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With an Appendix on Pressures over Surface of Control Fitted with Strips

By

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of the Aerodynamics Division, N.P.L.

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Summary.—Reasons for Investigation.—To find a method of modifying ailerons so that a machine may be more responsive in roll.

Range of Investigation.—(1) Hinge moment was measured on a 1/2·25 scale "Hurricane" aileron with the following modifications :—

(*a*) Strips (depth 0·02 in. and 0·04 in.) fitted near trailing edge.
(*b*) Aileron chord increased from 0·18*c* to 0·22*c* and 0·26*c*.
(*c*) Aileron chord 0·22*c*, extended to the wing tip.
Strips (depth 0·04 in.) also fitted near trailing edge.

Range of aileron angle 0° to ±15° ;
Range of incidence —4° to 8°.

(2) Pressures were measured over the surface of a control (0·4*c*) of an aerofoil (N.A.C.A. 0020 section, 30 in. chord) with and without strips (depth 0·05 in.–0·20 in.) or cords (0·09 in. diameter) by means of a static pressure tube : Angles of incidence 0°, 4° and 8° : Control angles ±10° and ±15°.

Results.—b_1 $(dC_H/d\alpha)$ and b_2 $(dC_H/d\xi)$ are both increased negatively by about 0·2 when strips of about 0·8 per cent. of aileron chord are fitted to the "Hurricane" aileron. These slopes are increased similarly when aileron chord is increased, but by a little under half the amount (Fig. 6). Extending the aileron to the wing tip also increases b_1 and b_2 (Fig. 7). In magnitude this increase in b_1 lies roughly between that due to fitting 0·04 in. strips, and that due to increasing the aileron chord from 0·18*c* to 0·26*c*. The value of b_2 is appreciably affected by gap at the nose.

Measurements of pressure over the surface of a control reveal the following facts :—

(*a*) Increase in magnitude of hinge moment due to strips is due to a boosting up of pressure at and forward of strip. This is considerable for a down-going (positive) control but may be negligible for a small negative setting (Fig. 9).

(*b*) If the diameter of cords and the depth of strips are the same, and if the cords or strips are at the same fore and aft position along control, the effect on hinge moment will be approximately the same (Fig. 9).

(*c*) The optimum position for strip is at the trailing edge (Fig. 11).

(*d*) Hinge moment increases as depth of strip increases (Fig. 10).

(*e*) Only the strips on the pressure side of the control are effective : on a down-going control, a lower surface strip gives the same increase in hinge moment as both strips, while on an up-going control it reduces the effectiveness of the upper strip (Fig. 12).

These experiments were made in order to ascertain whether it is possible to modify the existing design of ailerons so as to enable fighter machines to bank faster at high speeds. To do this, it appears necessary to obtain an aileron such that the operating control force decreases as soon as the roll commences.

If P = control force to initiate a roll,

and kP = control force when rolling is established,

it has been found that k would be of the order $1 - \frac{1}{4}\, b_1/b_2$,

where b_1 = slope of hinge moment—incidence curve $(dC_H/d\alpha)$,

and b_2 = slope of hinge moment—aileron setting curve $(dC_H/d\xi)$.

It is thus seen that the value of k depends on the sign and magnitude of b_1/b_2. For a reduction in the control force after the roll has commenced, i.e., k less than 1, b_1/b_2 must be positive ; and, as b_2 for ailerons with a small degree of underbalance must of necessity be of negative sign, b_1 must also be negative. Further, it is seen from the above that in order to halve the initial force, b_1 should be of the order of twice b_2.

There is but little data on b_1 available. The following modifications have therefore been made to an existing aileron with a view to obtaining a large negative value of b_1 :—

(*a*) By fitting strips (or cords) on both surfaces of the control along the trailing edge.

(*b*) By increasing the chord of the control.

(*c*) By extending the control to and beyond the wing tip.

These results show that strips, each of about 0·8 per cent. of the mean aileron chord in depth, increase both b_1 and b_2 negatively by about 0·2, that increasing the aileron chord from 18 per cent. to 22 per cent. of the wing chord similarly increases these slopes but by a little under half the amount and that extending the aileron to the wing tip increases appreciably in magnitude both negative b_1 and b_2, the increase in b_1 being generally slightly the greater. Thus it appears that a large positive value of b_1/b_2 can be obtained, if the increase in underbalance due to fitting strips (or cords) or modifying the control be neutralised by use of geared tabs, shrouded balance or any other means provided that these modifications do not materially alter the increase in negative b_1.

These experiments were carried out in the 7 ft. No. 2 wind tunnel at a wind speed of 60 ft. per sec. The model available was the outer portion of the " Hurricane " wing, scale 1/2·25, which had previously been used for experiments on the aerodynamic balancing of controls.[1] A photograph showing the arrangement of the model in the tunnel and a drawing of the wing, with section, are given in Figs. 1 and 2 respectively. In the case of aileron extended to wing tip it is seen that an extreme case has been taken, the wing tip being raked to an angle of 30°. The aileron was practically unbalanced, the flow-through from the pressure side to the suction side of the wing just forward of the aileron hinge being prevented by a rubber diaphragm extending along the entire span of the control. To obtain an aileron movement of at least ±15°, the nose was recessed as seen in Fig. 2. As some ailerons (such as the " Frise " with a positive setting) have a gap forward of the nose giving a flow-through from the lower to the upper surface thus altering the flow over the aileron, it was also thought to be of interest to investigate the effect of such a flow-through on the present model by removing the rubber diaphragm. The scope of the experiments is shown at a glance in the following table :—

Aileron Chord	Range of α (degrees)	
$0 \cdot 18c$	$-4, 0, 4, 8$	no strips
	$-4, 0, 4, 8$	strips, depth $0 \cdot 02$ in.
	$-4, 0, 4, 8$	strips, depth $0 \cdot 04$ in.
$0 \cdot 22c$	$-4, 0, 4, 8$	no strips
	$-4, 0, 4$	strips, depth $0 \cdot 04$ in.
$0 \cdot 26c$	$-4, 0, 4, 8$	no strips
	$-4, 0, 4$	strips, depth $0 \cdot 04$ in.
	Aileron extended to wing tip	
$0 \cdot 22c$	$-4, 0, 4, 8$	no strips
	$-4, 0, 4$	strips, depth $0 \cdot 04$ in.
	(with a flow-through forward of aileron nose)	
	$0, 4$	no strips
	$0, 4$	strips, depth $0 \cdot 04$ in.

