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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WARTIME REPORT

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COLLECTION OF BALANCED-AILERON TEST DATA

By F. M. Rogallo

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Langley Field, Va.



WASHINGTON

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Rogallo, F. M.

Aerodynamics (2)
Control Surfaces (3)
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Collection of balanced-aileron test data

National Advisory Committee for Aeronautics, Washington, D. C.

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table, diagrs, graphs

Test data of balanced ailerons collected from NACA and British sources are presented in the form of charts. These data include ailerons with Frise balances, blunt nose balances, internal balances, contour modifications, and tabs. Results of flight and wind-tunnel tests in both two- and three-dimensional flow are given but no correlation or resume of the data is included.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

ADVANCE CONFIDENTIAL REPORT

COLLECTION OF BALANCED-AILERON TEST DATA

By F. M. Regallo

SUMMARY

Test data of balanced ailerons have been collected from NACA and British sources. These data, which are presented in the form of charts, are grouped as A - ailerons with Frise balances, B - ailerons with blunt-nose balances, C - ailerons with internal balances, D - ailerons with contour modifications, and E - ailerons with tabs. Results of flight tests and of wind-tunnel tests in both two- and three-dimensional flow are presented but no correlation nor résumé of the data has been included. Résumés are being published separately as completed.

INTRODUCTION

The demand for high rates of roll at high speed in combat aircraft and the general increase in the size and speed of airplanes of all types have made it necessary to provide very close aileron balance.

Provision of close balance at large aileron deflections at high speed frequently results in overbalance at small aileron deflections or at low speeds. In some installations, moreover, an undesirable shaking of the controls has occurred under some conditions of flight.

Many experimental investigations of ailerons have been made but all the results obtained have not been available to the manufacturers and, in general, the results have not been correlated nor summarized. A large amount of test data has been collected herein for convenient reference. These data are being analyzed, correlated, and summarized by the NACA; the results of these studies are being published separately as completed. (See references 1 and 2.)

2

Test results of balanced control surfaces of larger chord than are generally used for ailerons are not included in the present collection but are collected in reference 3.

CLASSIFICATION OF DATA

The present collection of data is divided into five sections as follows:

- A - ailerons with Frise balances
- B - ailerons with blunt-nose balances
- C - ailerons with internal balances
- D - ailerons with contour modifications
- E - ailerons with tabs

The parameters and symbols used in the presentation of data

are:

- C_L lift coefficient
- C_D drag coefficient
- c_l section lift coefficient
- c_{d_0} section profile-drag coefficient
- C_h hinge-moment coefficient
- c_h section hinge-moment coefficient
- C_l rolling-moment coefficient about axis in plane of symmetry of complete model or airplane, referred to wind axes

$C_{D'}$	yawing-moment coefficient about axis in plane of symmetry of complete airplane or model, referred to wind axes
C_m	pitching-moment coefficient
c_m	section pitching-moment coefficient about quarter-chord point of airfoil
$\phi/\Delta V$	helix angle of airplane in roll
p	rolling velocity; also, static pressure
p_0	free-stream static pressure
α	angle of attack
α_0	section angle of attack
ψ	angle of yaw
δ	deflection angle
A	aspect ratio
λ	ratio of tip chord to root chord
b	wing span; also used with subscripts to denote components of wing
l_1	distance from plane of symmetry to inboard end of aileron
l_0	distance from plane of symmetry to outboard end of aileron
c	wing chord; also used with subscripts to denote components of wing
$\bar{c}$	mean wing chord; also used with subscripts to denote components of wing

t_a aileron semithickness at hinge
 Δt increase of aileron trailing-edge thickness
 R_b radius of juncture between bevel and control surface
 ϕ trailing-edge angle, included between sides which form trailing edge
 q local dynamic pressure
 q_0 free-stream dynamic pressure
 Δp pressure across balance
 P pressure coefficient $\left(\frac{p - p_0}{q_0} \right)$
 V free-stream velocity
 V_i indicated velocity
 R Reynolds number
 M Mach number
 F_s stick force

Subscripts:

a aileron
 b balance; also, bevel
 f flap
 s stick
 t tab

Results of flight tests and of wind-tunnel tests in both two- and three-dimensional flow are presented. Some of the data have been replotted and are given in a form different from that in the original source. Supplementary information on the models and on the test conditions is given in table I. This table also gives published references and serves as an index to the results presented because the model or airplane designation is given in the first column of the table and

in the upper right-hand corner of each page of model drawings or test results. Some of the data have been corrected for tunnel-boundary effects. When such corrections have been estimated but not applied to the data, the estimated correction factors are given in table I.

AILERONS WITH FRISE BALANCES

The results of tests and the test conditions for models and airplanes having ailerons with Frise balances are given in table IA and in figures A1 to A86. The section characteristics of three models equipped with Frise ailerons are presented in figures A1 to A13. In general, the ailerons tested did not seem very satisfactory in the negative deflection range; that is, sharp breaks occurred in the hinge-moment and effectiveness curves at relatively low negative deflections. This characteristic seems to be caused by separation of flow at the protruding nose. Figure A4 shows that such separation may be delayed considerably by increasing the radius of the nose. A similar improvement was obtained for the aileron of model A-VIII by raising the nose but maintaining the same nose radius (fig. A39). The ailerons of model A-III buffeted very badly over a large part of the negative deflection range (reference 6) and only a few test points could be obtained in this region (fig. A13). The results of tests of various partial-span wing models and complete airplane models are presented in figures A14 to A49. Flight test results are given in figures A50 to A86. The improvement obtained by increasing the nose radius is again evident from figure A22. Figure A24 shows that a high pressure peak can be expected at the nose portion which protrudes below the lower surface even though the nose radius is relatively large. The buffeting tendency of Frise ailerons was again evident in the tests of model A-VI (reference 7). The deflections at which oscillation occurred are indicated in figures A27 to A34. The characteristics of the ailerons of this series of tests were improved by bulging the lower surface or by attaching a slot to the aileron nose. The same modifications were found to reduce aileron buffeting in the flight tests of airplane A-XII. In connection with this series of tests, it was pointed out that bulging the lower surface may be unsatisfactory in some installations because it increases the downfloating tendency of the aileron. The

buffeting tendency of the ailerons of airplane A-XV was almost eliminated by slightly reducing the maximum negative deflections. Practically no loss in effectiveness accompanied this alteration.

