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By

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9th November, 1953

Summary

The charts of R. & M.2730 for estimating two-dimensional control derivatives were based mainly on data for aerofoils of 15 per cent thickness. Supplementary tests have been carried out on a two-dimensional 10 per cent thick RAE 102 aerofoil with 20 per cent and 40 per cent plain round-nosed control surfaces. Lift, pitching moment and hinge moment were determined from balance measurements and from integrated pressure distributions at one section. In most cases, consistent coefficients were obtained by the two methods.

Particular care was taken in observing or fixing with wires the positions of boundary-layer transition on both surfaces of the aerofoil. The experimental derivatives varied smoothly with position of transition and were in fair agreement with the general charts of R. & M.2730.

1. Introduction

R. & M.2730[1] (Bryant, Halliday and Batson, 1950) provides charts for estimating the steady, low speed, two-dimensional derivative coefficients of lift, pitching moment and hinge moment on aerofoils with plain round-nosed control surfaces. These charts were based largely on experiments with aerofoils of 15 per cent thickness. To amplify the results of this work, the present report gives data obtained with a 10 per cent RAE 102 aerofoil with alternative 20 per cent and 40 per cent controls.

Similar tests on a modified RAE 102 aerofoil with a cusped trailing edge are in progress. To obtain results unaffected by hinge-gap a model of RAE 102 section without a control surface is also being tested. The final assessment of the research on two-dimensional controls will require the results of these further tests.

In addition, it is proposed to use the model without a control surface for an investigation of boundary layers and their effect on the pressure distribution.

2. Description of Model

The ordinates of the symmetrical RAE 102 aerofoil are taken from Table II of Ref.2 (Pankhurst, Squire, 1950) and are given in Table I of this report. The model was mounted in the N.P.L. 7 ft No.3 square tunnel; and the two-dimensional arrangement and method of measuring both forces and pressures was precisely that used for previous tests and given in A.R.C. report 15,456 (Ref.3). As before, the working portion of the aerofoil, finished with a black smooth surface, was of 5 ft span and 30 in. chord and fitted with alternative plain controls, one of 6 in. chord, $E = 0.2$, and the other of 12 in. chord, $E = 0.4$. Two separate models were made. The first aerofoil, $E = 0.2$, and its control surface, were found to distort under the static load. At the section used for pressure plotting, 10 in. from the midspan, the control sagged about 0.010 in. relative to

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the main portion of the aerofoil (see Fig.3, inset). In consequence of this, the second aerofoil and its 40 per cent control were stiffened with spanwise steel bars and the spindles supporting the model at the quarter-chord position were increased in diameter from 1 in. to 1.125 in. No distortion was observed for this aerofoil.

3. Notation

a_1, m_1, b_1	$\frac{\partial C_L}{\partial \alpha}$, $\frac{\partial C_m}{\partial \alpha}$, $\frac{\partial C_H}{\partial \alpha}$
a_2, m_2, b_2	$\frac{\partial C_L}{\partial \eta}$, $\frac{\partial C_m}{\partial \eta}$, $\frac{\partial C_H}{\partial \eta}$
c	chord of aerofoil (2.5 ft)
c_η	chord of control, measured from hinge
C_L	$\frac{L}{\frac{1}{2}\rho V^2 S}$
C_m	$\frac{M}{\frac{1}{2}\rho V^2 Sc}$
C_H	$\frac{H}{\frac{1}{2}\rho V^2 S_\eta c_\eta}$
E	c_η/c
H	hinge moment
h	aerodynamic centre
L	lift
M	pitching moment about $\frac{1}{4}$ chord
p	pressure at surface of aerofoil
p_o	pressure in undisturbed stream
R	Reynolds number
S	area of plan form
S_η	area of control
V	wind speed, uncorrected for blockage
x, y	ordinates of aerofoil referred to leading edge
x_t	distance of transition from leading edge
α	angle of incidence
η	control setting
ρ	density of air

suffix	u	denotes upper surface
"	l	denotes lower surface
"	T	denotes theoretical derivative
prefix	δ	denotes increment due to change in transition.

4. Scope and Accuracy of Tests

The scope of the experiments is given fully in Table 2. Lift, pitching moment and hinge moment were obtained from measurements on roof balances of the tunnel and isolated pressures on both surfaces of one section were measured on a multi-tube manometer.

The results of the tests were obtained with a fair degree of accuracy, the maximum departure from the smooth curves, being within the values given in Ref.3; viz: 0.007 for C_L, 0.0010 for C_m, 0.0015 for C_H and 0.015 for $(p - p_o)/\frac{1}{2}\rho V^2$.

In assessing accuracy, the sagging of the smaller control should be borne in mind, but it is not expected to alter the final derivatives by more than 1%. The small gap at the nose of the control has an effect on transition when E = 0.4 (see Fig.1), apart from this the values of a_1 and m_1 should be the same for the two controls. Results from balance measurements show a difference in a_1 of about 5 per cent for the smooth wing and about 3 per cent when the transition is fixed at 0.1c, a_1 being larger for E = 0.4 control. There are also changes in the aerodynamic centre of about 0.006 and 0.002 respectively for these two transition positions. These differences are too large to be explained by the sagging of the smaller control. This conclusion is borne out by similar differences in a_1 from identical experiments which were carried out on a cambered aerofoil with both controls stiffened (Ref.3).

5. Control of Transition

In the earlier tests with E = 0.2, the diameters of wire used to fix transition at each position were 0.022 in. and 0.036 in. for wind speeds of 60 ft/sec and 40 ft/sec respectively.

Apart from the forward position, these diameters were less than those subsequently laid down in Fig.1 of Ref.4 (Bryant and Garner, 1950), namely:-

at x_t = 0.1c - not less than 0.020 in. at 60 ft/sec and 0.027 in. at 40 ft/sec.

at x_t = 0.3c - not less than 0.026 in. at 60 ft/sec and 0.035 in. at 40 ft/sec.

at x_t = 0.5c - not less than 0.029 in. at 60 ft/sec and 0.039 in. at 40 ft/sec.

Though the results at the time appeared to be consistent in themselves, it was thought better for the later tests, with E = 0.4 and V = 60 ft/sec, to increase the diameter to 0.028 in. at position x_t = 0.3c and to 0.032 in. at x_t = 0.5c.

The position of natural transition was measured on the upper surface by the paraffin - evaporation method and the results are given in Fig.1. These tests included the effect of wind speed and of E over a range of incidence of the model and of E over a range of control setting. There was a rapid forward movement of natural transition from about x_t = 0.55c to x_t = 0.15c at 60 ft/sec as incidence increased from about 1.5 deg. to 3 deg. As wind speed decreased so transition receded from the leading-edge, the amount of movement for a change of wind speed from 60 to 40 ft/sec being of the order of x_t = 0.05c.

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For α = 0 deg, transition was back roughly at a constant value of x_t = 0.6c, over a range of control setting from η = -5 to +5 deg: for α = +2 deg it moved slowly forward from about x_t = 0.55c to x_t = 0.15c over the same range of η from -5 to +5 deg. Transition was consistently farther forward for the larger control surface, remaining at a constant position of x_t = 0.6c, presumably due to the presence of the hinge-gap, over a range of α from -5 to 0 deg.

6. Balance Measurements

All coefficients of lift, pitching moment and hinge moment, uncorrected for tunnel blockage and wall interference are given in Table 3 for E = 0.2 and in Table 4 for E = 0.4. These coefficients, when plotted against α or η, form well-defined straight lines to the accuracy stated in §4, provided that there is little or no change of transition with incidence or control setting. Taking the lower surface also into consideration, Fig.1 shows that, for the smooth-wing case, transition is approximately constant over only a limited range of incidence from -1.5 to +1.5 deg when η = 0 deg and over a range of control setting from -5 to +5 deg when α = 0 deg.

Experiments were also carried out at some angles of incidence and control settings with a wire on the upper surface and natural transition on the lower. The uncorrected increments to the coefficient of lift, pitching moment and hinge moment, as the transition on the upper surface is moved from 0.1c to x_u, have been plotted against x_u/c in Fig.2(a) for η = 0 deg and certain values of α and E. Straight lines have been drawn allowing for a reasonable scattering of the points. The effect of moving the transition is expressed by the slopes of these lines $\left(\frac{dC_L}{d\chi}, \frac{dC_m}{d\chi} \text{ and } \frac{dC_H}{d\chi}\right)$, where the difference in transition on the two surfaces is denoted by $\chi = (x_u - x_l)/c$. These slopes are plotted against α or η in Fig.2(b) so as to compare the effect of asymmetric transition on lift, pitching moment and hinge moment for the two values of E.

7. Pressure Distributions

Pressures in the form $(p - p_o)/\frac{1}{2}\rho V^2$ are given for each aerofoil surface in Table 5 for E = 0.2 and in Table 6 for E = 0.4. p_o is measured at a position upstream of the model and no correction has been made for pressure-drop, as in the NPL 7 ft No.3 tunnel this is practically zero. In Fig.3, pressures over the rear portion of the aerofoil with α = 0 deg, η = 0 deg are plotted against x/c $(0.8 < x/c < 1.0)$ for both values of E. With each control at neutral setting, complete curves of the pressure distributions are given in Fig.4 for α = -2 and +2 deg, η = 0 deg. Similar curves with α = 0 deg for various settings of the larger control are given in Fig.5. In Figs.3, 4 and 5 calculated pressure distributions from Table III of Ref.2 are included. As stated in the footnote on page 1 of Ref.2, these pressure distributions were calculated for the original shape at the trailing edge which was modified later.

Except towards the trailing edge where they are less positive, the experimental values of $(p - p_o)/\frac{1}{2}\rho V^2$ agree very well with those calculated. As the experimental curves for the two surfaces of E = 0.2 in Fig.3 should be coincident, the difference between them shows the effect of discontinuity of surface due to sagging of the control (see Fig.3, inset). The curves for the two surfaces of E = 0.4 are, however, coincident to the accuracy stated in §4 and the plotting of points over the same part of the aerofoil chord for this control indicates that the difference in the case of E = 0.2 is almost entirely due to the 'cliff' along the lower surface near the hinge of the control. Otherwise the agreement for the two control chords in Fig.4 is reasonably good.

In the case of the larger control surface, there were no pressure holes between x/c = 0.55 and the hinge at x/c = 0.6 so that for purposes of integration the curves for this portion of the chord were assumed to be reflections of those aft of the hinge. Table 7(a) gives the integrated values of C_L, C_m and

C_H together with those from balance measurements, all uncorrected for wind-tunnel interference. Also uncorrected integrated values of C_H are given in Table 7(b) for different values of E, estimated from the pressure distribution on the model with the larger control ($\alpha = \pm 2$ deg, $\eta = 0$ deg). Mean values are taken for positive and negative angles of incidence and control settings. For pitching moment and hinge moment the two methods of measurement give reasonably good agreement; but for lift, with the larger control set over and $\alpha = 0$ deg, the integrated C_L is from 3 to 5 per cent larger than that obtained from balance measurements.