Range of aileron angle, mostly from $0°$ to $\pm 15°$.
Mean chord of aileron, rear of hinge $= 0 \cdot 18c$ (normal).
$= 0 \cdot 423$ ft.

The strips were $0 \cdot 08$ in. in width and were fitted in both surfaces of the aileron, the distance between the trailing edges of aileron and strip being of the order of $0 \cdot 10$ in.

Hinge moment was measured on a roof balance by the usual method and is here given in the form of coefficient :—

$$C_H = \frac{H}{qS_\xi \, c_\xi},$$

where
$H =$ hinge moment,
$S_\xi =$ aileron area aft of hinge,
$c_\xi =$ mean aileron chord aft of hinge,
$q = \frac{1}{2}\rho V^2$.

In the tables, the coefficients have been multiplied by 10^3.

The results are given in Tables 1–4 and in Figs. 3–5. They have been corrected for the drag of wires and for the deflection of the aileron under load.

Curves of C_H against aileron angle, ξ, for different angles of incidence have not been plotted. Generally speaking, they are lines nearly straight and almost parallel.

By cross-plotting the results given in Tables 1–4 for aileron angles $0°$ and $\pm 10°$, curves of C_H against α are shown plotted in Fig. 3 for aileron of normal chord ($0 \cdot 18c$), in Fig. 4 for aileron of increased chord, and in Fig. 5 for aileron extended to wing tip. These curves clearly show the appreciable negative change in slope due to fitting strips to the control.

These slopes, b_1 ($dC_H/d\alpha$), given as the mean slope at $\alpha = 0°$, together with b_2 ($dC_H/d\xi$) are given tabulated in Tables 5 and 6. They are also shown plotted against strip depth as abscissa in Figs. 6 and 7. The following are the salient features of these curves. Both b_1 and b_2 are increased negatively by the addition of strips, the increase being of the order of $0 \cdot 2$ for $0 \cdot 04$ in. strip depth (about 0·8 per cent. c_s). Although the rate of increase appears to fall off as the strip depth increases, too much reliance cannot be placed on this conclusion as only a 0·005 in. error in measurement of strip depth is necessary to give a proportional variation. The curves show a similar result for the effect of increase in aileron chord except that the magnitude is less. Altering the chord from $0 \cdot 18c$ to $0 \cdot 22c$ gives a variable negative increase in b_1 and b_2, but generally it is of the order of a little less than 0·1. Extending the aileron to the wing tip on a tapered wing such as the " Hurricane " also increases the negative values of both b_1 and b_2, the increase in b_1 being generally the larger especially at small angles of incidence. This is clearly shown in Fig. 7 where it is also seen that roughly the same increase is obtained when 0·04 in. strips are fitted. As regards magnitude of b_1, the results indicate that the effect of extending the aileron to the wing tip roughly comes between that of fitting 0·04 in. strips and that of increasing the aileron chord from 18 per cent. to 26 per cent. Fig. 7 also reveals that the increase in b_2 due to extending the aileron to the wing tip appears to become progressingly greater as α increases. Referring to Fig. 5, it is seen that fitting strips tends to straighten the curves of hinge moment against incidence thus making b_1 roughly independent of α.

The effect of a flow-through forward of the nose of the aileron is given in Table 4. The values of C_H indicate that without strips b_2 is reduced and with strips it is a little increased by a flow-through. From these tests it appears that fitting strips to an aileron should be a means of obtaining quite a large positive value of b_1/b_2 if the increase in negative b_2 is neutralised by fitting a geared tab, a shrouded balance or by any other method provided that the increase in negative b_1 is not thereby appreciably altered by these modifications to the aileron. Previous experiments[2] indicate the effect of a tab on b_1 to be small, but, although not conclusive, there is an indication that fitting a shrouded balance would give a small positive b_1.

Appendix

The first part of this report revealed the fact that strips or cords of very small depth—less than 1 per cent. of the control chord—fastened near the trailing edge of the control, gave results of much greater magnitude than would be expected from so small a modification. The experiments described in this Appendix were made in an endeavour to throw further light on the subject. After unsuccessful attempts to visualise by means of hot-wire shadow-graphs the effect on the flow produced by the strips, an exploration of the pressure normal to the control surface with and without strips was made over both surfaces of the control. This indicated that the large negative increase in hinge-moment due to strips for a positive control setting was, in the main, the result of a large boosting up of pressure at and forward of the strip itself.

The model on which this work was carried out was an aerofoil, 5 ft. span and 30 in. chord, of symmetrical section, N.A.C.A. 0020, the ratio maximum thickness to chord being thus 20 per cent. This aerofoil was designed so that the trailing edge portion operated as a flap of 12 inches chord ($0 \cdot 4c$). To enable this control to be set over through a range of control settings, the nose was recessed and, to prevent a flow-through from the pressure to the suction side of the aerofoil, a rubber diaphragm was used as in the case of the " Hurricane " wing (see Fig. 2). The curtain gap was set at a constant value of 0·3 in.

Pressures against atmosphere were measured on a " Chattock " manometer by means of a static-pressure tube, 0·05 in. diameter, in the upper surface of which a small hole, 0·03 in. diameter, had been drilled 0·3 in. from the forward sealed end. This tube was supported so that it could be traversed along and parallel to the surface of the control at the mid-section of the aerofoil (see Fig. 8). The work was carried out in the Open Jet Tunnel No. 1 at a wind speed of 40 ft. per sec.

The results, expressed as the non-dimensional coefficient, intensity of pressure/$\frac{1}{2}\rho V^2$ (p/q), have been plotted against distance from hinge along and perpendicular to the plane of symmetry of the control. From these curves were computed hinge moments expressed in the usual form of coefficient, viz. :—

$$\frac{\text{hinge moment (lb. ft. per ft. run)}}{\frac{1}{2}\rho\, V^2 c_1{}^2}$$

where $c_1 =$ chord of control (hinge to trailing edge).