AILERONS WITH BLUNT-NOSE BALANCES

Data pertaining to the tests of models having ailerons with blunt-nose balances are given in table IB and in figures B1 to B43. Section characteristics for two models equipped with blunt-nose ailerons are presented in figures B1 to B14. The blunt-nose ailerons on an NACA 23012 airfoil seemed to be more satisfactory than similar ailerons on an NACA 66(215)-216, $\alpha = 1.0$ airfoil; that is, the values of $(\partial c_h / \partial \delta_a)_\alpha$ and $(\partial c_h / \partial \alpha)_{\delta_a}$ were close to zero and the unstalled deflection range was greater for the NACA 23012 airfoil. Increasing the nose radii resulted in a slight loss in $(\partial c_l / \partial \delta_a)_\alpha$ and a slight negative increase in $(\partial c_h / \partial \delta_a)_\alpha$ for small deflections but, because the ailerons with small nose radii tended to stall at lower deflections, the maximum values of Δc_l were usually greater and the corresponding hinge moments were usually lower for the ailerons with larger nose radii. These characteristics may also be noted from the results of tests of blunt-nose ailerons on conventional and low-drag wing models of finite span as given in figures B15 to B32. The peak pressures that occurred over the noses of ailerons of this type were relatively high, as may be seen from figure B17. That the effectiveness of ailerons with blunt-nose balances was greater than the effectiveness of plain unbalanced ailerons is indicated by figure B19. The results of tests of a blunt-nose aileron on a complete airplane model are given in figures B33 to B43. The effects of controlling the boundary-layer thickness by fixing the point of transition and the effects of moving the hinge axis rearward to obtain a higher degree of balance may be obtained from these results.

AILERONS WITH INTERNAL BALANCES

Data pertaining to ailerons with internal balances are given in table IC and in figures C1 to C89. Section characteristics are shown in figures C1 to C33; data for finite-span models in figures C34 to C77; and flight data in figures C78 to C89. Many of these data have been analyzed and summarized in reference 2 in which a discussion is given of the balance required. The effects of changing the vent location, the surface contour at the vents, or the amount of leakage across the seal are also discussed and it is shown that these modifications may sometimes be utilized for adjustment of the hinge-moment characteristics. The importance of leakage cannot be overemphasized. The reduction of aileron rolling-moment effectiveness due to leakage may be inconsequential but a leakage area of only two-tenths of the vent area may reduce the effectiveness of the internal balance by 30 percent, as shown in figure 7 of reference 2. The effects of varying the length of the fabric seal and of varying the shape of the balance chamber near the seal may sometimes be important but these effects cannot be determined from the data now available. An investigation of these variables, however, is now under way.

AILERONS WITH CONTOUR MODIFICATIONS

The material presented in table ID and in figures D1 to D60 includes data on several contour modifications that reduce hinge moments - such as bevels, bulges, and increased profile thickness - and also data on several contour modifications that increase hinge moments - such as trailing-edge strips, increased aileron chord and span, and decreased profile thickness. Section characteristics are shown in figures D1 to D17; data for finite-span models in figures D18 to D54; and flight data in figures D55 to D60. A preliminary correlation has been made of the effect of bevels at small deflections of sealed control surfaces (reference 1). The correlation was made on the basis of the included angle between the upper and the lower surfaces at the trailing edge and included most of the data for sealed ailerons presented in figures D2 to D39.

The improvement in effectiveness and the more nearly linear hinge-moment curves obtainable by sealing the aileron gap when a bevel is used are shown in figures D22 to D24, D34, and D39.

The data on bulged or thickened aileron profiles shown in figures D46 to D48 were obtained on an unsealed Frise aileron. The effect of the changed profile was correlated in references 25 to 27 with the maximum amount of the change in profile thickness and its position along the aileron chord as parameters. The effect of a hollow or a thickened profile on a plain sealed aileron is shown in figures D2 to D7. An unsymmetrical bulge or bevel (figs. D30, D35, and D47) or a reflexed trailing edge (fig. D17) may be used to give an upfloating or a downfloating tendency; this effect may be desirable if the aileron has a differential linkage.

The aileron-contour modifications previously mentioned provide balance by utilizing the difference in the boundary-layer thickness over the upper and the lower surfaces of the rear portion of the airfoil in such a way that the lift over this portion is altered. The aileron effectiveness as indicated by the static rolling moments will thus be reduced when a bevel or bulge is used. As is pointed out in reference 1, the loss in rolling power of an aileron will be less than the loss in static rolling moment indicates, however, because the damping in roll is also reduced by the bevel or bulge.

The results of flight tests of several unsealed-aileron arrangements on a fighter airplane are given in figures D56 to D60. The effects of using large trailing-edge angles and of fixing transition are shown.

The modifications shown in figures D16 and D49 to D54 are intended to increase the ratio of the hinge-moment parameters $(\partial C_h / \partial \alpha)_{\delta_a}$ and $(\partial C_h / \partial \delta_a)_{\alpha}$. Analysis shows that increasing the positive value of the ratio $\frac{(\partial C_h / \partial \alpha)_{\delta_a}}{(\partial C_h / \partial \delta_a)_{\alpha}}$ will tend to lighten stick forces during rolling.

AILERONS WITH TABS

The results of tests and the test conditions for models and airplanes having ailerons with tabs are given in table IE and in figures E1 to E53. Section characteristics of tabs on two low-drag airfoils are presented in figures E1 to E7. Characteristics of ailerons with tabs on a number of semispan and full-span models are presented in figures E8 to E46. A fairly large range of wing sections, tab chords, tab spans, aileron chords, and aileron balances is covered.

A fair amount of data for tabs on ailerons with thickened and beveled trailing edges is included. Tabs on such ailerons, unfortunately, are most effective in producing aileron hinge moment when deflected in the same direction as the aileron. Figure E30 shows a decrease in tab effectiveness $\partial C_h / \partial \delta_t$ with increase in trailing-edge angle.

Data from flight tests of an aileron equipped with a spring tab (fig. E47) are shown in figure E48. Because the spring unit was preloaded, the tab did not deflect until the stick force exceeded approximately $9\frac{1}{2}$ pounds. Both aileron and tab were mass-balanced. Severe flutter was experienced when play developed in the tab linkage. This phenomenon is not peculiar to spring tab but may occur with any tab linkage having backlash.