8. Derivatives

The uncorrected derivatives with respect to incidence and control setting have been obtained from the slopes of curves of the experimental coefficients given in Tables 3 and 4. For a backward transition, the ranges of α and η have been limited roughly to $-1.5° < \alpha < +1.5°$ and to $-5° < \eta < +5°$ respectively. After applying a blockage correction from equation (1) of Ref. 3, §7, the slopes thus obtained were corrected for tunnel interference by using equations (3) and (4) of Ref. 3.

The corrected derivatives are given, together with their theoretical values* in Table 8; a_1, m_1 and b_1 ($\eta = 0$ deg) are plotted against x_t/c in Fig. 6 and a_2, m_2 and b_2 ($\alpha = 0$ deg) similarly in Fig. 7. These results include both controls at wind speed 60 ft/sec and the smaller control at 40 ft/sec.

With the exception of m_1 there is a reduction in the numerical experimental values of the derivatives as transition moves forward. m_1 has a small positive value and does not vary greatly with movement of transition. With transition fixed at 0.1c the values of a_2, m_2 and b_2, for $\alpha = 2$ deg, were found to be within 2 per cent of those for $\alpha = 0$ deg. As E is changed from 0.4 to 0.2, a_1 is reduced by about 5% when the transition is back and by about 3% when it is forward and the small positive value of m_1 is increased giving a slightly more forward position of the aerodynamic centre. Results of recent experiments, to be published later, on an aerofoil of the same section without a control surface give values of a_1 and m_1 very nearly the same as the present values when $E = 0.4$.

The effect of camber on the derivatives is fully given in Table 9, where the results of experiments on the cambered aerofoil from Tables III and IV of Ref. 3 are set beside the present results taken from Table 8. The differences between these two sets of derivatives show that the effect of camber is approximately independent of transition position for all the values and independent of E for a_1, m_1 and b_1.

In Table 10 the present experimental results are compared with values of the derivatives deduced from the general charts given in R. & M. 2730[1]. The present experimental values of a_1 fit Fig. 14 of Ref. 1 reasonably well. But in view of the uncertainty about this derivative, the known values of $a_1/(a_1)_T$ from Table 8 have been used as a starting point: hence from Figs. 18, 29, 32, 65 and 67 of Ref. 1, as indicated in Table 10, the other ratios have been calculated. Except for $b_1/(b_1)_T$, the results of these experiments support the charts, in some cases very closely: but the expression $\dfrac{b_1}{a_1}\Big/\left(\dfrac{b_1}{a_1}\right)_T$, from the experimental data for $E = 0.2$, has a value of only about 0.6 of that obtained from the appropriate chart.

9. Acknowledgements

Most of the experimental work on the first model, $E = 0.2$, was carried out by A. S. Halliday, Miss D. K. Cox and Miss C. M. Tracy The author wishes to acknowledge the assistance of H. L. Nixon and W. C. Skelton with the later experiments.

References/

*The values of the derivatives, a_2, m_2, b_1 and b_2 are taken from the theoretical charts of Ref. 1.

References

No.	Author(s)	Title, etc.
1	L. W. Bryant, A. S. Halliday and A. S. Batson	Two-dimensional control characteristics. R. & M. 2730. April, 1950.
2	R. C. Pankhurst and H. B. Squire	Calculated pressure distributions for the RAE 100-104 aerofoil sections. C.P.80. March, 1950.
3	H. C. Garner and A. S. Batson	Measurement of lift, pitching moment and hinge moment on a two-dimensional cambered aerofoil. R. & M. 2946. December, 1952.
4	L. W. Bryant and H. C. Garner	Control testing in wind tunnels. R. & M. 2881. November, 1950.

Table 1/

Table 1

Ordinates of RAE 102 - Trailing-edge Angle = 10.91 deg.

x/c	100 y/c	x/c	100 y/c
0	0	0.35	4.9992
0.001	0.3701	0.36	4.9997
0.002	0.5231	0.38	4.9869
0.003	0.6402	0.4	4.9534
0.004	0.7388	0.42	4.8942
0.005	0.8254	0.44	4.8154
0.006	0.9036	0.45	4.7699
0.007	0.9753	0.46	4.7207
0.0075	1.0092	0.48	4.6124
0.008	1.0420	0.5	4.4920
0.009	1.1044	0.52	4.3603
0.01	1.1634	0.54	4.2201
0.012	1.2727	0.55	4.1465
0.0125	1.2985	0.56	4.0709
0.014	1.3727	0.58	3.9142
0.016	1.4655	0.6	3.7507
0.018	1.5523	0.62	3.5813
0.02	1.6340	0.64	3.4068
0.025	1.8205	0.65	3.3179
0.03	1.9873	0.66	3.2279
0.035	2.1390	0.68	3.0454
0.04	2.2786	0.7	2.8598
0.05	2.5293	0.72	2.6720
0.06	2.7506	0.74	2.4825
0.07	2.9491	0.75	2.3873
0.075	3.0412	0.76	2.2920
0.08	3.1291	0.78	2.1011
0.09	3.2937	0.8	1.9101
0.1	3.4450	0.82	1.7191
0.12	3.7142	0.84	1.5281
0.14	3.9463	0.85	1.4326
0.15	4.0505	0.86	1.3371
0.16	4.1475	0.88	1.1461
0.18	4.3219	0.9	0.9551
0.2	4.4727	0.92	0.7641
0.22	4.6021	0.925	0.7163
0.24	4.7117	0.94	0.5730
0.25	4.7595	0.95	0.4775
0.26	4.8027	0.96	0.3820
0.28	4.8761	0.975	0.2388
0.3	4.9323	0.98	0.1910
0.32	4.9718	0.9875	0.1194
0.34	4.9943	1.0	0

Table 2/

Table 2

Scope of Experiments

Balance Measurements of Lift, Pitching Moment and Hinge Moment.

$\eta = 0^\circ$		Range of α° from no-lift angle (at intervals of 1°)		
		Model, E = 0.2		Model, E = 0.4
		Wind speed = 60 ft/sec*	Wind speed = 40 ft/sec*	Wind speed = 60 ft/sec*
Smooth wing		−4 to +5	−4 to +5	−3 to +2, $\pm\frac{1}{2}$
Wires at x_u and x_l	= 0.1c	−5 to +5	−5 to +5	−5 to +5
	= 0.3c	−	−	−5 to +5
	= 0.4c	−2 to +2	−	−
	= 0.5c	−2 to +2	−	−2 to +2, $\pm\frac{1}{2}$
Wire at x_u	= 0.1c	−4 and +4	−4 and +4	−5 to +5
	= 0.3c	−3 and +3	0	−5 to +5
	= 0.5c	−3 and +3	−	−2 to +5
		Control settings, η=0° ±2° ±3° ±4° ±5° ±10° for E=0.2 η=0° ±1° ±2° ±3° ±5° ±10° for E=0.4		
<u>$\alpha = 0^\circ$</u>				
Smooth wing		−10 to +10	−10 to +10	−10 to +10
Wires at x_u and x_l	= 0.1c	−10 to +10	−10 to +10	−5 to +5
	= 0.3c	−	−	−5 to +5
	= 0.5c	−	−	−5 to +5
Wire at x_u	= 0.1c	−10 to +10	−10 to +10	−5 to +5
	= 0.3c	−10 to +10	−	−5 to +5
	= 0.5c	−10 to +10	−	−5 to +5
<u>$\alpha = -5^\circ$</u>				
Smooth wing		−5 to +5	−10 to +10	−5 to +5
<u>$\alpha = -2^\circ$</u>				
Smooth wing		−10 to +10	−10 to +10	−10 to +10
Wires at x_u and x_l	= 0.1c	−10 to +10	−10 to +10	−
Wire at x_u	= 0.1c	−5,−3,0,+3,+5	−5,−3,0,+3,+5	−
	= 0.3c	−5,−3,0,+3,+5	−	−
	= 0.5c	−5,−3,0,+3,+5	−	−
<u>$\alpha = +2^\circ$</u>				
Smooth wing		−10 to +10	−10 to +10	−10 to +10
Wires at x_u and x_l	= 0.1c	−10 to +10	−10 to +10	−
Wire at x_u	= 0.1c	−5,−3,0,+3,+5	−5,−3,0,+3,+5	−
	= 0.3c	−5,−3,0,+3,+5	−	−
	= 0.5c	−5,−3,0,+3,+5	−	−

Table 2 (contd.)/

Table 2 (contd.)

Pressure Distributions

	Model, E = 0.2		Model, E = 0.4
	Wind speed = 60 ft/sec	Wind speed = 40 ft/sec	Wind speed = 60 ft/sec
	α° from no lift angle ($\eta=0^\circ$)		
Smooth wing	-2,+2 0° (control surface only)	-	-2,+2
	Control setting, η° ($\alpha=0^\circ$)		
Smooth wing	-	-	-5,0,+3,+5,+10

*Actual V = 60.5 and 40.2_5 ft/sec.
R = 0.95×10^6 and 0.63×10^6.

Table 3/

Table 3

Uncorrected Coefficients from Balance Measurements.

(a) E = 0.2 : η = 0 deg., varying α

α (deg.)	C_L	C_m	C_H	C_L	C_m	C_H
	Smooth wing (60 ft/sec)			Wires at 0.1c (60 ft/sec)		
-5	-	-	-	-0.497_5	-0.0031	0.0190
-4	-0.397	-0.0018_5	0.0136	-0.394	-0.0018	0.0159
-3	-0.288_5	-0.0017_5	0.0094	-0.301	-0.0015	0.0116
-2	-0.193_5	-0.0010_5	0.0074	-0.197	-0.0008	0.0079
-1	-0.094_5	-0.0005_5	0.0031	-0.094_5	-0.0003	+0.0037
0	0	-0.0000_5	0	-	-	-
+1	+0.099	$+0.0005_5$	-0.0037	+0.094	+0.0003	-0.0037
2	0.196_5	0.0015_5	-0.0074	0.192	0.0005	-0.0074
3	0.300_5	0.0020_5	-0.0110	0.300_5	0.0015	-0.0117
4	0.401_5	0.0029_5	-0.0131	0.403_5	0.0021	-0.0154
5	0.494	0.0035_5	-0.0173	0.494_5	0.0030	-0.0170
	Wires at 0.5c (60 ft/sec)			Wires at 0.4c (60 ft/sec)		
-2	-0.197_5	-0.0011	0.0081	-0.193	-0.0019_5	0.0067
-1	-0.098	-0.0005	0.0044	-0.096	-0.0004_5	0.0046
0	$+0.000_5$	-0.0003	-0.0014	$+0.001_5$	-0.0000_5	-0.0002
+1	0.097_5	+0.0008	-0.0040	0.088_5	$+0.0004_5$	-0.0039
2	0.194	-0.0002	-0.0098	0.194_5	0.0004_5	-0.0086
	Smooth wing (40 ft/sec)			Wires at 0.1c (40 ft/sec)		
-5	-	-	-	-0.487_5	-0.0024	0.0179
-4	-0.403_5	-0.0018	0.0154	-0.406_5	-0.0012	0.0158
-3	-0.303	-0.0017	0.0106	-0.294_5	-0.0016	0.0108
-2	-0.199	-0.0008	0.0082	-0.203_5	-0.0013	0.0066
-1	-0.098_5	-0.0003	0.0058	-0.089_5	-0.0005	0.0028
0	0	-0.0001	-0.0002	+0.001	+0.0002	-0.0002
1	$+0.094_5$	+0.0006	-0.0038	+0.090	-0.0003	-0.0036
2	0.196	0.0009	-0.0086	0.208_5	+0.0010	-0.0081
3	0.298	0.0020	-0.0122	0.292_5	+0.0011	-0.0105
4	0.397	0.0023	-0.0134	0.392	0.0022	-0.0155
5	0.486_5	0.0030	-0.0182	0.478_5	0.0039	-0.0183

Table 3 (contd.)/

Table 3 (contd.)