Only the p/q curves illustrating the following points are given plotted in the report :—

(*a*) Effect of strips, depth 0·1 in., at $\alpha = 8°$ and $\theta = \pm 15°$ (approx.) together with the effect of cords, 0·09 in. diameter (Fig. 9).

(*b*) Effect of strip depth at $\alpha = 8°$ and $\theta = + 10°$ (approx.) (Fig. 10).

(*c*) Effect of fore and aft positions of strip, depth 0·2 in., at $\alpha = 8°$ and $\theta = +10°$ (approx.) (Fig. 11).

(*d*) Effect of strips, depth 0·1 in., taken separately and together at $\alpha{=}8°$ and $\theta = \pm 10°$ (approx.) (Fig. 12).

It is seen in Fig. 9 that the increase in hinge moment is mainly due to a boosting up of pressure at and forward of the strip or cord. This is most marked for the down-going (positive) control ; while this sudden increase, which is quite small at an up-going setting of $-15°$, is almost non-existent at $-10°$ (see Fig. 12). This apparently gives a reason as indicated in Fig. 13, in which hinge moment is plotted against control setting and angle of incidence, for the increase in negative b_1 ($dC_H/d\alpha$) due to strips at neutral control setting. It is further seen in Fig. 9 that cords and strips of approximately the same diameter and depth (0·1 in.) and at the same fore and aft position along the control (i.e., the leading edges being coincident) give roughly the same pressure diagram. The points in the figure give the results obtained by substituting cords for strips.

The effect of varying the depth and the fore and aft position of the strips at $\alpha = 8°$, $\theta{=}10°$ (approx.) is shown in Figs. 10 and 11. It appears that the sudden boosting up of pressure at and just forward of the strips increases approximately in proportion to the strip depth, at any rate up to a depth of 0·2 in. There is, however, a sudden and uniform increase in suction over practically the whole surface (the upper) when the strip depth is increased from 0·1 in. to 0·2 in. For smaller depths the effect of strips on suction is quite small (see also Fig. 9). The hinge moment curve against strip depth, also given in Fig. 10, shows that the moment due to strips is roughly proportional to strip depth.

It is also found that the optimum position for strip effect is at the trailing edge of the control. For this experiment strips 0·2 in. deep were used and the pressure curves indicate that the boosting up of the pressure decreases as the strips are moved forward from the trailing edge.

It was thought to be of interest to find the effect of strips taken separately and the result is given both as pressures and hinge moments in Fig. 12 for a positive and negative control setting. The only strip which proves to be effective is the one on the pressure side of the control, that is, the strip on the lower surface for the down-going or positive setting and on the upper surface for the negative setting. It can also be seen in Fig. 9 that whereas the upper surface strip on the down-going control has no apparent effect, the lower surface strip on the up-going control reduces the effectiveness of the other strip.

Hinge moment coefficient calculated from the pressure diagrams, for the various cases tried, has been plotted against control angle and angle of incidence in Fig. 13. The curves again indicate the effectiveness of strips, as shown before from direct balance measurements on the "Hurricane" aileron, in increasing negatively both b_1 and b_2.

In conclusion, the authors wish to acknowledge the assistance given by H. L. Nixon and K. C. Wight in taking the observations and in working out the results.

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TABLE 1

No Strips

	18% Aileron		22% Aileron		26% Aileron	
$\alpha°$	$\xi°$ (Aileron Angle)	$C_H \times 10^3$	$\xi°$	$C_H \times 10^3$	$\xi°$	$C_H \times 10^3$
−4	−14·8	100·6	−14·7	114·5	−14·5	118·6
	− 9·9	60·7	− 9·8	77·0	− 9·7	83·5
	− 4·9	33·8	− 4·9	46·2	− 4·8	48·3
	− 2·5	20·1	− 2·4	28·9	− 2·4	29·3
	0	+ 7·2	0	+ 10·9	0	+ 11·0
	+ 2·5	− 5·0	+ 2·5	− 6·0	+ 2·5	− 7·0
	5·0	− 18·7	4·9	− 24·1	4·9	− 25·4
	9·9	− 42·6	9·8	− 59·1	9·7	− 63·5
	14·9	− 74·6	14·7	− 94·0	14·6	−100·4
0	−14·8	90·7	−14·7	102·7	−14·6	108·9
	− 9·9	56·9	− 9·8	73·2	− 9·7	77·1
	− 4·9	35·4	− 4·9	41·8	− 4·8	40·6
	− 2·5	23·1	− 2·4	23·8	− 2·4	22·3
	0	+ 10·1	0	+ 6·9	0	+ 3·7
	+ 2·5	− 2·6	+ 2·5	− 10·6	+ 2·4	− 14·6
	5·0	− 16·7	4·9	− 29·2	4·9	− 33·3
	9·9	− 44·0	9·8	− 63·1	9·7	− 71·9
	14·8	− 83·6	14·7	−102·2	14·5	−110·6
4	−14·8	82·0	−14·7	98·8	−14·6	105·2
	− 9·9	62·2	− 9·8	72·0	− 9·7	71·3
	− 4·9	38·6	− 4·9	36·6	− 4·9	33·6
	− 2·5	25·4	− 2·4	18·8	− 2·4	+ 15·7
	0	+ 11·6	0	+ 0·9	0	− 4·0
	+ 2·5	− 2·6	+ 2·5	− 16·4	+ 2·4	− 22·4
	5·0	− 17·2	4·9	− 35·6	4·8	− 42·1
	9·9	− 51·2	9·8	− 71·0	9·7	− 80·0
	14·8	− 96·7	14·7	−115·0	14·5	−123·6
8	−14·9	76·6	−14·7	96·5	−14·6	100·5
	− 9·9	62·5	− 9·8	65·0	− 9·8	61·7
	− 4·9	37·1	− 4·9	28·9	− 4·9	21·7
	− 2·5	23·1	− 2·5	+ 10·3	− 2·5	+ 2·4
	0	+ 8·9	0	− 8·0	− 0·1	− 16·1
	+ 2·5	− 6·5	+ 2·4	− 26·2	+ 2·4	− 35·6
	5·0	− 21·4	4·9	− 44·4	4·8	− 54·4
	9·9	− 61·4	9·8	− 81·6	9·6	− 92·8
	14·8	−108·1	14·6	−129·1	14·4	−141·6