Characteristics of an airplane having ailerons with beveled trailing edges are shown in figures E49 to E53. For the balancing-tab tests (fig. E52), the stick travel was inadvertently set at ± 8 inches instead of ± 9 inches. As a result, figures E52 and E53 are not directly comparable. Information presented in figure E50 for balancing tabs in operation has been corrected to a stick travel of ± 9 inches.

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TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRFOILS

[Designations of low-drag airfoils, regardless of the form in which they appear in the other references, are changed throughout to the form described on p.11a of reference 4.]

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A - AIRFOILS WITH PRISM BALANCES

Designation (1)	Model or airplane		Typical airfoil section	Airfoil section		A	λ	Alleron location		Type of test	Corrections estimated but not applied	Air-flow characteristics	References
	Plan form of surface			Root	Tip			$\frac{2}{3} \frac{b}{c}$	$\frac{2}{3} \frac{b}{c}$				
A-I				MACA 23012		∞	----	-----	0.80	Two dimensional	$M_{\infty} = 1.034$	$M = 2.8 \times 10^6$ $M = 6.8 \times 10^6$ $M = 0.80$ to 0.49	5
A-II				MACA low drag (See fig. 4B.)		∞	----	-----	0.80	Two dimensional	None	$M = 6.0 \times 10^6$ $M = 0.14$	
A-III ^a				MACA conventional (approx. 14 percent thick)		∞	----	-----	0.80	Two dimensional	Sub-plate effects uncertain	$M = 1.91 \times 10^6$ $M = 0.13$	6
A-IV ^b				MACA 23012-222, 45(218)-418, $M = 1.0$		12.0	0.32	0.641	0.948	Quarter-span wing model	None	$M = 1.99 \times 10^6$ $M = 0.11$	
A-V ^c				MACA low drag (See fig. 4B.)		7.3	0.42	0.508	0.880	Half-span wing model	None	$M = 2.38 \times 10^6$ $M = 0.11$	
A-VI ^d				MACA 23012		4.0	1.00	0.88	1.000	Full-span wing model	$C_{D,0} = 0.0071$ $C_{D,0} = C_{D,0}$ $-0.0485 C_L$	$M = 1.44 \times 10^6$ $M = 2.38 \times 10^6$ $M = 0.10$ and 0.11	7
A-VII ^e				Davis (16 percent thick)		6.1	1.00	0.864	0.996	Full-span wing model	Sub-plate effects uncertain	$M = 2.38 \times 10^6$ $M = 0.16$	

^a All designations that have the same superscript (a, b, c, ..., or p) denote models of airplanes having the same wing plan form and the same airfoil section.

TABLE 2.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRFOILS - Continued

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A - AIRFOILS WITH PRISM BALANCES - Continued

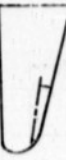
Model or airplane		Typical airfoil section	Airfoil section		A	λ	Airfoil location		α_c/α	Type of test	Corrections estimated but not applied	Air-flow characteristics	Remarks	
Designation (1)	Plan form of surface		Root	Tip			$\frac{2}{\pi} \frac{b}{c}$	$\frac{2}{\pi} \frac{b}{c}$						
A-VIII				Unknown	NACA 4415	6.8 (approx.)	0.50 (approx.)	0.594	0.578	0.52	Complete model	Neither corrections were applied nor known	Unknown	8
A-IX				NACA 5415	NACA 4409	8	0.5	0.489	0.531	0.15	Complete model	None	$R = 0.78 \times 10^6$ $M = 0.11$	
A-X				NACA 67(125)-1(14.5)		6.5	0.48 (tip)	0.481	1.00	0.80	Complete model	None	$R = 0.38 \times 10^6$ $M = 0.15$	
A-XI ^f				NACA 23015	NACA 23009	8.5	0.47	0.565	0.531	0.20 (approx.)	Complete model	None	$R = 2.74 \times 10^6$	
A-XII ^f				NACA 23015	NACA 23009	8.5	0.47	0.56	0.59	0.20 (approx.)	Flight	None	-----	
A-XIII				Conventional		4.93	0.66	0.54	0.56	0.19 (approx.)	Flight	None	-----	
A-XIV ^f				NACA 23015.5 (approx.)	NACA 23009.25 (approx.)	8.5	0.40	0.565	0.538	0.208	Flight	None	-----	9

^f All designations that have the same superscript (a, b, c, ..., or p) denote models of airplanes having the same wing plan form and the same airfoil section.

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TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANE HAVING BALANCED AIRFOILS - Continued

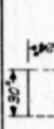
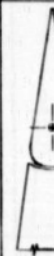
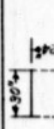
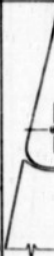
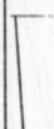
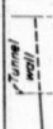
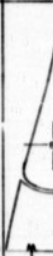
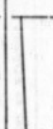
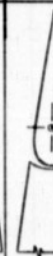
A - AIRFOILS WITH PRISM BALANCE - Continued

Designation (1)	Model or airplane Plan form of surface	Typical airfoil section	Airfoil section		A	λ	Alleron location		α_c	Type of test	Correction method used but not applied	Air-flow characteristics	Remarks
			Root	Tip			$\frac{x}{c}$	$\frac{y}{c}$					
A-27			NACA 23015	NACA 23009	6.0	0.38	0.681	0.887	0.388	Flight	None	-----	
A-272			-----	-----	5.5	-----	0.54	0.94	0.37 (sp. para.)	Flight	None	-----	
A-2711			NACA 23015	NACA 23009	5.9	0.40	0.589	0.883	0.30 (sp. para.)	Flight	None	-----	
A-2712 ^a			NACA 23015	NACA 23009	5.5	Elliptical wing	0.600	0.888	0.37 (sp. para.)	Flight	None	-----	10

^aAll designations that have the same superscript (a, b, c, ..., or p) denote models or airplanes having the same wing plan form and the same airfoil section.

TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF BOMBS AND AIRPLANES HAVING BALANCED AIRFOILS - Continued

B - AIRFOILS WITH BLUNT-NOSE BALANCE

Model or airplane		Typical airfoil section/ Plan form of surface	Airfoil section		A	λ	Aileron location		e_a/c	Type of test	Corrections estimated but not applied	Air-flow characteristics	Published
Designation			Root	Tip			$\frac{x}{c}$ 57%	$\frac{y}{c}$ 57%					
B-I			NACA 23012		∞	-----	-----	0.20	Two dimensional	$\Delta C_{L_0} = 1.038ac$	$R = 2.8 \times 10^6$ to 6.8×10^6 $M = 0.20$ to 0.45	11	
B-II			NACA 66(215)-215, $a = 1.0$		∞	-----	-----	0.20	Two dimensional	$\Delta C_{L_0} = 1.038ac$	$R = 2.8 \times 10^6$ to 6.8×10^6 $M = 0.20$ to 0.45	12	
B-III ^a			NACA 23012.5 (approx.)	NACA 25008.25 (approx.)	5.6	0.60	0.579	0.984	0.155	Semi-span wing model	None	$R = 1.54 \times 10^6$ $M = 0.08$	13
B-IV ^b			NACA 65(225)-325, $a = 1.0$	NACA 65(215)-415, $a = 0.5$	12.0	0.32	0.641	0.948	0.25	Quarter-span wing model	None	$R = 1.98 \times 10^6$ $M = 0.11$	
B-V			NACA 23015	NACA 4412	7.2	0.42	0.500	0.960	0.206	Complete model	$C_L' = 0.97C_L$ $C_D' = C_D$ $C_M' = 0.08C_L$	$R = 0.8 \times 10^6$ $M = 0.11$	

^a All designations that have the same superscript (a, b, c, ..., or v) denote models or airplanes having the same wing plan form and the same airfoil section.

TABLE I.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRFOILS - Continued

C - AIRFOILS WITH INTERNAL BALANCES

NATIONAL ADVISORY
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Model or airplane Plan form of surface		Typical airfoil section	Airfoil section	A	λ	Airfoil location	c_d/c	Type of test	Corrections esti- mated but not applied	Air-flow characteristics	Published Reference
			Root	Tip			$\frac{y}{b}$ $\frac{y}{b}$ $\frac{y}{b}$ $\frac{y}{b}$				
C-I			MACA 66(2215)-216, $\alpha = 0.6$	Tip	∞	-----	----- 0.3248 and 0.1359	Two dimensional	None	$R = 4.2 \times 10^6$ to 5.2×10^6 $M = 0.14$ to 0.18	
C-II			MACA 66(2215)-116, $\alpha = 0.6$	Tip	∞	-----	----- 0.167	Two dimensional	None	$R = 6 \times 10^6$ $M = 0.14$	
C-III			MACA low drag (See fig. C10.)	Tip	∞	-----	----- 0.20	Two dimensional	None	$R = 2.5 \times 10^6$ $M = 0.17$	
C-IV			MACA low drag (See fig. C13.)	Tip	∞	-----	----- 0.232	Two dimensional	None	$R = 6 \times 10^6$ $M = 0.14$	
C-V			MACA 66(215)-216, $\alpha = 0.6$	Tip	∞	-----	----- 0.1722	Two dimensional	None	$R = 9.6 \times 10^6$ $M = 0.20$	
C-VI			MACA low drag (See fig. C14.)	Tip	∞	-----	----- 0.173	Two dimensional	None	$R = 7.5 \times 10^6$ $M = 0.16$	
C-VII			MACA 66(215)-216, $\alpha = 1.0$	Tip	∞	-----	----- 0.20	Two dimensional	None	$R = 2.8 \times 10^6$ to 5.86×10^6 $M = 0.20$ to 0.42	14

All designations that have the same superscript (a, b, c, ..., or p) denote models or airplanes having the same wing plan form and the same airfoil section.

Chapter 7 - SUBSTANTIAL INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AILETRONS - Continued

Designation (1)	Model or airplane		Typical airfoil section	Airfoil section		λ	Alleron location		c_a/c	Type of test	Corrections estimated but not applied	Airplane characteristics	Published
	Plan form of surface			Root	Tip		$\frac{1}{2} \frac{y}{V/2}$	$\frac{3}{2} \frac{y}{V/2}$					
C-111 ^a				MACA conventional (approx. 16 percent thick)					0.20	Two dimensional	None	$R = 1.91 \times 10^6$ $M = 0.13$	8
C-112 ^b				MACA 66(215)-216, $a = 0.6$					0.20	Two dimensional	None	$R = 6.7 \times 10^6$ to 9.6×10^6 $M = 0.24$ to 0.33	
C-113 ^c				MACA 23015.6 (approx.)	MACA 23008.26 (approx.)	6.6	0.479	0.964	0.185	Semi-span wing model	None	$R = 2.05 \times 10^6$ $M = 0.11$	15
C-114 ^d				MACA 66(216)-116, $a = 1.0$	MACA 66(216)-116, $a = 1.0$	6.1	0.496	0.906 and 0.977	0.176 and 0.149	Semi-span wing model	$C_{l'e} = 0.900$ $C_{l'e} = C_{l'e}$ $C_{l'e} = 0.030 C_{l'e}$	$R = 1.9 \times 10^6$ $M = 0.11$	16
C-115 ^e				MACA 23012		4.0	0.63	1.000	0.19	Semi-span wing model	$C_{l'e} = 0.860$ $C_{l'e} = C_{l'e}$ $C_{l'e} = 0.040 C_{l'e}$	$R = 1.48 \times 10^6$ $M = 0.05$	17
C-116 ^f				Davis (16 percent thick)		6.1	0.565	0.976	0.15	Semi-span wing model	End-plate effects uncertain	$R = 2.28 \times 10^6$ $M = 0.16$	
C-117 ^g				MACA 66(203)-222, $a = 1.0$	MACA 66(216)-415, $a = 0.6$	12.0	0.641	0.945	0.23	Quarter-span wing model	None	$R = 1.98 \times 10^6$ $M = 0.11$	

all) designations that have the same number (a, b, c, or n) denote models or airplanes having the same wing plan form and the same airfoil section.

TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRTECHNICS - Continued

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C - AIRTECHNICS WITH INTERNAL BALANCE - Continued

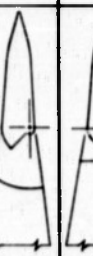
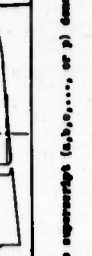
Model or airplane	Plan form of surface	Typical airfoil section	Airfoil section		A	λ	Airfoil location		Type of test	Corrections estimated but not applied	Air-flow characteristics	Published performance
			Root	Tip			$\frac{y}{b}$	$\frac{z}{b}$				
C-XV ^c			NACA low drag (See fig. C26.)		7.3	0.42	0.809	0.880	Third-span wing model	None	$R = 6.25 \times 10^6$ $M = 0.11$	
C-XVI			NACA 662028-1014.5, 67(112)-213, $a = 1.0$	NACA 662028-1014.5, 67(112)-213, $a = 0.7$	5.4	0.60	0.84	0.893	Complete model	None	$R = 6.25 \times 10^6$ $M = 0.11$	
C-XVII ^c			Clark YH modified (19 percent thick)	Clark YH modified (12 percent thick)	6.2	0.49	0.84	0.83	Complete-span wing model	Whether corrections were applied not known	$R = 1.1 \times 10^6$ $M = 0.08$	18
C-XVIII ^c			NACA 23018.5 (approx.)	NACA 23008.25 (approx.)	5.6	0.60	0	0.894	Endplate wing model	None	$R = 2.05 \times 10^6$ $M = 0.11$	19
C-XIX			NACA 23017	NACA 23010	6.0	0.55 (tip)	0.885	0.940	Complete model	None	$R = 0.74 \times 10^6$ $M = 0.082$	
C-XX			NACA 23012		7.2	1.00	0.86	0.94	Flight	None	-----	20
C-XXI ^b			NACA 662028-1014.5, 67(112)-213, $a = 1.0$	NACA 662028-1014.5, 67(112)-213, $a = 1.0$	6.2	0.33	0.485	0.992	Flight	None	-----	21

All designations that have the same superscript (a, b, c, ..., or p) denote models or airplanes having the same wing plan form and the same airfoil section.

TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRFOILS - Continued

D - AIRFOILS WITH CONTOUR MODIFICATIONS

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

Designation (1)	Model or airplane Plan form of surface	Typical airfoil section	Airfoil section		A	λ	Airfoil section		Type of test	Corrections estimated but not applied	Airfoil characteristics	Published Reference
			Root	Tip			$\frac{2}{\pi} \frac{b}{c}$	$\frac{2}{\pi} \frac{b}{c}$				
D-1 ¹			MCA 66(23)-216, 6 x 0.6		∞	∞	∞	∞	Two dimensional	None	$\alpha = 0.8$ $\beta = 0.16$ $\gamma = 0.04$	
D-11			MCA 0009		∞	∞	∞	∞	Two dimensional	Correction applied only to lift	$\alpha = 1.45 \times 10^3$ $\beta = 0.10$	
D-111 ²			MCA conventional section (approx. 16 percent thick)		∞	∞	∞	∞	Two dimensional	Undetermined	$\alpha = 1.01 \times 10^3$ $\beta = 0.13$	6
D-17 ³			MCA 25013.5 (approx.)	MCA 25008.25 (approx.)	5.5	0.40	0.579	0.588	Semi-span wing model	None	$\alpha = 1.54 \times 10^3$ $\beta = 0.08$	22
D-17 ⁴			MCA low drag (See fig. 207.)		7.5	0.42	0.509	0.580	Third-span wing model	None	$\alpha = 1.58 \times 10^3$ $\beta = 0.11$	23
D-17 ⁵			MCA low drag (See fig. 208.)		7.5	0.42	0.509	0.583	Third-span wing model	None	$\alpha = 1.58 \times 10^3$ $\beta = 0.11$	24
D-171 ⁶			MCA 25015	MCA 25009	5.5	0.47	0.568	0.581	Full-scale complete model	Correction applied to angle of attack	$\alpha = 1.0 \times 10^3$ $\beta = 0.10$	

^{1,11} designations that have the same superscript (a,b,c,..., or p) denote models of airplanes having the same wing plan form and the same airfoil section.

TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRFOILS - Continued

D - AIRFOILS WITH CONTOUR MODIFICATIONS - Continued

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

Designation (1)	Model or airplane		Typical airfoil section	Airfoil section		A	λ	Airfoil location		$c_{d/c}$	Type of test	Corrections estimated but not applied	Air-flow characteristics	Published Reference
	Plan form of surface			Root	Tip			y_1 5/8	y_2 5/8					
D-III ^b				NACA 2213	NACA 2205	5.7	Elliptical wing	0.500	0.868	0.17	Third-span wing model	Weather corrections were applied not known	$R = 1.5 \times 10^6$ $M = 0.05$	25 26 27
D-IV ^b				NACA 2213	NACA 2205	5.7	Elliptical wing	0.500	0.868	0.222	Third-span wing model	Weather corrections were applied not known	$R = 1.5 \times 10^6$ $M = 0.05$	28
D-V ^b				Clark YH modified (19 percent thick)	Clark YH (15 percent thick)	6.2	0.49	0.54	0.83	0.18	Quarter-span wing model	Weather corrections were applied not known	$R = 1.5 \times 10^6$ $M = 0.05$	29 30
D-VI ^b				NACA compromise low drag		5.8	0.45	0.61	0.905	0.187	Flight	None	$R = \text{full scale}$ $M_{\text{max}} = 0.69$	

^bAll designations that have the same superscript (a, b, c, ..., or p) denote models of airplanes having the same wing plan form and the same airfoil section.

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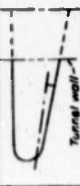
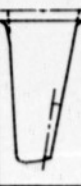
3 - ATTERONS WITH TABS