(b) $E = 0.2 : \alpha = 0$ deg., varying η

η (deg.)	C_L	C_m	C_H	C_L	C_m	C_H
	Smooth Wing (60 ft/sec)			Wires at 0.1c (60 ft/sec)		
-10	-0.459_5	0.0936	0.1061	-0.436	0.0868	0.1008
-5	-0.233	0.0496	0.0558	-0.237_5	0.0447	0.0507
-4	-0.185	0.0401	0.0458	-0.176	0.0360	0.0428
-3	-0.131	0.0291	0.0335	-0.132_5	0.0261	0.0307
-2	-0.086_5	0.0193	0.0222	-0.094_5	0.0169	0.0206
0	0	-0.0000_5	0	0	0	0
2	$+0.085_5$	-0.0176	-0.0203	$+0.081_5$	-0.0176	-0.0197
3	0.136_5	-0.0274	-0.0314	0.129_5	-0.0268	-0.0303
4	0.178_5	-0.0377	-0.0426	0.171	-0.0356	-0.0403
5	0.220_5	-0.0457	-0.0519	0.213_5	-0.0449	-0.0498
10	0.461	-0.0925	-0.0993	0.410	-0.0851	-0.0963
	Smooth Wing (40 ft/sec)			Wires at 0.1c (40 ft/sec)		
-10	-0.470_5	0.0962	0.1126	-0.431	0.0865	0.1004
-5	-0.245_5	0.0505	0.0586	-0.215_5	0.0448	0.0496
-4	-0.193	0.0398	0.0467	-0.171_5	0.0357	0.0387
-3	-0.142	0.0300	0.0335	-0.128	0.0268	0.0297
-2	-0.098	0.0200	0.0227	-0.083	0.0176	0.0198
0	0	-0.0001	-0.0002	+0.001	+0.0002	-0.0002
2	+0.092	-0.0188	-0.0219	0.096_5	-0.0177	-0.0207
3	0.138	-0.0293	-0.0333	0.125	-0.0265	-0.0302
4	0.190	-0.0393	-0.0435	0.174_5	-0.0356	-0.0414
5	0.237_5	-0.0494	-0.0548	0.220	-0.0443	-0.0507
10	0.478	-0.0978	-0.1094	0.430_5	-0.0850	-0.0965

Table 3 (contd.)/

Table 3 (contd.)

(c) E = 0.2 : α = -5, -2, +2 deg., varying η

η (deg.)	C_L	C_m	C_H	C_L	C_m	C_H
	Smooth Wing (60 ft/sec)			Wires at 0.1c (60 ft/sec)		
		α=-5 deg.				
-5	-0.731_5	0.0430	0.0719			
-4	-0.684_5	0.0342	0.0602			
-3	-0.642	0.0251	0.0510			
-2	-0.598	0.0154	0.0396			
0	-0.504	-0.0025	0.0183			
2	-0.422_5	-0.0196	-0.0010			
3	-0.364	-0.0287	-0.0121			
4	-0.327	-0.0387	-0.0231			
5	-0.281_5	-0.0491	-0.0352			
		α=-2 deg.			α=-2 deg.	
-10	-0.637	0.0886	0.1100	-0.627_5	0.0843	0.1089
-5	-0.426	0.0471	0.0600	-0.418_5	0.0444	0.0580
-4	-0.378_5	0.0373	0.0481	-0.380_5	0.0354	0.0480
-3	-0.327	0.0272	0.0372	-0.335_5	0.0265	0.0386
-2	-0.280_5	0.0177	0.0268	-0.289_5	0.0181	0.0285
0	-0.193_5	-0.0010_5	0.0074	-0.197	-0.0008	0.0079
2	-0.107_5	-0.0189	-0.0141	-0.125_5	-0.0171	-0.0117
3	-0.065	-0.0286	-0.0251	-0.075_5	-0.0265	-0.0218
4	-0.016_5	-0.0384	-0.0362	-0.030_5	-0.0357	-0.0319
5	+0.028	-0.0479	-0.0472	$+0.012_5$	-0.0449	-0.0419
10	0.275	-0.0981	-0.1041	0.224	-0.0860	-0.0895
		α=+2 deg.			α=+2 deg.	
-10	-0.271_5	0.0985	0.1030	-0.225_5	0.0876	0.0920
-5	-0.029_5	0.0494	0.0477	-0.014	0.0444	0.0429
-4	+0.019	0.0400	0.0362	+0.036	0.0356	0.0329
-3	0.068	0.0292	0.0241	0.078	0.0264	0.0228
-2	0.114	0.0196	0.0136	0.120	0.0175	0.0132
0	0.196_5	0.0015_5	-0.0074	0.192	0.0005	-0.0074
2	0.288_5	-0.0189	-0.0300	0.291	-0.0177	-0.0270
3	0.340	-0.0276	-0.0393	0.336	-0.0266	-0.0370
4	0.374_5	-0.0417	-0.0508	0.378_5	-0.0359	-0.0476
5	0.435	-0.0467	-0.0611	0.437	-0.0447	-0.0580
10	0.637	-0.0868	-0.1108	0.625_5	-0.0842	-0.1076
	Smooth Wing (40 ft/sec)					
		α=-5 deg.				
-10	-0.924	0.0826	0.1223			
-5	-0.729	0.0431	0.0689			
-4	-0.683	0.0349	0.0583			
-3	-0.651	0.0251	0.0466			
-2	-0.596	0.0160	0.0371			
0	-0.501	-0.0025	0.0168			
2	-0.413	-0.0218	-0.0072			
3	-0.378_5	-0.0299	-0.0157			
4	-0.324_5	-0.0403	-0.0289			
5	-0.280	-0.0501	-0.0410			
10	-0.048_5	-0.0993	-0.0985			

Table 3 (contd.)/

Table 3 (contd.)

(c) contd. E = 0.2 : α = -5, -2, +2 deg., varying η

η (deg.)	C_L	C_m	C_H	C_L	C_m	C_H
	Smooth Wing (40 ft/sec)			Wires at 0.1c (40 ft/sec)		
	α=-2 deg.			α=-2 deg.		
-10	-0.646	0.0910	0.1154	-0.622_5	0.0821	0.1076
-5	-0.436_5	0.0484	0.0668	-0.415_5	0.0424	0.0558
-4	-0.397	0.0390	0.0561	-0.364_5	0.0341	0.0458
-3	-0.352_5	0.0288	0.0430	-0.321	0.0252	0.0366
-2	-0.302_5	0.0191	0.0311	-0.281	0.0157	0.0262
0	-0.199	-0.0008	0.0082	-0.203_5	-0.0013	0.0066
2	-0.113_5	-0.0200	-0.0135	-0.112	-0.0194	-0.0140
3	-0.064_5	-0.0299	-0.0243	-0.067_5	-0.0270	-0.0232
4	-0.022_5	-0.0400	-0.0363	-0.035	-0.0362	-0.0317
5	$+0.030_5$	-0.0503	-0.0508	$+0.009_5$	-0.0429	-0.0401
10	0.095	-0.1000	-0.1112	0.209	-0.0873	-0.0909
	α=+2 deg.			α=+2 deg.		
-10	-0.290_5	0.1004	0.1096	-0.227_5	0.0869	0.0914
-5	-0.047	0.0504	0.0491	-0.019	0.0447	0.0421
-4	+0.009	0.0404	0.0383	$+0.019_5$	0.0374	0.0323
-3	0.056	0.0298	0.0251	0.081_5	0.0278	0.0222
-2	0.102	0.0199	0.0130	0.110	0.0191	0.0129
0	0.196	0.0009	-0.0086	0.208_5	+0.0010	-0.0081
2	0.287	-0.0191	-0.0315	0.277_5	-0.0168	-0.0268
3	0.338	-0.0288	-0.0422	0.333	-0.0253	-0.0380
4	0.390_5	-0.0380	-0.0529	0.382_5	-0.0343	-0.0483
5	0.427_5	-0.0475	-0.0624	0.412_5	-0.0436	-0.0589
10	0.636	-0.0887	-0.1134	0.613	-0.0851	-0.1303

Table 4/

Table 4

Uncorrected Coefficients from Balance Measurements

(a) E = 0.4 : η = 0 deg., varying α : V = 60 ft/sec.

α (deg.)	C_L	C_m	C_H	C_L	C_m	C_H
		Smooth Wing			Wires at 0.1c	
-5				-0.510	-0.0008_5	0.0400
-4				-0.402_5	-0.0014	0.0314
-3	-0.299	-0.0003	0.0236	-0.300_5	-0.0006	0.0241
-2	-0.198_5	$+0.0004_5$	0.0155	-0.199_5	-0.0016	0.0157
-1	-0.103	0.0000_5	0.0082	-0.102_5	+0.0002	0.0090
-0.5	-0.056	+0.0004	0.0044			
0	-0.001	-0.0001	-0.0002_5	-0.003	-0.0020	0
+0.5	$+0.048_5$	-0.0001	-0.0044			
1	0.105_5	-0.0005_5	-0.0090_5	$+0.104_5$	$+0.0000_5$	-0.0081
2	0.210	+0.0002	-0.0175	0.201_5	0.0007_5	-0.0149
3				0.303	0.0007_5	-0.0234
4				0.405	0.0025	-0.0305
5				0.503	0.0024_5	-0.0382
		Wires at 0.5c			Wires at 0.3c	
-5				-0.506_5	$+0.0002_5$	0.0408
-4				-0.402	-0.0003_5	0.0316
-3				-0.304	-0.0006_5	0.0237
-2	-0.197_5	-0.0004_5	0.0165	-0.200_5	-0.0001_5	0.0163
-1	-0.100_5	$+0.0000_5$	0.0092_5	-0.104	-0.0000_5	0.0082
-0.5	-0.049_5	-0.0000_5	0.0045			
0	$+0.001_5$	$+0.0000_5$	-0.0002	-0.001	-0.0003	-0.0001_5
+0.5	0.051_5	-0.0007	-0.0045			
1	0.105	-0.0001_5	-0.0086	$+0.100_5$	0	-0.0085
2	0.196	-0.0000_5	-0.0157	0.205_5	$+0.0000_5$	-0.0175
3				0.308_5	-0.0002_5	-0.0256
4				0.402_5	$+0.0002_5$	-0.0319
5				0.511_5	0.0003	-0.0411

Table 4 (contd.)/

Table 4 (contd.)