TABLE 2

0·04 *in. Strips*

	18% Aileron		22% Aileron		26% Aileron	
α°	ξ° (Aileron Angle)	$C_H \times 10^3$	ξ°	$C_H \times 10^3$	ξ°	$C_H \times 10^3$
−4	−14·5	146·1	−14·5	160·4	−14·3	164·9
	− 9·8	104·7	− 9·6	121·0	− 9·5	123·1
	− 4·9	67·0	− 4·8	73·7	− 4·7	73·7
	− 2·4	42·7	− 2·4	48·9	− 2·3	49·2
	0	+ 17·5	+ 0·1	+ 22·5	+ 0·1	+ 23·0
	+ 2·5	− 7·1	2·5	− 3·6	2·5	− 3·4
	4·9	− 31·9	4·9	− 30·0	4·9	− 28·6
	9·8	− 79·2	9·8	− 82·9	9·7	− 81·0
	14·8	−124·3	14·6	−133·8	14·5	−132·9
0	−14·7	134·0	−14·6	146·7	−14·4	152·0
	− 9·8	96·0	− 9·7	106·9	− 9·6	105·4
	− 4·9	54·3	− 4·8	57·2	− 4·8	56·0
	− 2·4	29·0	− 2·4	31·4	− 2·4	30·4
	0	+ 3·1	0	+ 4·0	0	+ 3·4
	+ 2·5	− 22·0	+ 2·4	− 22·7	+ 2·4	− 22·0
	4·9	− 46·7	4·9	− 50·5	4·8	− 48·3
	9·8	− 92·0	9·7	−101·3	9·6	−100·6
	14·7	−139·3	14·6	−151·7	14·4	−152·3
4	−14·8	120·5	−14·6	137·8	−14·5	136·9
	− 9·8	86·3	− 9·7	90·0	− 9·7	87·0
	− 4·9	40·0	− 4·9	38·3	− 4·9	35·0
	− 2·5	+ 14·6	− 2·5	+ 11·3	− 2·5	+ 10·4
	0	− 11·3	0	− 15·9	− 0·1	− 17·1
	+ 2·4	− 36·8	+ 2·4	− 42·5	+ 2·3	− 43·9
	4·9	− 61·3	4·8	− 68·8	4·7	− 69·1
	9·8	−106·3	9·6	−120·6	9·5	−121·0
	14·7	−156·5	14·5	−169·0	14·3	−169·6
8	−14·8	109·6				
	− 9·9	70·9				
	− 5·0	+ 22·2				
	− 2·5	− 3·7				
	− 0·1	− 28·0				
	+ 2·4	− 51·6				
	4·9	− 74·7				
	9·8	−120·2				
	14·6	−167·4				

TABLE 3

0·02 *in. Strips*

	18% Aileron	
$\alpha°$	$\xi°$	$C_H \times 10^3$
−4	−14·7	132·8
	− 9·8	89·0
	− 4·9	54·3
	− 2·4	35·3
	0	+ 14·7
	+ 2·5	− 7·1
	4·9	− 28·8
	9·9	− 70·0
	14·8	−106·9
0	−14·8	117·2
	− 9·8	81·7
	− 4·9	46·5
	− 2·5	25·9
	0	+ 4·7
	+ 2·5	− 17·6
	4·9	− 38·6
	9·8	− 77·0
	14·8	−118·5
4	−14·8	104·9
	− 9·9	77·3
	− 4·9	38·4
	− 2·5	+ 17·2
	0	− 5·4
	+ 2·4	− 27·0
	4·9	− 48·0
	9·8	− 86·9
	14·7	−135·4
8	−14·8	97·0
	− 9·9	68·3
	− 5·0	26·3
	− 2·5	+ 5·0
	0	− 16·2
	+ 2·4	− 37·6
	4·9	− 57·0
	9·8	− 99·3
	14·7	−145·9

TABLE 4

Aileron Extended to Wing Tip. (*Originally* 22% *Chord*)

$\alpha°$	No Strips		Strips (0·04 in. deep)		No Strips		Strips (0·04 in. deep)	
	$\xi°$ (Aileron Angle)	$C_H \times 10^3$	$\xi°$	$C_H \times 10^3$	$\xi°$	$C_H \times 10^3$	$\xi°$	$C_H \times 10^3$
					With a flow-through forward of aileron nose.			
−4	−14·7	154·9	—	—				
	− 9·8	98·2	−9·8	145·1				
	− 4·9	55·5	−4·9	85·2				
	− 2·4	33·6	—	—				
	0	+ 12·6	0	+ 25·0				
	2·5	− 8·2	—	—				
	5·0	− 28·5	4·9	− 37·3				
	9·9	− 63·8	9·8	− 97·6				
	14·8	−108·1	—	—				
0	−14·8	122·4	—	—	—	—	—	—
	− 9·9	80·7	−9·8	120·4	−9·9	72·5	−9·8	+120·8
	− 4·9	40·8	−4·9	+ 60·2	−4·9	38·5	—	—
	− 2·5	+ 20·5	—	—	—	—	—	—
	0	− 0·6	0	− 2·6	0	+ 1·2	0	− 0·9
	+ 2·5	− 22·1	—	—	—	—	—	—
	4·9	− 43·7	+4·9	− 65·8	4·9	−39·0	—	—
	9·8	− 86·1	9·8	−128·4	9·9	−77·2	9·8	−132·0
	14·7	−132·5	—	—	—	—	—	—
4	−14·8	109·2	—	—	—	—	—	—
	− 9·9	73·0	−9·8	92·1	−9·9	66·6	−9·8	99·4
	− 4·9	30·4	−4·9	+ 30·6	−5·0	+28·3	−4·9	+ 37·9
	− 2·5	+ 8·1	—	—	—	—	—	—
	0	− 14·9	−0·1	− 35·1	0	−13·0	−0·1	− 36·5
	+ 2·4	− 36·2	—	—	—	—	—	—
	4·9	− 59·7	+4·8	− 98·6	4·9	−53·6	+ 4·8	−103·9
	9·8	−103·6	+9·7	−163·0	9·8	−99·3	9·7	−162·6
	14·9	−165·4	—	—	—	—	—	—
8	−14·8	104·0						
	− 9·9	64·6						
	− 5·0	+ 19·6						
	− 2·5	− 4·6						
	0	− 28·2						
	+ 2·4	− 51·0						
	4·9	− 73·8						
	10·0	−124·7						
	15·1	−191·5						