Designation (1)	Model or airplane		Typical airfoil section	Airfoil section		A	λ	Airfoil location		α_0/θ	Type of test	Corrections estimated but not applied	Air-flow characteristics	Published reference
	Plan form of surface			Root	Tip			$\frac{Y}{b/2}$	$\frac{Y}{b/2}$					
E-1 ^j				MACA 66(215)-215, $a = 0.6$		∞				0.20	Two dimensional	None	$R = 6.7 \times 10^6$ $\text{to } 9.0 \times 10^6$ $M = 0.084 \text{ to } 0.11$	
E-1 ⁱ				MACA 66(215)-215, $a = 0.6$		∞				0.20	Two dimensional	None	$R = 6.7 \times 10^6$ $\text{to } 9.0 \times 10^6$ $M = 0.084 \text{ to } 0.11$	
E-1 ⁱⁱ				MACA 66(215)-215, $a = 0.6$		∞				0.20	Two dimensional	None	$R = 6.7 \times 10^6$ $\text{to } 9.0 \times 10^6$ $M = 0.084 \text{ to } 0.11$	
E-1 ⁱⁱⁱ				Clark Y		6.0	1.00	0.70	1.00	0.40	Full-span wing model	None	$R = 0.6 \times 10^6$ $M = 0.11$	3.
E-1 ^{iv}				Clark Y		6.0	1.00	0.60	1.00	0.28	Full-span wing model	None	$R = 0.6 \times 10^6$ $M = 0.11$	31
E-1 ^v				MACA 25015.6	MACA 25008.38	6.6	0.60	0.679	0.694	0.156	Semi-span wing model	None	$R = 1.6 \times 10^6$ $M = 0.08$	32
E-1 ^{vi}				MACA 66(215)-115, $a = 1.0$	MACA 66(215)-115, $a = 1.0$	6.2	0.35	0.480	0.684	0.149	Semi-span wing model	$C_{1,0} = 0.007$ $C_{2,0} = C_{3,0} = 0.0316 \times 10^{-1}$	$R = 1.9 \times 10^6$ $M = 0.11$	36
E-1 ^{vii}				MACA low drag (see fig. 253.)		7.5	0.42	0.509	0.690	0.30	Third-span wing model	None	$R = 2.4 \times 10^6$ $M = 0.11$	

all determinations that have the same surmount (a, b, c, ..., or n) denote models or airplanes having the same wing plan form and the same airfoil section.

TABLE 1.- SUPPLEMENTARY INFORMATION REGARDING TESTS OF MODELS AND AIRPLANES HAVING BALANCED AIRFOILS - Continued

B - AIRFOILS WITH TABS - Continued

Model or airplane	Plan form of surface	Typical airfoil section	Airfoil section		A	λ	Alleron location		$c_{a/e}$	Type of test	Corrections subtracted but not applied	Airfoil characteristics	Published reference
			Root	Tip			$\frac{z}{c}$	$\frac{z}{c}$					
B-VIII ^a			NACA low drag (See FIG. 280.)		7.5	0.42	0.005	0.000	0.30	Third-span wing model	None	$R = 2.4 \times 10^6$ $M = 0.11$	23
B-IX ^a			NACA low drag (See FIG. 280.)		7.5	0.42	0.005	0.005	0.30	Third-span wing model	None	$R = 2.4 \times 10^6$ $M = 0.11$	24
B-X			-----		7.0 (approx.)	0.34 (approx.)	0.75	0.39 (approx.)	0.40	Endspan wing model	No corrections applied	$R = 0.6 \times 10^6$ $M = 0.04$	33
B-XI ^a			NACA 2213	NACA 2205	8.7	Elliptical wing	0.50	0.005	0.20 (approx.)	Third-span wing model	Probably no corrections applied	$R = 1.5 \times 10^6$ $M = 0.03$	28
B-XII ^a			NACA 2213	NACA 2205	8.7	Elliptical wing	0.5	0.005	0.27 (approx.)	Flight	None	-----	34
B-XIII ^a			NACA composite low drag		8.8	0.45	0.61	0.005	0.197	Flight	None	-----	-----

^aAll designations that have the same superscript (a,b,c,...., or p) denote models or airplanes having the same wing plan form and the same airfoil section.NATIONAL ADVISORY
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Model A-I

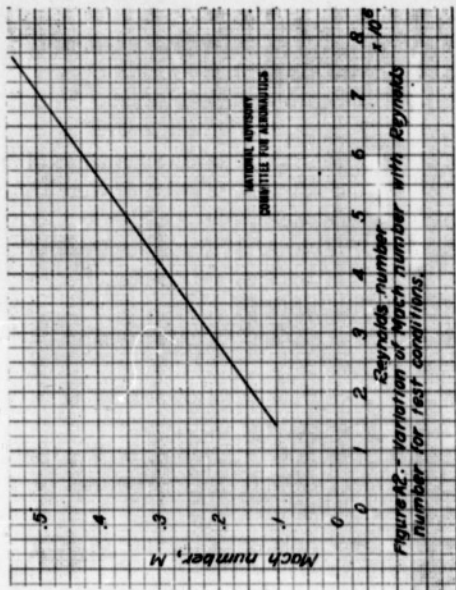


Figure A2.- Variation of Mach number with Reynolds number for test conditions.

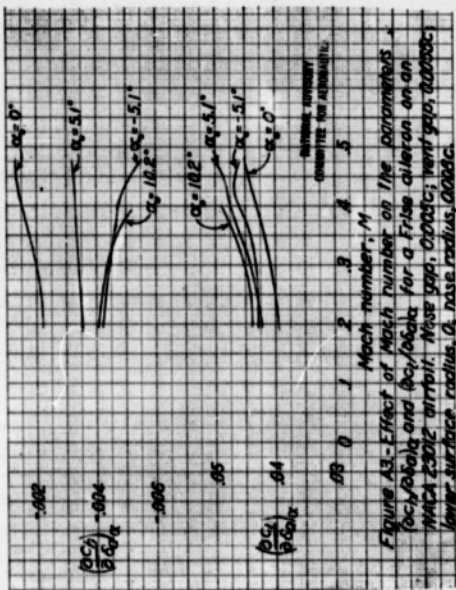


Figure A3.-Effect of Math number on the parameters $\rho_{\text{cyl}}/\rho_{\text{bld}}$ and $\rho_{\text{cyl}}/\rho_{\text{bld}}$ for a Frise airfoil on an NACA 23012 airfoil. Nose gap, 0.0035; vent gap, 0.0050; lower surface radius, 0; base radius, 0.0035.