(b) E = 0.4 : α = 0 deg., varying η : V = 60 ft/sec.

η (deg.)	C_L	C_m	C_H	C_L	C_m	C_H
	Smooth Wing			**Wires at 0.1c**		
-10	-0.701_5	0.0938	0.1235			
-5	-0.367	0.0510	0.0665	-0.357	0.0463	0.0625
-3	-0.218	0.0307	0.0395	-0.209_5	0.0265	0.0360
-2	-0.146	0.0212	0.0277	-0.140	0.0165	0.0232
-1	-0.072	0.0099	0.0130	-0.072_5	0.0069	0.0110
0	-0.001	-0.0001	-0.0002_5	-0.003	-0.0020	0
1	+0.064	-0.0101	-0.0131	$+0.059_5$	-0.0117_5	-0.0126
2	0.145	-0.0213	-0.0265	0.129	-0.0215_5	-0.0253
3	0.216	-0.0327	-0.0406	0.197_5	-0.0310	-0.0371
5	0.367	-0.0525_5	-0.0667	0.350_5	-0.0510_5	-0.0635
10	0.695_5	-0.0996	-0.1247			
	Wires at 0.5c			**Wires at 0.3c**		
-5	-0.356_5	0.0517	0.0660	-0.361_5	0.0491_5	0.0633_5
-3	-0.213	0.0316_5	0.0396	-0.211_5	0.0287	0.0363_5
-2	-0.139_5	0.0212_5	0.0266	-0.139	0.0192	0.0238_5
-1	-0.067	0.0113_5	0.0150	-0.069_5	0.0091_5	0.0116_5
0	$+0.001_5$	0.0000_5	-0.0002	-0.001	-0.0003	-0.0001_5
1	0.068	-0.0093	-0.0120	$+0.066_5$	-0.0105	-0.0138_5
2	0.151	-0.0201_5	-0.0267	0.134_5	-0.0201_5	-0.0251_5
3	0.216_5	-0.0303_5	-0.0389	0.209	-0.0303	-0.0371_5
5	0.372_5	-0.0512	-0.0660	0.356	-0.0507_5	-0.0651_5

(c) E = 0.4 : α = -5, -2, +2 deg., varying η

Smooth Wing (60 ft/sec)						
	α=-5°					
-5	-0.847_5	0.0445	0.1028			
-3	-0.728	0.0271	0.0774			
-2	-0.656	0.0174	0.0643			
-1	-0.592_5	0.0099	0.0549			
0	-0.524_5	-0.0010	0.0402			
1	-0.454_5	-0.0097	0.0288			
2	-0.385_5	-0.0193	0.0173			
3	-0.315	-0.0296	0.0032			
5	-0.176	-0.0486	-0.0205			
	α=-2°			**α=+2°**		
-10	-0.837	0.0912	0.1425	-0.518_5	+0.1002	0.1130
-5	-0.551	0.0481	0.0765	-0.147_5	0.0508	0.0468
-3	-0.405_5	0.0285	0.0508	+0.001	0.0298	0.0202
-2	-0.329	0.0177	0.0367	0.072	0.0197	+0.0078
-1	-0.265	0.0093	0.0265	0.141	0.0092	-0.0055
0	-0.198_5	0.0004_5	0.0155	0.210	+0.0002	-0.0175
1	-0.125	-0.0099	+0.0022	0.285	-0.0103	-0.0308
2	-0.058	-0.0195	-0.0103	0.357_5	-0.0199	-0.0423
3	+0.015	-0.0301	-0.0243	0.430_5	-0.0296	-0.0548
5	0.165	-0.0513	-0.0511	0.576_5	-0.0490	-0.0805
10	0.546	-0.1025	-0.1190	0.886_5	-0.0911	-0.1379

Table 5/

Table 5

Measured Pressure Distributions. Uncorrected $(p - p_0)/\frac{1}{2}\rho V^2$

$E = 0.2 : \eta = 0^\circ$: Smooth Wing (60 ft/sec).

x/c	Upper Surface for α =			x/c	Lower Surface for α =		
	-2 deg.	0 deg.	+2 deg.		-2 deg.	0 deg.	+2 deg.
0.0010	0.990		-	0.0007	+0.132		-
0.0017	0.965		-	0.0020	-0.183		-
0.0037	0.852		-0.361	0.0037	-0.393		-
0.0080	0.618		-	0.0080	-0.535		0.618
0.0163	0.357		-0.677	0.0163	-0.628		0.369
0.0247	0.234		-0.708	0.0247	-0.629		0.258
0.0370	0.152		-0.572	0.0370	-0.560		-
0.0497	0.093		-0.538	0.0497	-0.529		+0.105
0.0663	+0.024		-0.537	0.0663	-0.519		-
0.0827	-0.026		-0.540	0.0833	-0.515		-0.017
0.0997	-0.053		-0.521	0.1000	-0.492		-0.038
0.124	-0.075		-0.471	0.125	-0.466		-0.057
0.150	-0.097		-0.460	0.151	-0.445		-0.088
0.199	-0.126		-0.445	0.200	-0.424		-0.134
0.249	-0.154		-	0.250	-0.416		-
0.299	-0.183		-0.408	0.300	-0.416		-0.183
0.349	-0.191		-0.388	0.349	-0.404		0.199
0.375	-0.193		-	0.374	-0.383		-
0.399	-0.197		-0.372	0.400	-0.377		-0.197
0.425	-0.191		-	0.424	-0.353		-
0.450	-0.183		-0.334	0.450	-0.342		-0.189
0.500	-0.158		-	0.500	-0.292		-
0.549	-0.132		-	0.549	-0.248		-
0.599	-0.108		-0.201	0.600	-0.211		-0.111
0.650	-0.075		-	0.649	-0.165		-
0.699	-0.043		-0.108	0.699	-0.120		-0.053
0.738	-0.024		-0.082	0.739	-0.087		-0.036
0.802	+0.032	0.004	-0.034	0.803	-0.136	-0.119	-0.109
0.817	0.028	0.006	-0.028	0.817	-0.082	-0.081	-0.035
0.834	0.028	0.004	-0.016	0.833	-0.060	-0.035	-0.012
0.851	0.032	0.004	-0.012	0.850	-0.042	-0.022	+0.006
0.867	0.035	0.012	-	0.867	-0.018	-0.004	-
0.884	0.048	0.022	+0.002	0.884	-0.003	+0.012	0.028
0.901	0.047	0.028	0.022	0.900	+0.014	0.022	0.043
0.917	0.059	0.039	0.030	0.916	0.030	0.035	0.049
0.934	0.061	0.052	-	0.933	0.041	0.052	-
0.951	0.081	0.069	0.067	0.950	0.067	0.071	0.075
0.967	0.093	0.095	-	0.967	0.087	0.099	-
0.976	0.103	0.102	0.099	0.975	0.108	0.112	0.112
0.984	0.112	0.118	-	0.983	0.114	0.128	-
0.989	0.120	0.112	0.118	0.990	0.128	0.124	0.120

Table 6

Measured Pressure Distributions. Uncorrected $\frac{p - p_o}{\frac{1}{2}\rho V^2}$

E = 0.4 : Smooth Wing (60 ft/sec)

x/c	Upper Surface							x/c	Lower Surface						
	α = 0 deg. for η =				η = 0 deg. for α =				α = 0 deg. for η =				η = 0 deg. for α =		
	-5 deg.	+3 deg.	5 deg.	10 deg.	-2 deg.	0 deg.	+2 deg.		-5 deg.	+3 deg.	5 deg.	10 deg.	-2 deg.	0 deg.	+2 deg.
0.0002	0.979	0.564	+0.248	-0.842	0.991	0.867	+0.253	0.0002	+0.438	0.995	0.963	0.570	0.333	0.932	0.925
0.0012	0.936	0.184	-0.143	-1.186	0.964	0.560	-0.088	0.0010	-0.013	0.916	0.983	0.938	+0.184	0.694	0.972
0.0027	0.859	+0.096	-0.227	-1.130	0.908	0.459	-0.325	0.0025	-0.299	0.711	0.857	0.995	-0.363	0.412	0.816
0.0057	0.656	-0.165	-0.455	-1.224	0.607	0.199	-0.419	0.0053	-0.438	0.511	0.677	0.927	-0.449	0.227	0.664
0.0097	0.459	-0.331	-0.600	-1.293	0.502	+0.013	-0.577	0.0093	-0.643	0.271	0.447	0.744	-0.609	-0.026	0.513
0.0140	0.365	-0.293	-0.620	-1.199	0.376	-0.051	-0.711	0.0142	-0.549	0.188	0.400	0.671	-0.641	-0.024	0.350
0.0237	0.203	-0.451	-0.658	-1.137	0.226	-0.199	-0.669	0.0250	-0.630	0.056	0.207	0.487	-0.658	-0.169	0.229
0.0340	0.147	-0.421	-0.602	-1.015	0.173	-0.199	-0.611	0.0357	-0.596	+0.002	0.137	0.391	-0.585	-0.196	0.139
0.0497	0.075	-0.423	-0.577	-0.927	0.077	-0.229	-0.573	0.0510	-0.564	-0.041	0.073	0.306	-0.551	-0.226	0.077
0.0750	+0.002	-0.417	-0.541	-0.825	+0.004	-0.250	-0.523	0.0757	-0.555	-0.105	0	0.211	-0.525	-0.254	+0.004
0.1000	-0.026	-0.400	-0.517	-0.769	-0.038	-0.263	-0.508	0.1007	-0.513	-0.126	-0.021	0.175	-0.485	-0.261	-0.058
0.125	-0.041	-0.395	-0.496	-0.692	-0.053	-0.256	-0.461	0.126	-0.494	-0.122	-0.039	0.143	-0.468	-0.256	-0.062
0.150	-0.068	-0.410	-0.496	-0.692	-0.085	-0.267	-0.457	0.151	-0.496	-0.149	-0.062	0.117	-0.442	-0.267	-0.088
0.200	-0.102	-0.412	-0.499	-0.686	-0.135	-0.291	-0.451	0.201	-0.498	-0.177	-0.103	0.071	-0.444	-0.293	-0.143
0.250	-0.115	-0.412	-0.499	-0.686	-0.162	-0.295	-0.429	0.251	-0.502	-0.192	-0.115	0.051	-0.421	-0.297	-0.165
0.300	-0.128	-0.429	-0.509	-0.696	-0.188	-0.314	-0.427	0.301	-0.502	-0.207	-0.132	0.030	-0.408	-0.316	-0.194
0.350	-0.124	-0.423	-0.509	-0.701	-0.199	-0.308	-0.402	0.351	-0.498	-0.196	-0.124	0.034	-0.395	-0.310	-0.201
0.374	-0.122	-0.414	-0.494	-0.696	-0.197	-0.303	-0.387	0.375	-0.498	-0.194	-0.124	0.036	-0.376	-0.303	-0.205
0.400	-0.113	-0.414	-0.496	-0.696	-0.201	-0.295	-0.368	0.400	-0.487	-0.190	-0.109	0.049	-0.363	-0.295	-0.197
0.425	-0.092	-0.385	-0.455	-0.675	-0.194	-0.276	-0.342	0.426	-0.474	-0.175	-0.098	0.064	-0.357	-0.282	-0.186
0.450	-0.077	-0.378	-0.455	-0.671	-0.180	-0.269	-0.323	0.450	-0.461	-0.158	-0.083	0.079	-0.325	-0.273	-0.190
0.500	-0.041	-0.353	-0.455	-0.675	-0.167	-0.227	-0.288	0.501	-0.425	-0.120	-0.039	0.133	-0.286	-0.224	-0.175
0.525	-0.019	-0.329	-0.431	-0.671	-0.156	-0.212	-0.288	0.525	-0.417	-0.094	-0.015	0.158	-0.270	-0.211	-0.145
0.598	-	-	-	-	-	-	-	0.598	-0.641	+0.229	+0.412	0.617	-	-0.130	-0.073