TABLE 5

	b_2				b_1*		
	$\alpha = -4°$	$\alpha = 0°$	$\alpha = +4°$	$\alpha = +8°$	$\xi = -10°$	$\xi = 0°$	$\xi = +10°$
18% Aileron							
No strips	−0·300	−0·297	−0·323	−0·348	+0·015	+0·031	−0·077
0·02 in. strips	−0·475	−0·481	−0·495	−0·487	−0·084	−0·142	−0·132
0·04 in. strips	−0·558	−0·570	−0·581	−0·562	−0·139	−0·209	−0·197
22% Aileron							
No strips	−0·405	−0·407	−0·423	−0·428	−0·038	−0·066	−0·097
0·04 in. strips	−0·605	−0·626	−0·628		−0·236	−0·287	−0·287
26% Aileron							
No strips	−0·435	−0·441	−0·447	−0·454	−0·085	−0·109	−0·125
0·04 in. strips	−0·615	−0·619	−0·621		−0·269	−0·302	−0·289

* Mean slope at α=0°.

TABLE 6

Aileron Extended to Wing Tip. (Originally 22% *Chord)*

	b_2				b_1*		
	$\alpha = -4°$	$\alpha = 0°$	$\alpha = +4°$	$\alpha = +8°$	$\xi = -10°$	$\xi = 0°$	$\xi = +10°$
1. Original aileron (22% chord)— no strips.	−0·405	−0·407	−0·423	−0·428	−0·038	−0·066	−0·097
2. Aileron extended to wing tip— no strips	−0·477	−0·489	−0·516	−0·540	−0·146	−0·195	−0·279
with flow-through		−0·445	−0·476				
3. Aileron extended to wing tip— 0·04 in. strips	−0·707	−0·735	−0·751		−0·364	−0·427	−0·467
with flow-through		−0·742	−0·802				

* Mean slope at α = 0°.

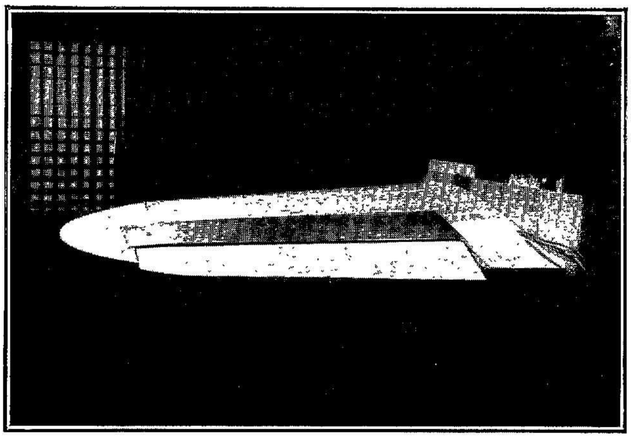


Fig. 1.—Arrangement of Model in Tunnel.

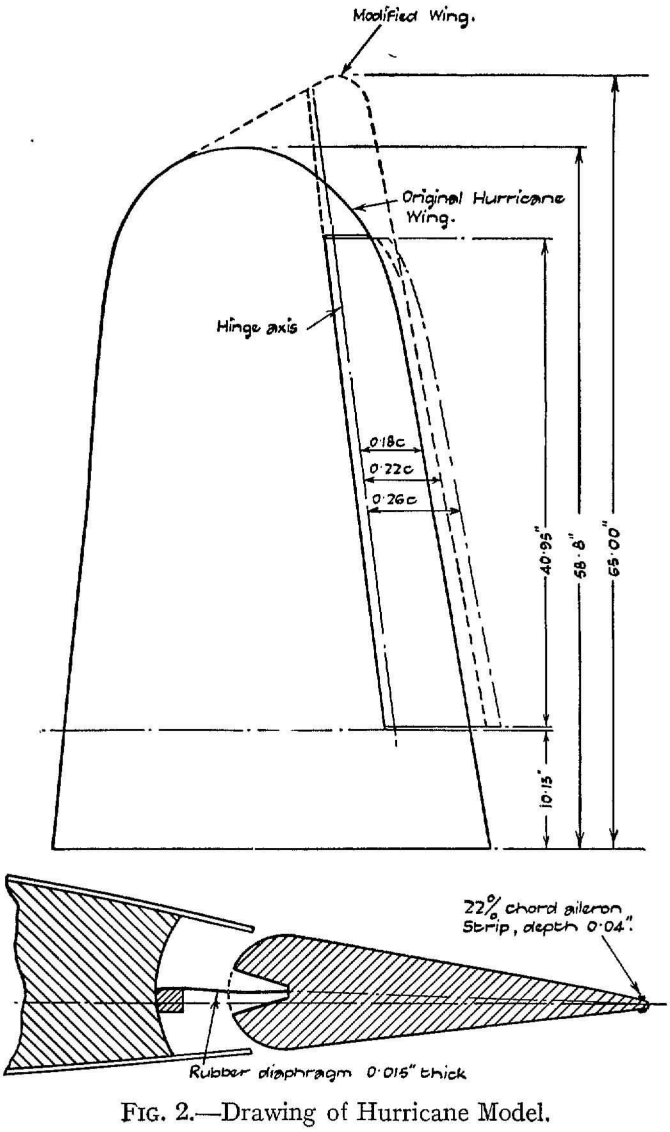


Fig. 2.—Drawing of Hurricane Model.