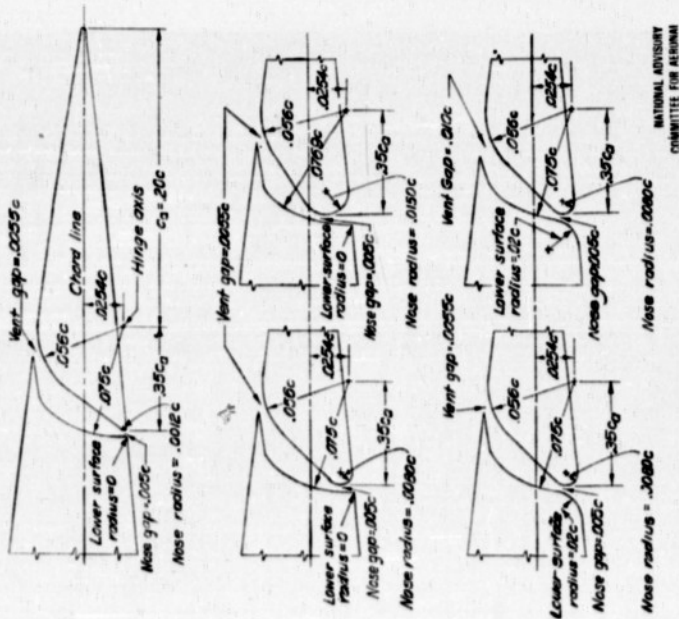
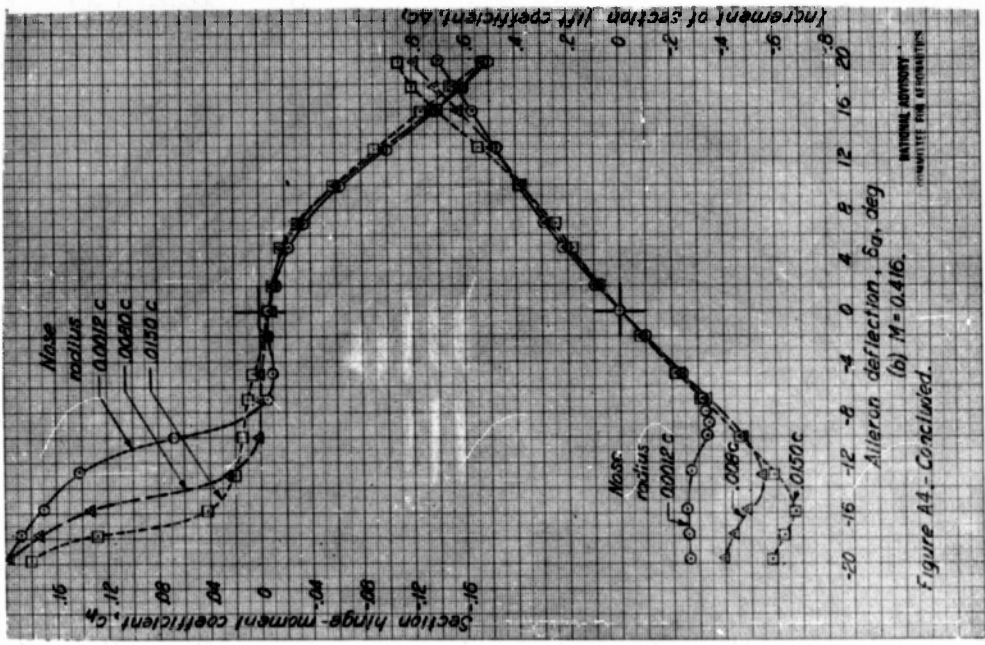
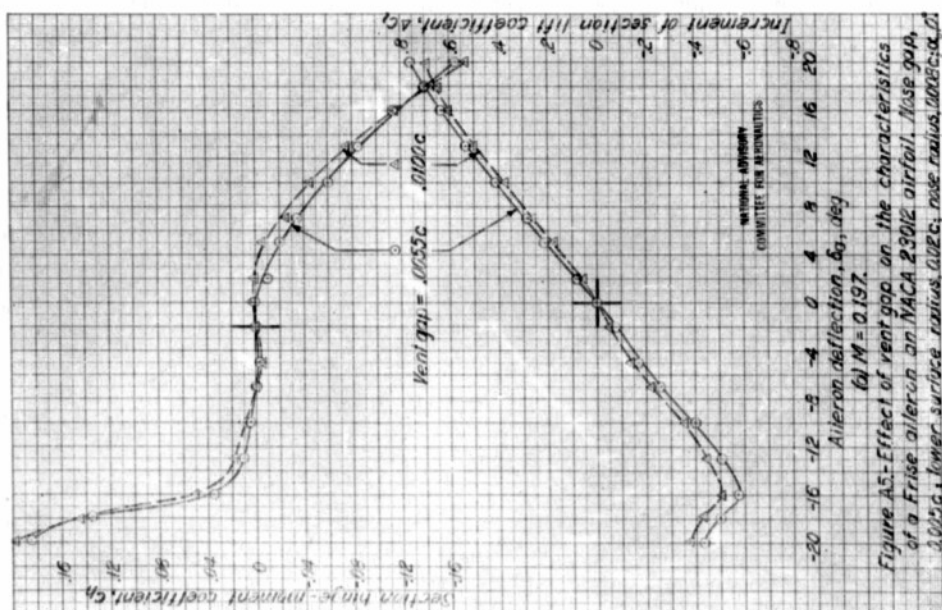
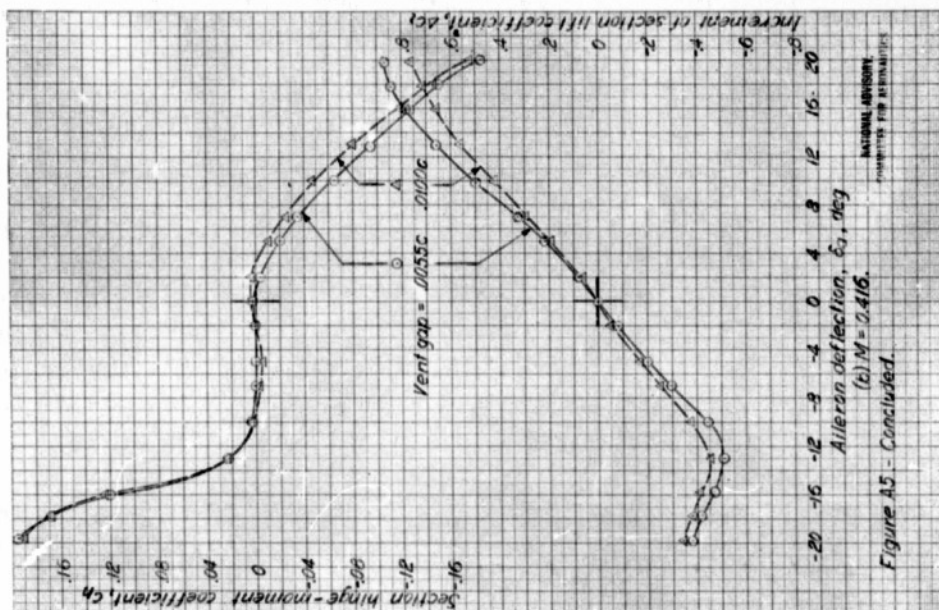


Figure A1. - The various Frise ailerons tested on an NACA 23012 airfoil section in two-dimensional flow. NACA stability tunnel.