Table 6 (contd.)/

Table 6 (contd.)

x/c	Upper Surface							x/c	Lower Surface						
	α = 0 deg. for η =				η = 0 deg. for α =				α = 0 deg. for η =				η = 0 deg. for α =		
	-5 deg.	+3 deg.	5 deg.	10 deg.	-2 deg.	0 deg.	+2 deg.		-5 deg.	+3 deg.	5 deg.	10 deg.	-2 deg.	0 deg.	+2 deg.
0.603	+0.254	-0.493	-0.713	-1.327	-0.117	-0.190	-0.271	0.603	-0.647	0.145	0.286	0.547	-0.229	-0.164	-0.085
0.613	0.177	-0.406	-0.553	-0.904	-0.098	-0.160	-0.227	0.613	-0.556	0.081	0.190	0.425	-0.207	-0.154	-0.079
0.628	0.141	-0.329	-0.438	-0.696	-0.090	-0.137	-0.196	0.628	-0.462	0.036	0.128	0.325	-0.196	-0.135	-0.077
0.648	0.105	-0.271	-0.363	-0.583	-0.070	-0.111	-0.164	0.648	-0.378	0.026	0.107	0.282	-0.165	-0.109	-0.062
0.673	0.090	-0.218	-0.303	-0.487	-0.045	-0.090	-0.141	0.672	-0.301	0.015	0.100	0.241	-0.145	-0.086	-0.049
0.698	0.083	-0.184	-0.256	-0.402	-0.039	-0.077	-0.122	0.699	-0.259	0.015	0.077	0.214	-0.122	-0.077	-0.045
0.749	0.073	-0.132	-0.188	-0.290	-0.015	-0.053	-0.085	0.748	-0.186	0.030	0.073	0.182	-0.083	-0.047	-0.015
0.799	0.073	-0.083	-0.126	-0.197	+0.004	-0.021	-0.053	0.799	-0.124	0.034	0.071	0.160	-0.049	-0.017	0
0.823	0.075	-0.060	-0.096	-0.160	0.013	-0.006	-0.034	0.823	-0.094	0.045	0.075	0.139	-0.026	-0.004	+0.015
0.849	0.075	-0.039	-0.066	-0.118	0.019	+0.004	-0.017	0.849	-0.073	0.047	0.075	0.133	-0.021	+0.004	0.023
0.875	0.075	-0.019	-0.060	-0.088	0.036	0.017	-0.002	0.873	-0.062	0.019	0.043	0.090	+0.008	0.015	0.032
0.899	0.079	-0.002	-0.013	-0.058	0.053	0.032	+0.017	0.899	-0.019	0.058	0.079	0.107	0.024	0.030	0.043
0.924	0.081	+0.026	+0.013	-0.032	0.064	0.049	0.034	0.924	+0.006	0.056	0.068	0.083	0.045	0.036	0.049
0.949	0.092	0.055	0.043	0	0.086	0.073	0.068	0.949	0.043	0.077	0.088	0.088	0.070	0.066	0.068
0.974	0.098	0.081	0.079	+0.030	0.094	0.096	0.096	0.974	0.079	0.105	0.107	0.075	0.094	0.098	0.098
0.984	0.088	0.098	0.092	0.030	0.094	0.098	0.100	0.984	0.096	0.128	0.117	0.071	0.113	0.117	0.113

Table 7/

Table 7

(a) Measured and Integrated Coefficients

E	α (deg.)	η (deg.)	C_L Balance	C_L Integration	C_m Balance	C_m Integration	C_H Balance	C_H Integration
0.2	±2	0	0.1949	0.1988				
0.4	±2	0	0.2041	0.2021	-0.0001_5	$+0.0009_5$	-0.0165	-0.0163
	0	±3	0.2164	0.2277	-0.0321	-0.0321	-0.0401	-0.0419
	0	±5	0.3670	0.3802	-0.0519	-0.0528	-0.0666	-0.0680
	0	±10	0.6982	0.7172	-0.0978	-0.0975	-0.1241	-0.1226

(b) Integrated C_H : different values of E : E = 0.4 model

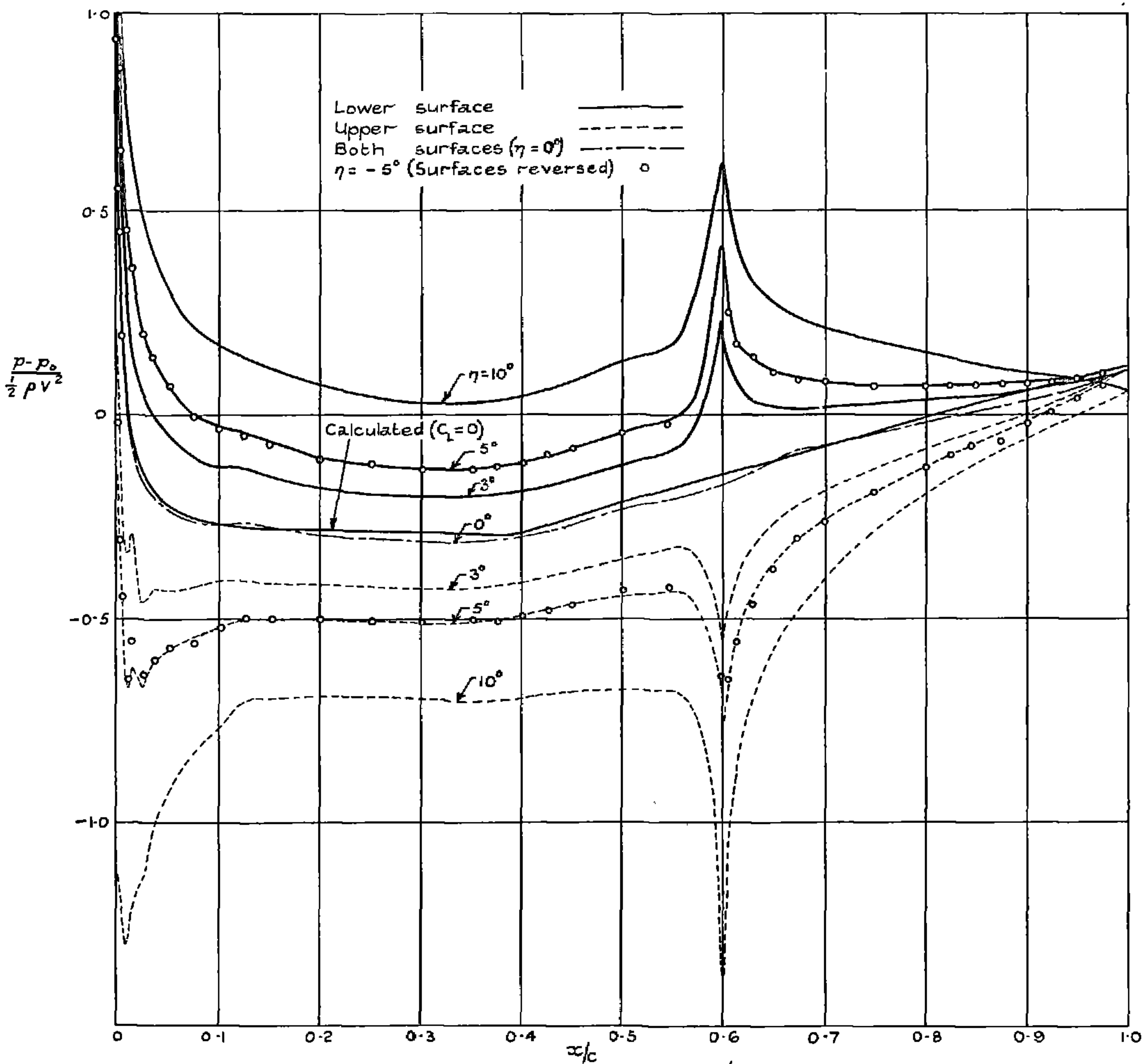
E	α (deg.)	η (deg.)	Integrated C_H
0.1	±2	0	-0.0030
0.2	±2	0	-0.0076
0.3	±2	0	-0.0116
0.4	±2	0	-0.0163

Table 8

Derivative	Theoretical	Smooth Wing	Wires at 0.5c	Wires at 0.4c	Wires at 0.3c	Wires at 0.1c
		E = 0.2 (60 ft/sec)				
a_1	6.767	5.33	5.33_5	5.29	-	5.27
m_1	-0.0704	0.063	0.062	0.060_5	-	0.056_5
b_1	-0.414	-0.18	-0.207	-0.204	-	-0.191
h	0.2604	0.2382	0.238_4	0.238_6	-	0.239_3
a_2	3.721	2.46	-	-	-	2.42
m_2	-0.677	-0.522	-	-	-	-0.485
b_2	-0.792	-0.601	-	-	-	-0.567
		E = 0.4 (60 ft/sec)				
a_1	6.767	5.60	5.56_5	-	5.51	5.45_8
m_1	-0.0704	0.028_5	0.032	-	0.034_5	0.046
b_1	-0.681	-0.438	-0.445	-	-0.419	-0.390
h	0.2604	0.244_9	0.244_3	-	0.243_7	0.241_6
a_2	5.060	3.97	3.94	-	3.88	3.79
m_2	-0.638	-0.566	-0.561	-	-0.539	-0.524
b_2	-0.911	-0.720_5	-0.714	-	-0.683	-0.671
		E = 0.2 (40 ft/sec)				
a_1	6.767	5.30_5	-	-	-	5.24
m_1	-0.0704	0.057_5	-	-	-	0.054_5
b_1	-0.414	-0.204_5	-	-	-	-0.182
h	0.2604	0.239_2	-	-	-	0.239_6
a_2	3.721	2.63	-	-	-	2.40
m_2	-0.677	-0.544	-	-	-	-0.489
b_2	-0.792	-0.622	-	-	-	-0.558

Table 9/

FIG. 5.