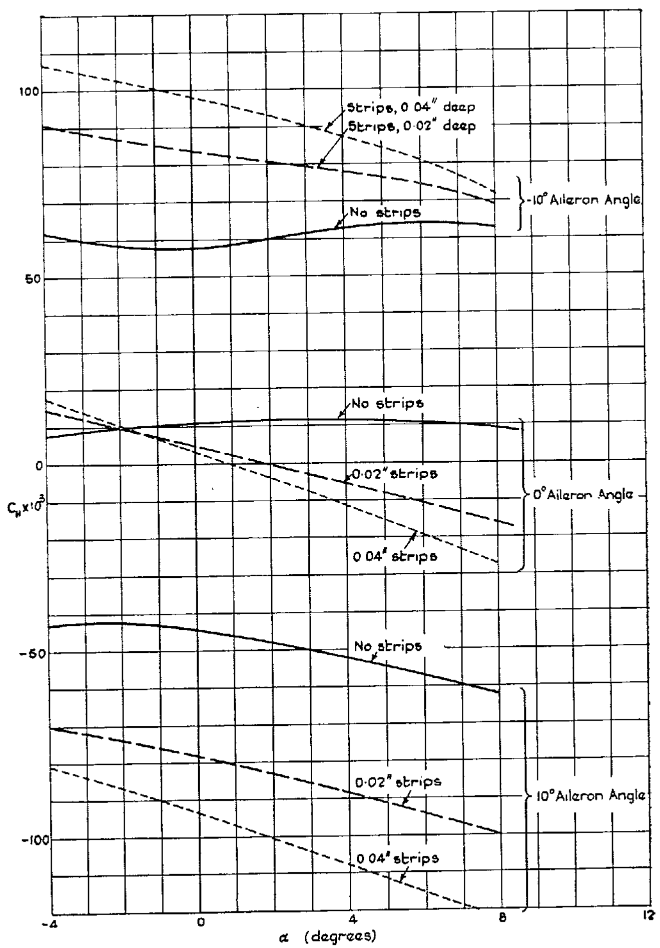


FIG. 3.—18% Chord Aileron.
Hinge Moment against Angle of Incidence.

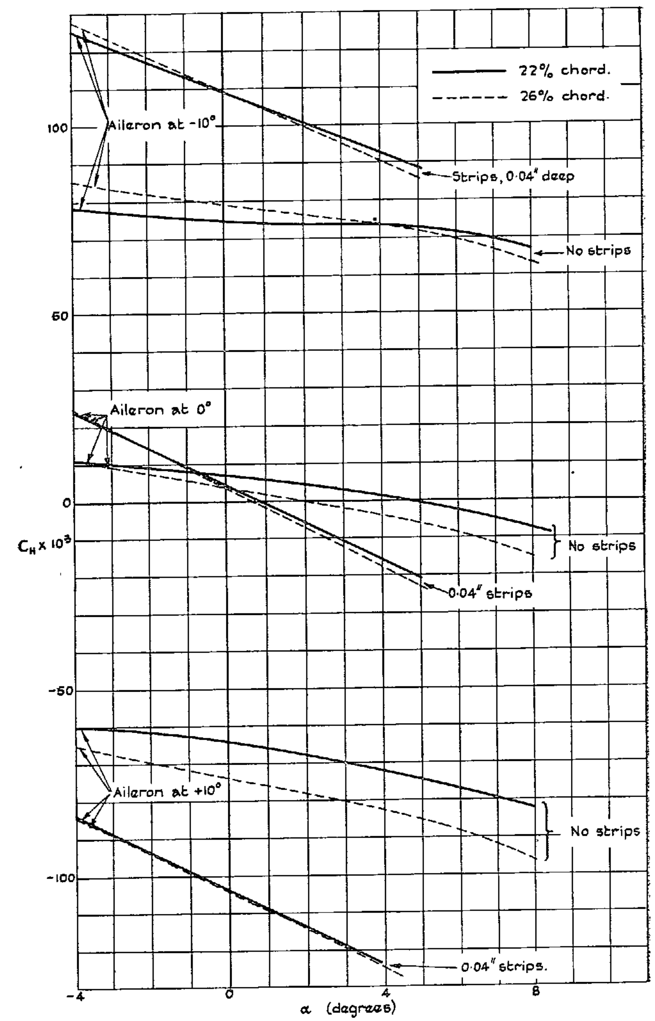
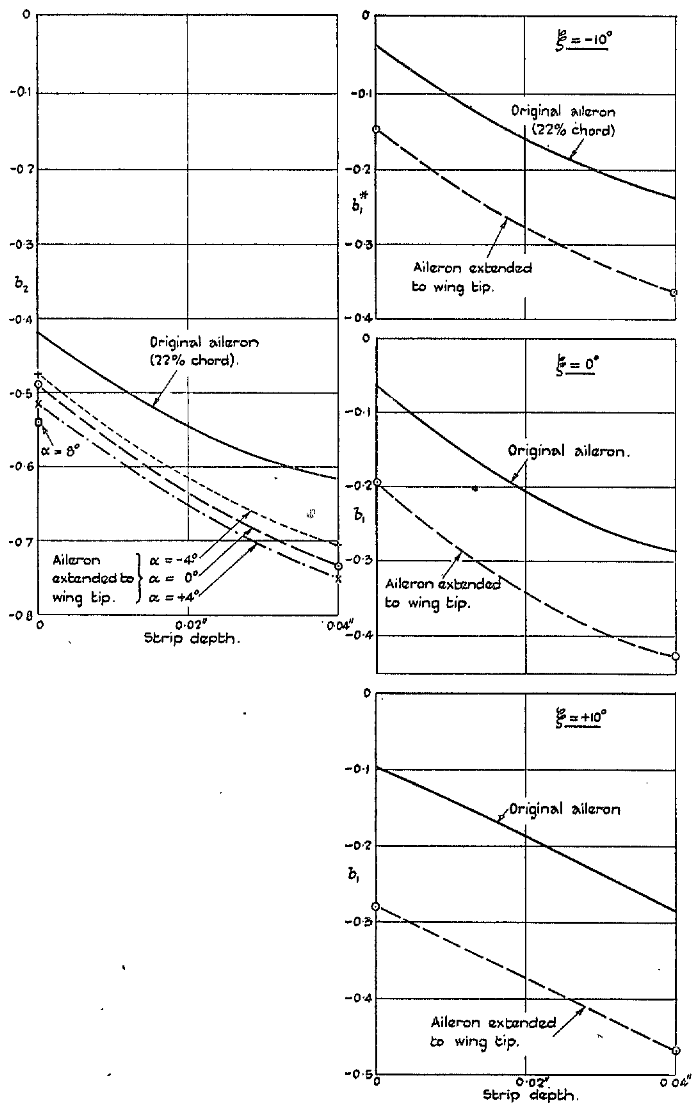


FIG. 4.—22% and 26% Chord Aileron.
Hinge Moment against Angle of Incidence.



