 5.- Characteristics of Clark Y-H airfoil with flap neutral.

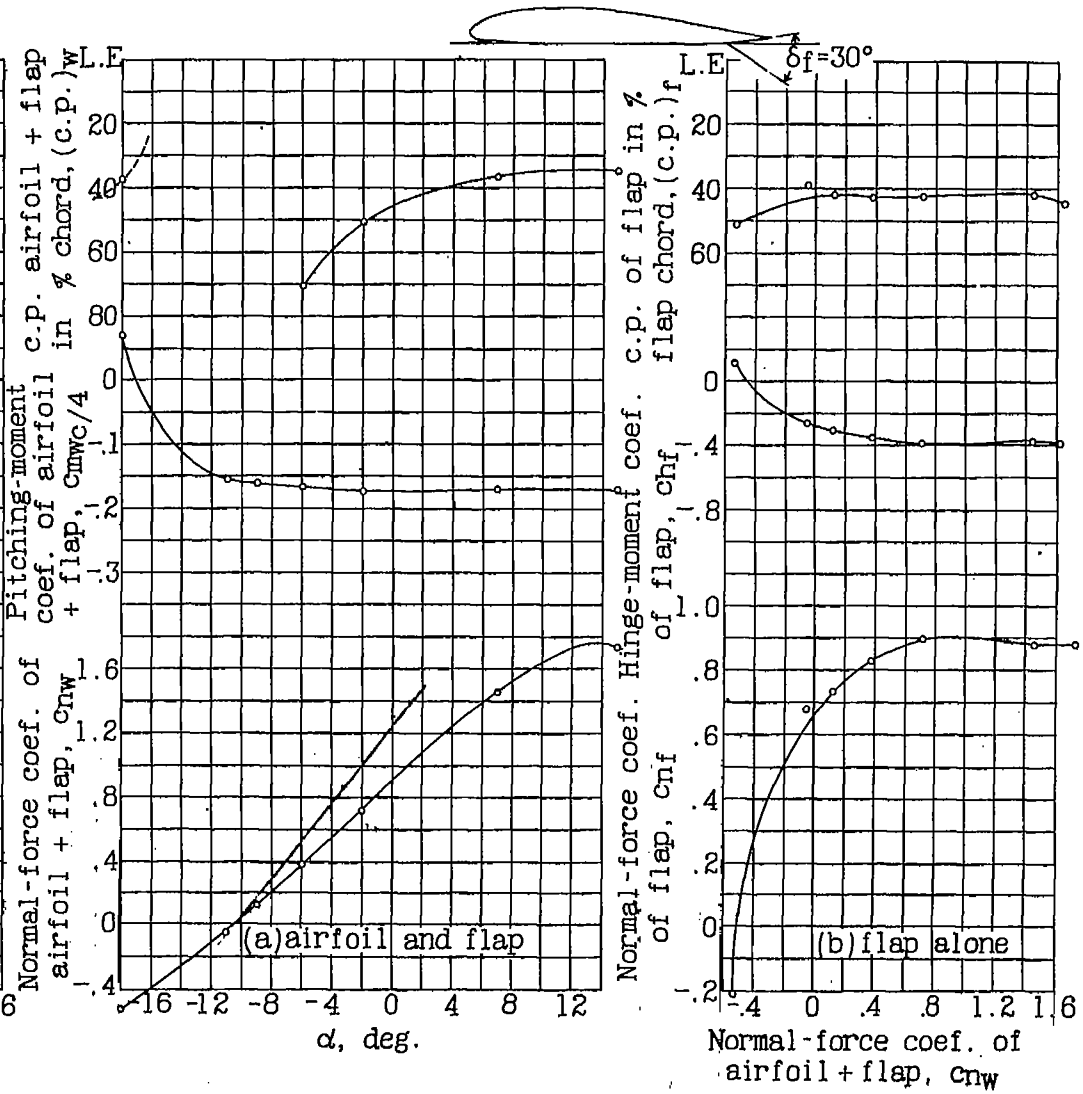


Figure 6.- Characteristics of Clark Y-H airfoil with $0.15c_w$ split flap deflected 30°.