Smooth wing: V = 60 ft / sec

Pressure distributions at α = 0 deg for various control settings (E = 0·4)

<u>Table 10</u>

Comparison of Experimental Derivatives and Values from Charts (Ref. 1)

RAE 102 Aerofoil (10% thick)

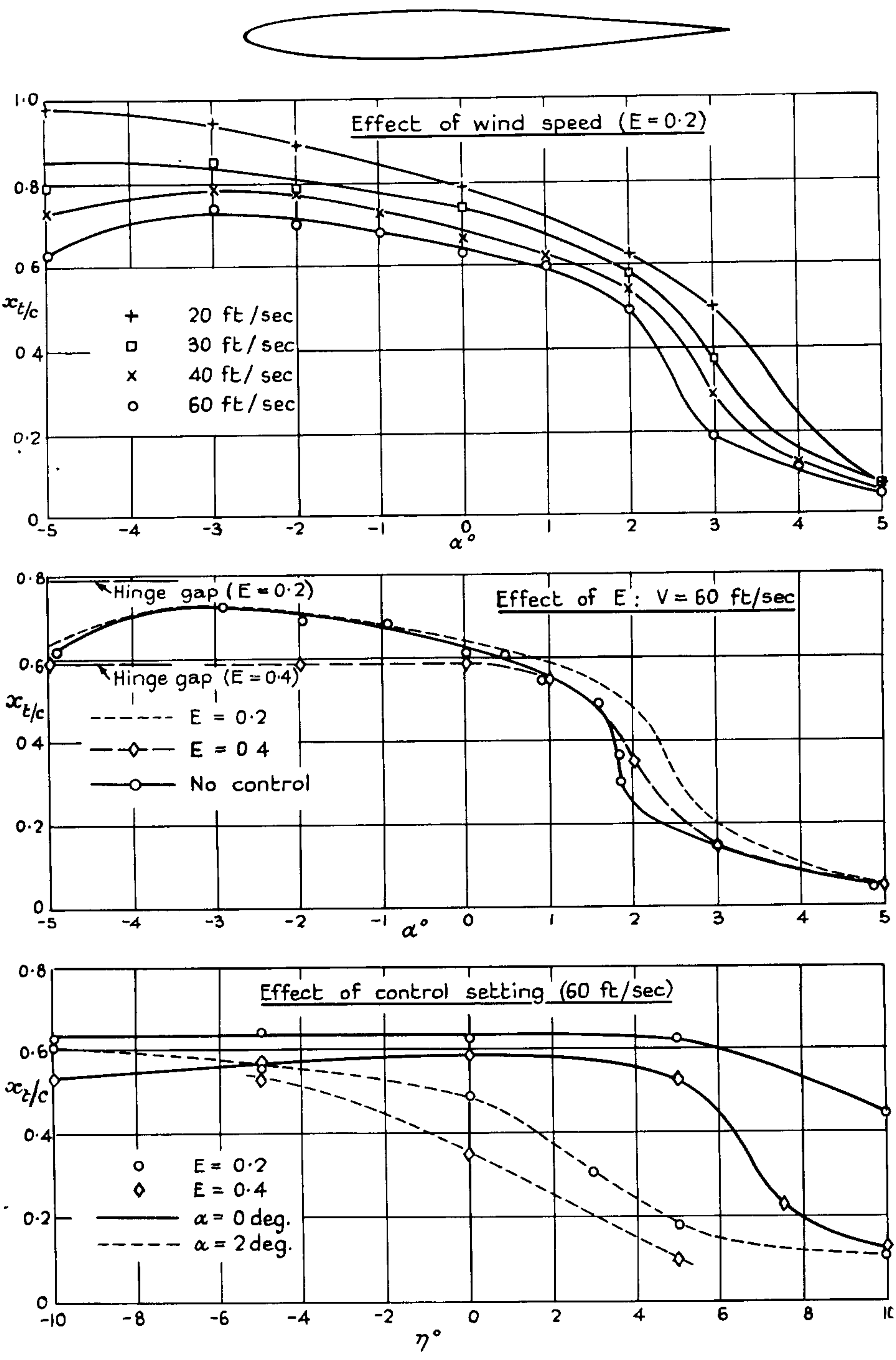
Derivative	Fig. of Ref. 1	From Charts (Ref. 1)				From Experiments			
		E = 0.2		E = 0.4		E = 0.2		E = 0.4	
		Transition		Transition		Transition		Transition	
		back	forward	back	forward	back	forward	back	forward
$a_1/(a_1)_T$	-	0.786*	0.777*	0.826*	0.805*	0.786	0.777	0.826	0.805
a_2/a_1	18	0.479	0.448	0.731	0.702	0.462	0.459	0.709	0.695
$b_1/a_1/(b_1/a_1)_T$	29, 30	0.896	0.932	0.889	0.370	0.55_5	0.595	0.779	0.712
$b_2/a_1/(b_2/a_1)_T$	31, 32	0.922	0.904	1.000	0.997	0.965	0.922	0.957	0.915
$b_1/(b_1)_T$	-	0.704	0.724	0.734	0.700	0.43_5	0.462	0.643	0.573
$b_2/(b_2)_T$	-	0.725	0.702	0.826	0.803	0.758	0.716	0.791	0.737
$h/(h)_T$	65	0.919	0.913	0.939	0.928	0.915	0.919	0.940	0.928
$^{**}m/(m)_T$	67	0.803	0.756	1.02	1.00	0.864	0.801	1.002	0.950

*taken from experiment

$$^{**}m = -m_2 + \frac{a_2}{a_1} m_1$$

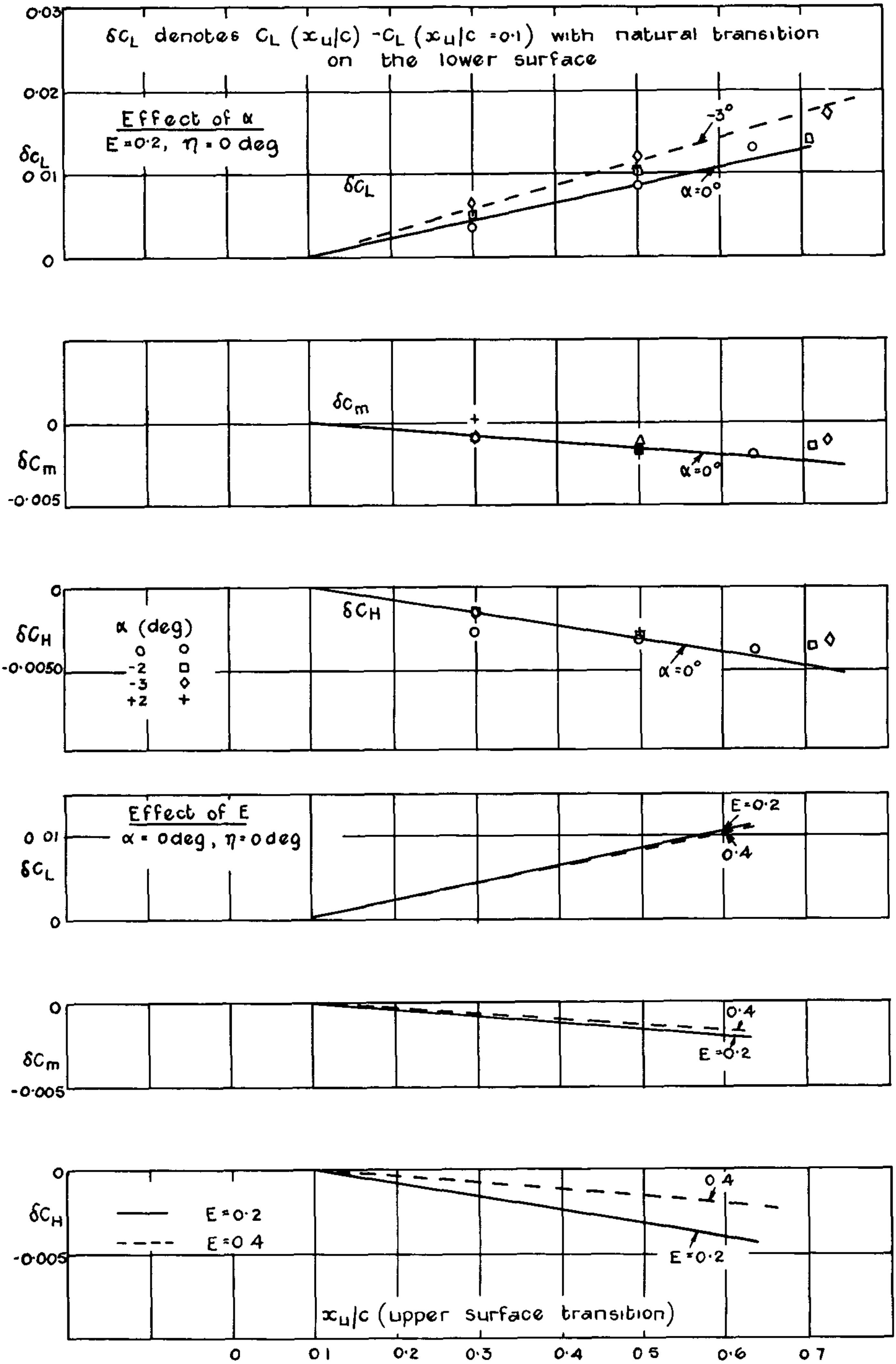
JDS : KM.

Fig. 1.