* Mean slope at $\alpha = 0°$.

Fig. 7.—Effect of Extending Aileron to Wing Tip on b_1 and b_2.

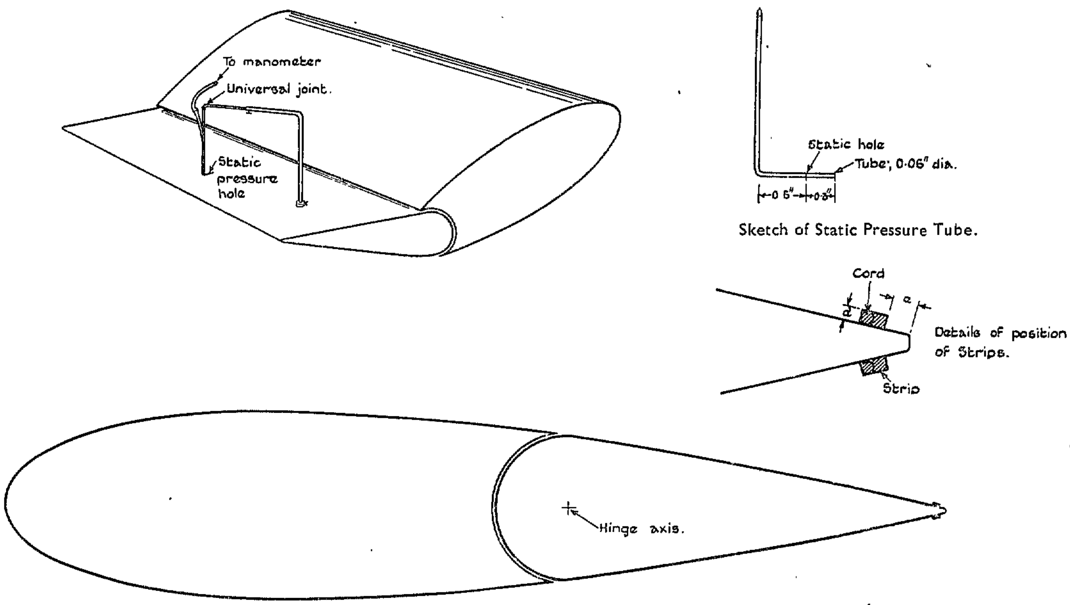


FIG. 8.

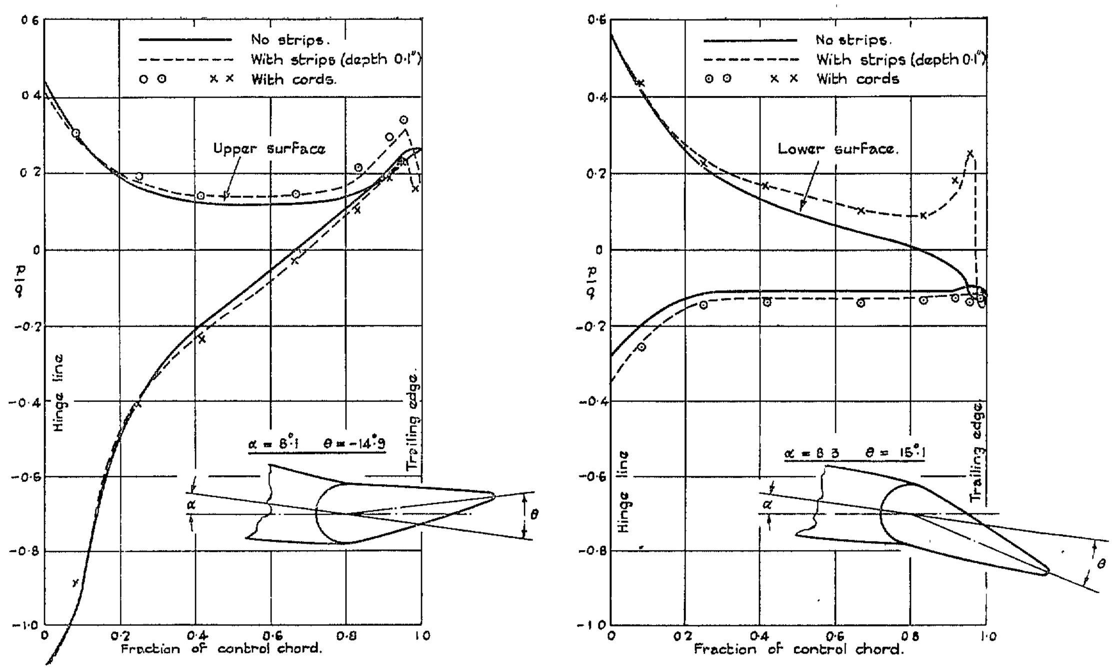


FIG. 9.—Effect of Strips and Cords.