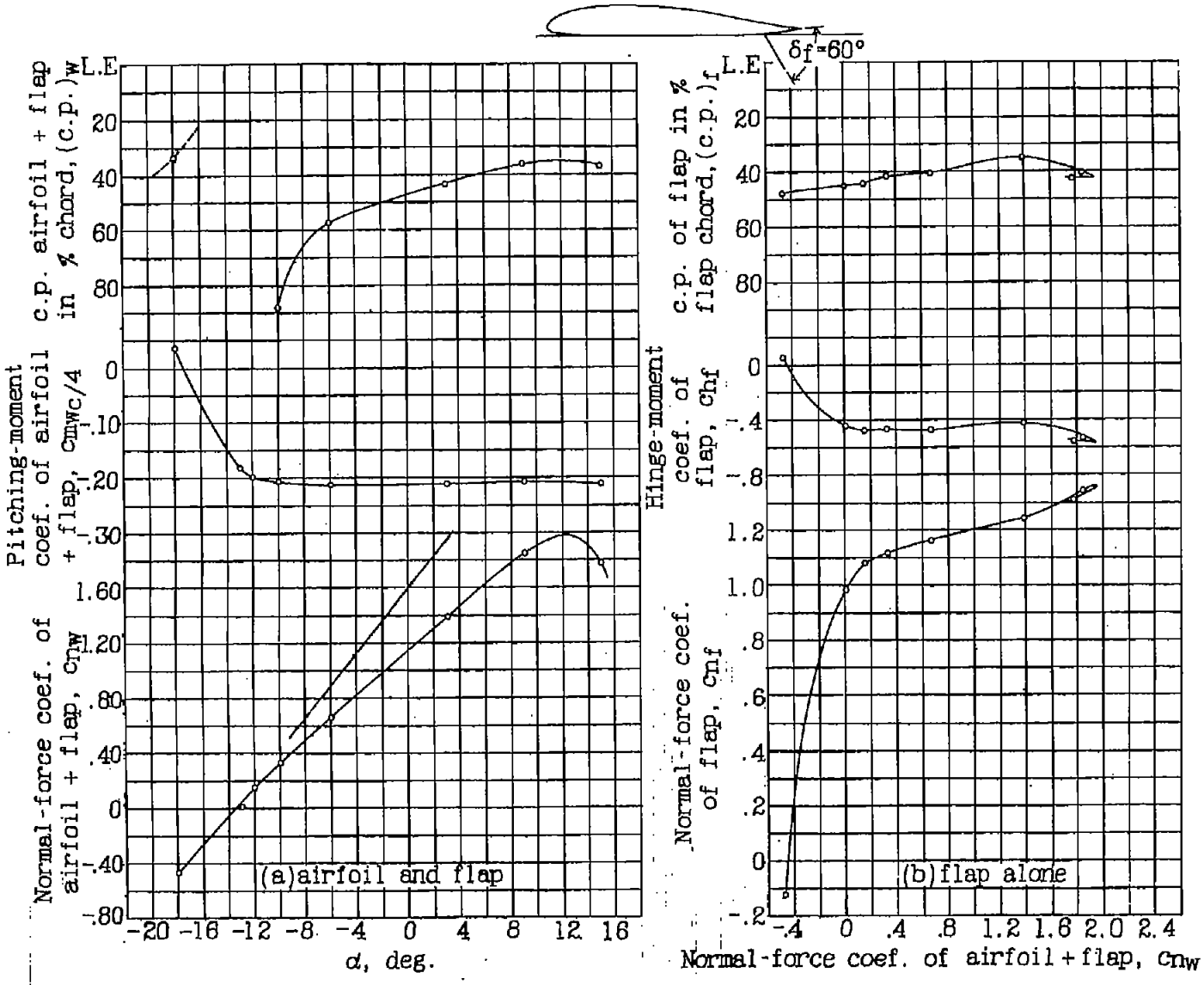


Figure 7.- Characteristics of Clark Y-H airfoil with 0.15c_w split flap deflected 60°.