Variation of natural transition on upper surface

FIG 2a



Variation of lift, pitching moment and hinge moment with transition

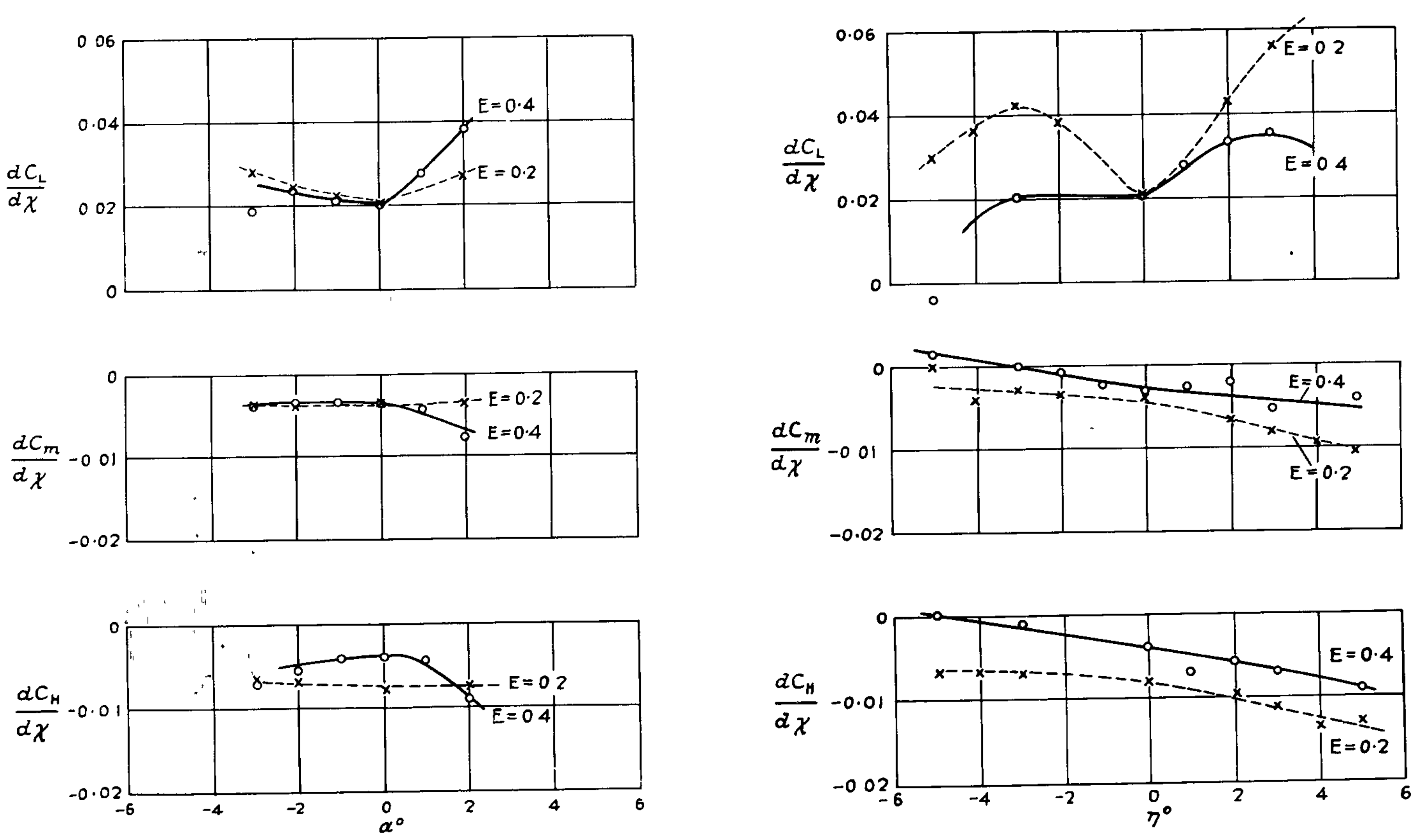
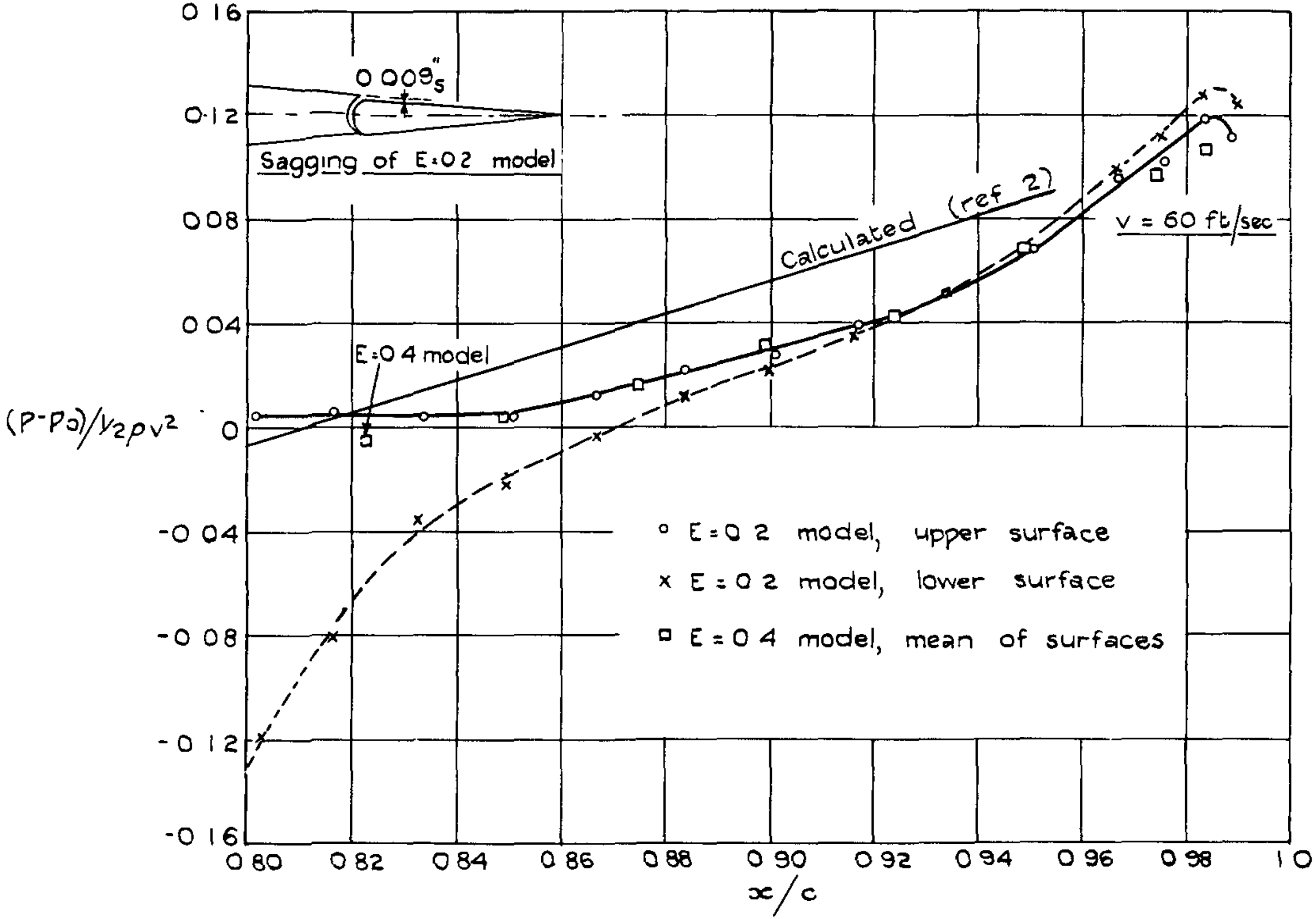


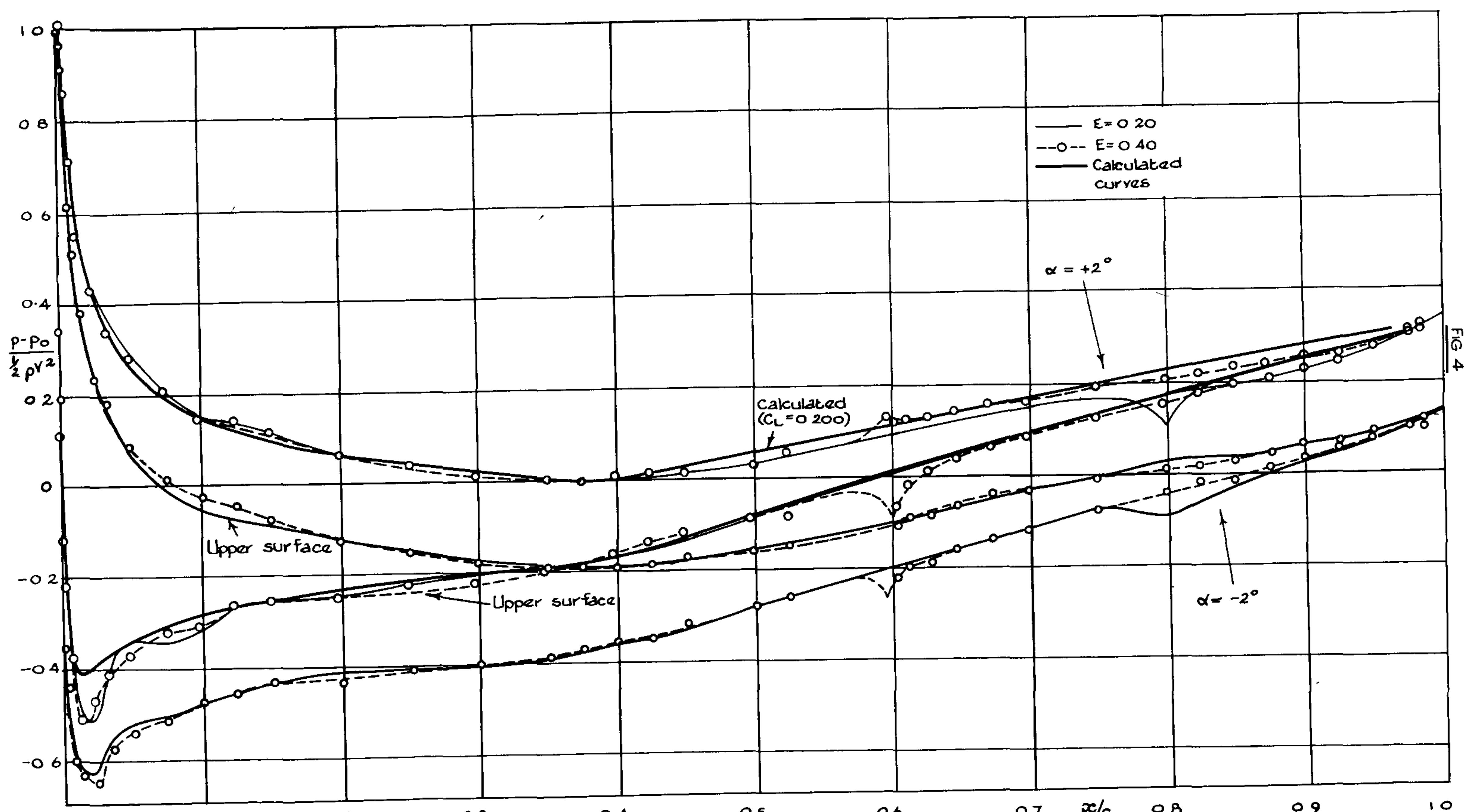
FIG. 2b.

Rate of variation of coefficients with change of transition.