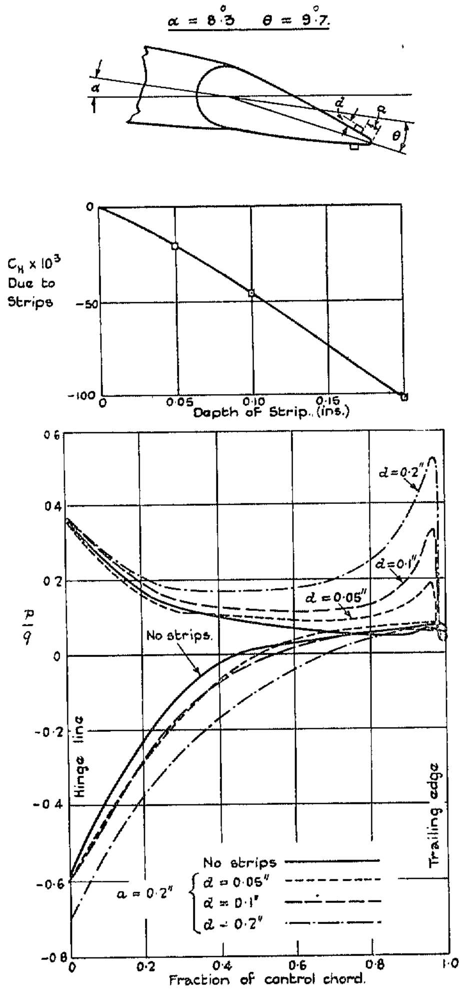


FIG. 10.—Effect of Varying Strip Depth.

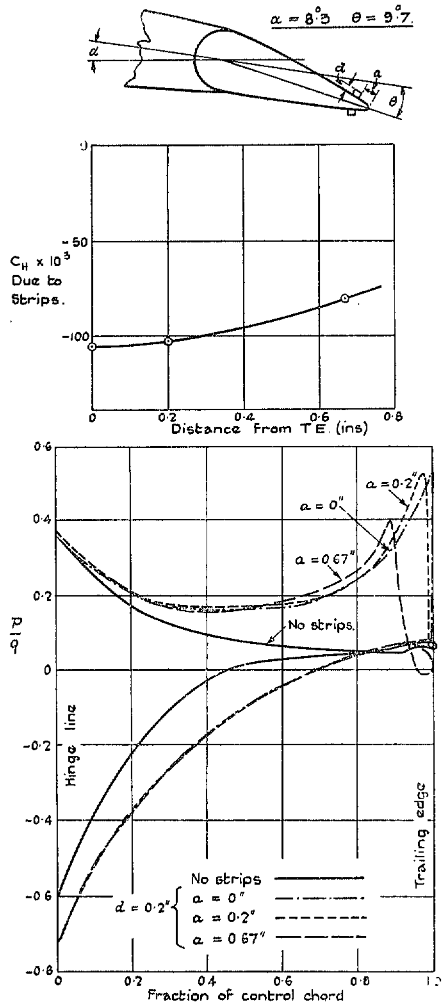


FIG. 11.—Effect of Varying Strip Position.

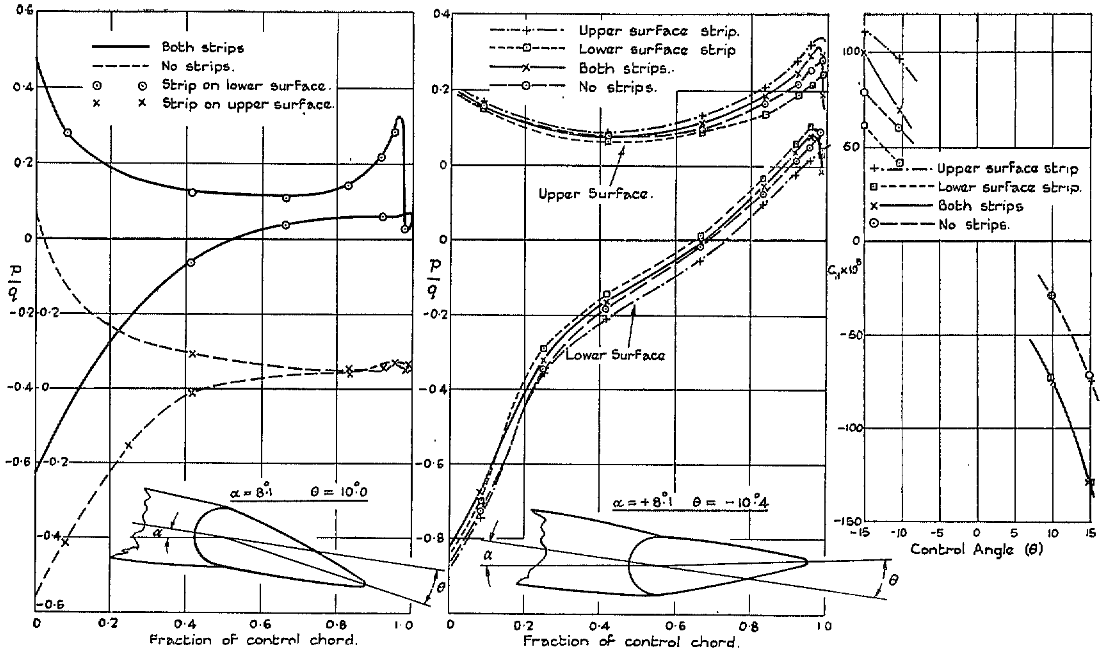


FIG. 12.—Effect of Strips taken separately and together.

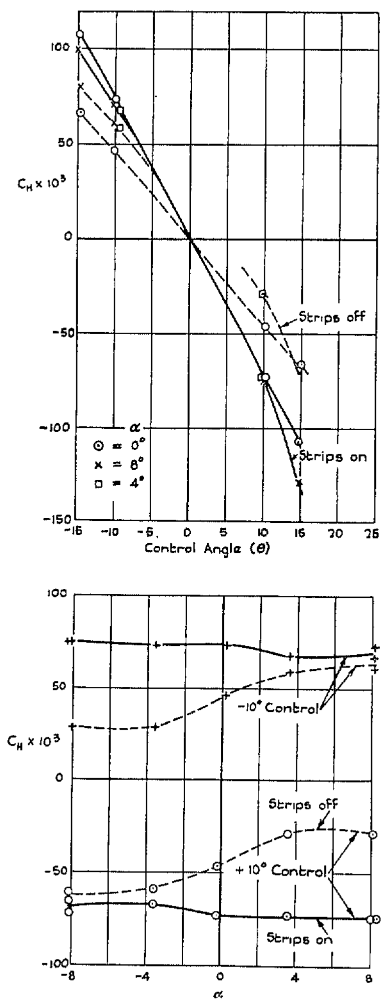


FIG. 13.—Hinge Moment against Control Angle and against Incidence.

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