FIG. 3

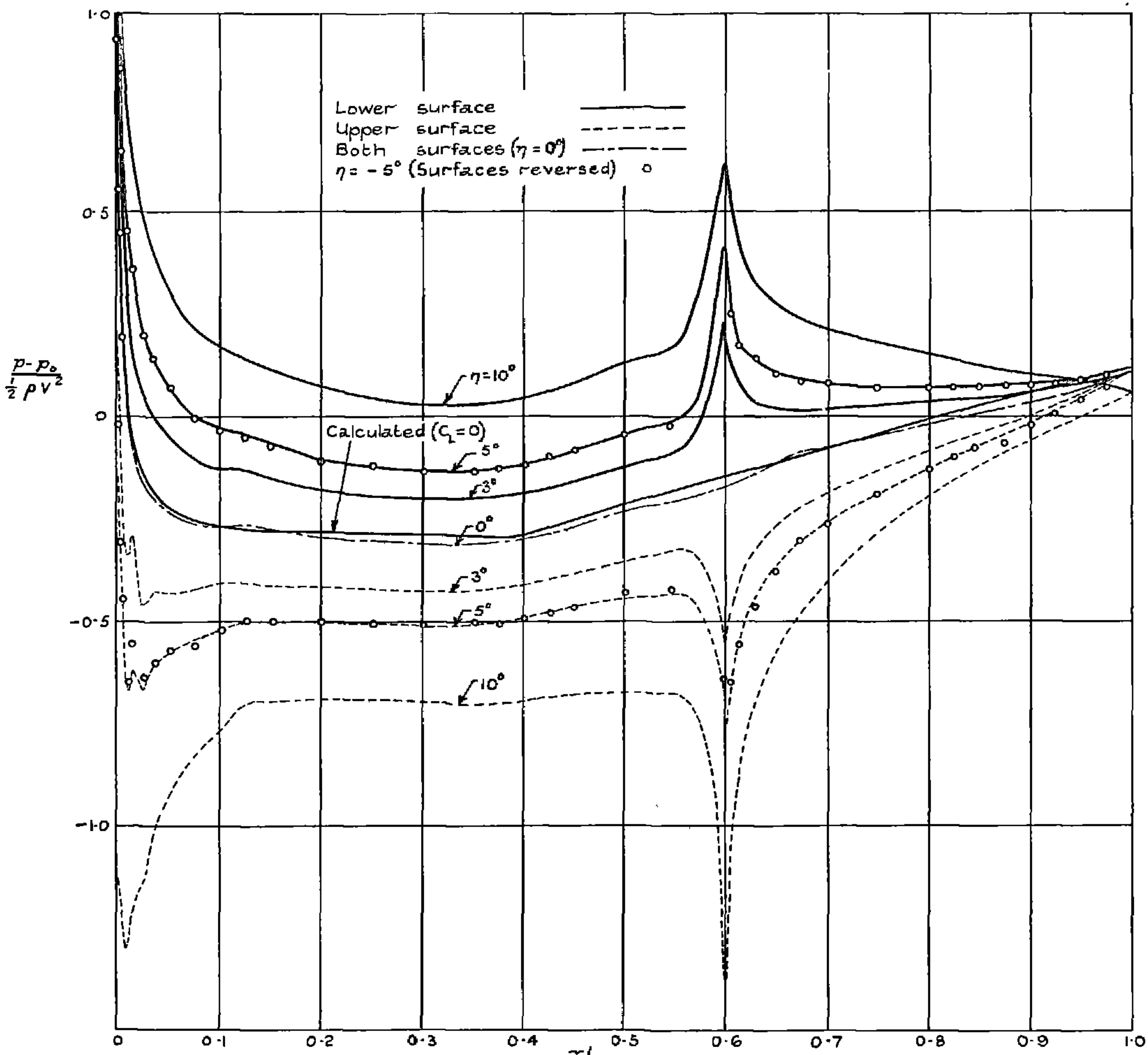


Pressure distribution on the rear 20% of the aerofoils at $\alpha = 0$ deg, $\eta = 0$ deg.



Pressure distributions on aerofoils at $\alpha = \pm 2$ deg, $\eta = 0$ deg

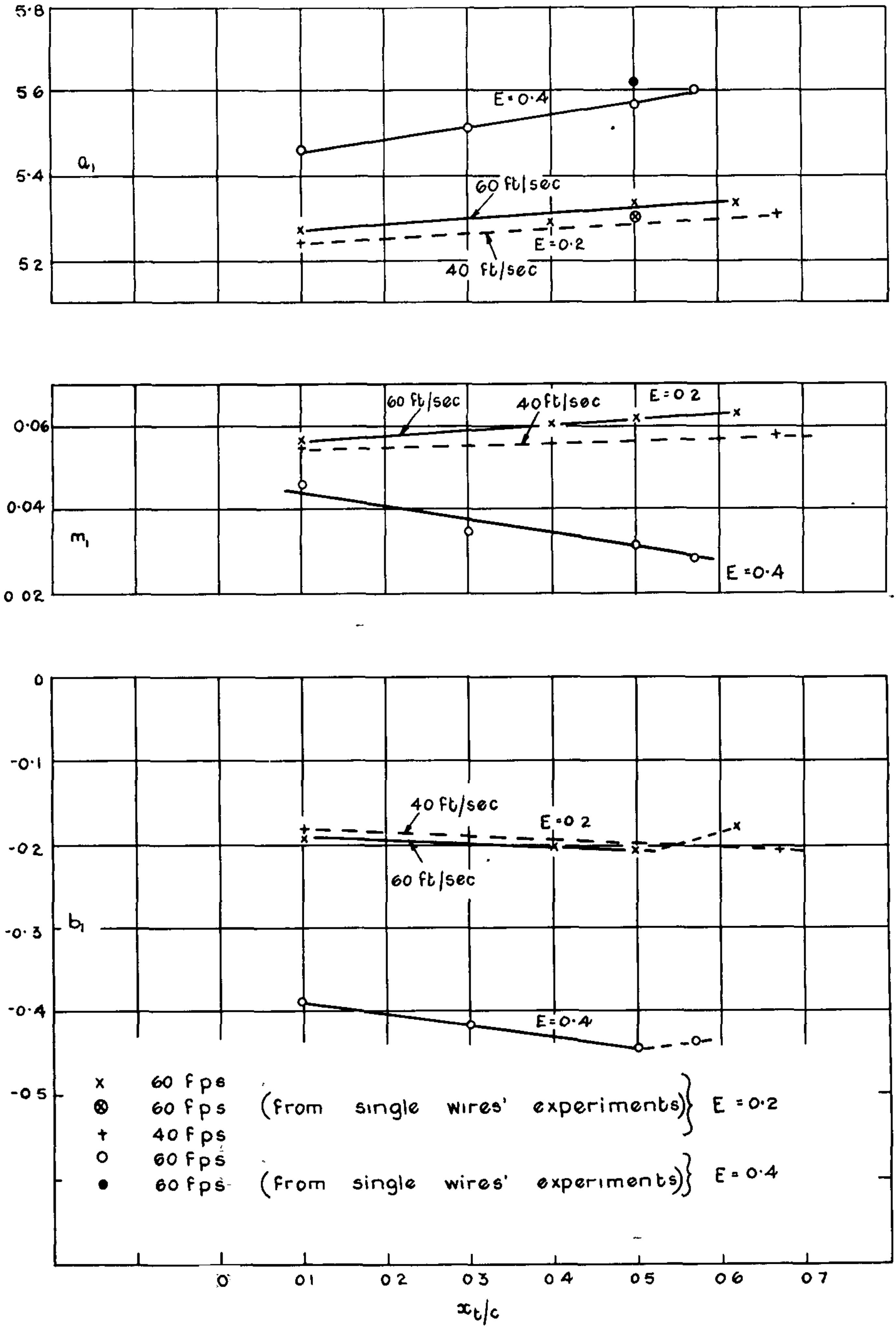
FIG. 5.



Smooth wing: V = 60 ft / sec

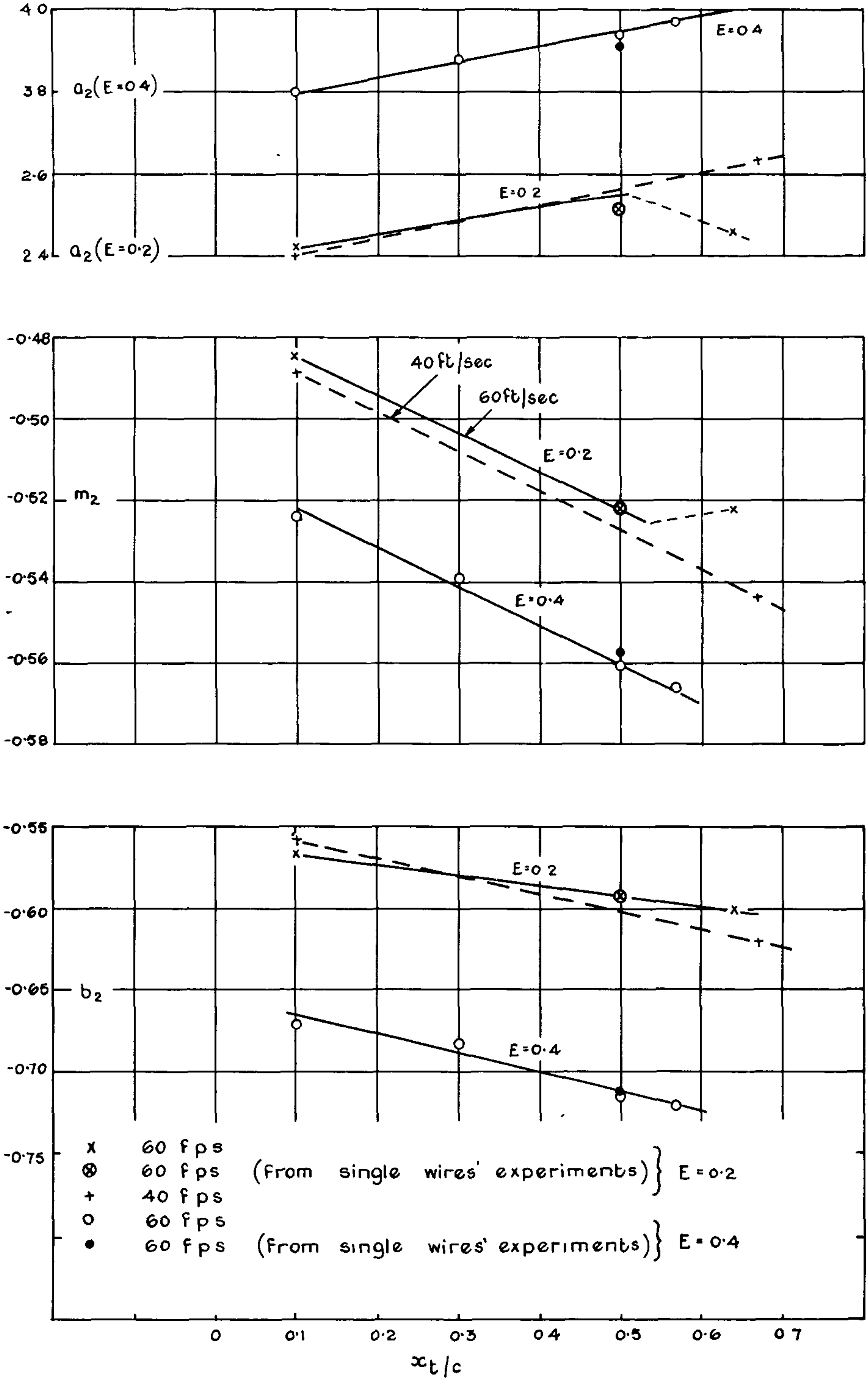
Pressure distributions at α = 0 deg for various control settings (E = 0·4)

FIG 6



Experimental a_1, m_1, b_1 against position of transition

FIG 7



Experimental a_2, m_2, b_2 against position of transition.

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