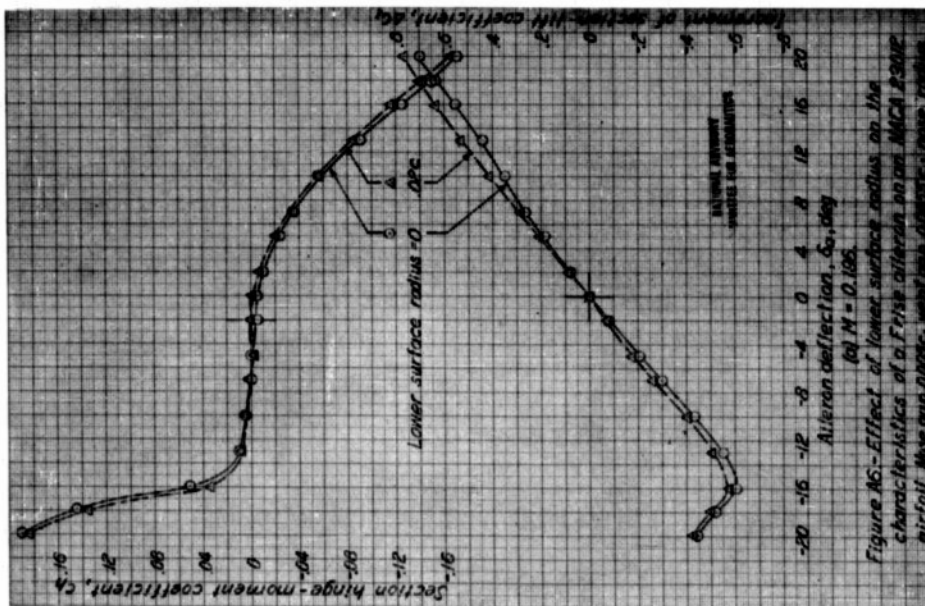
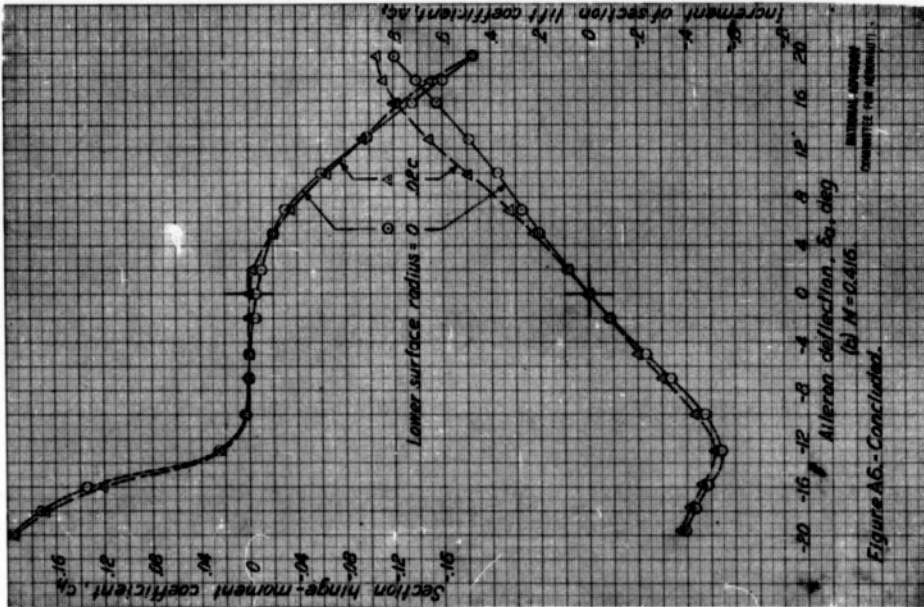
Model A-1



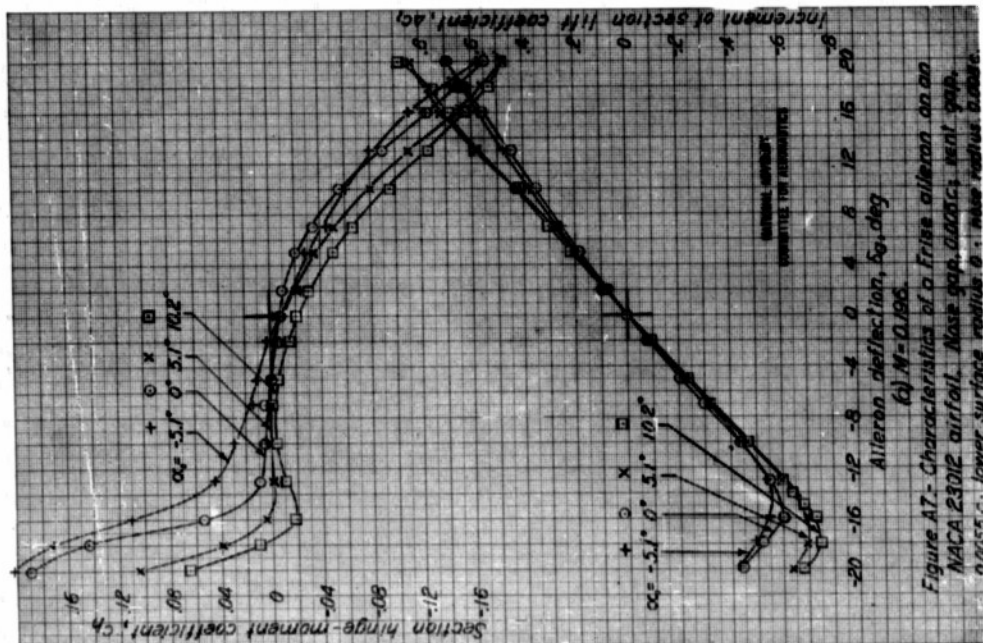
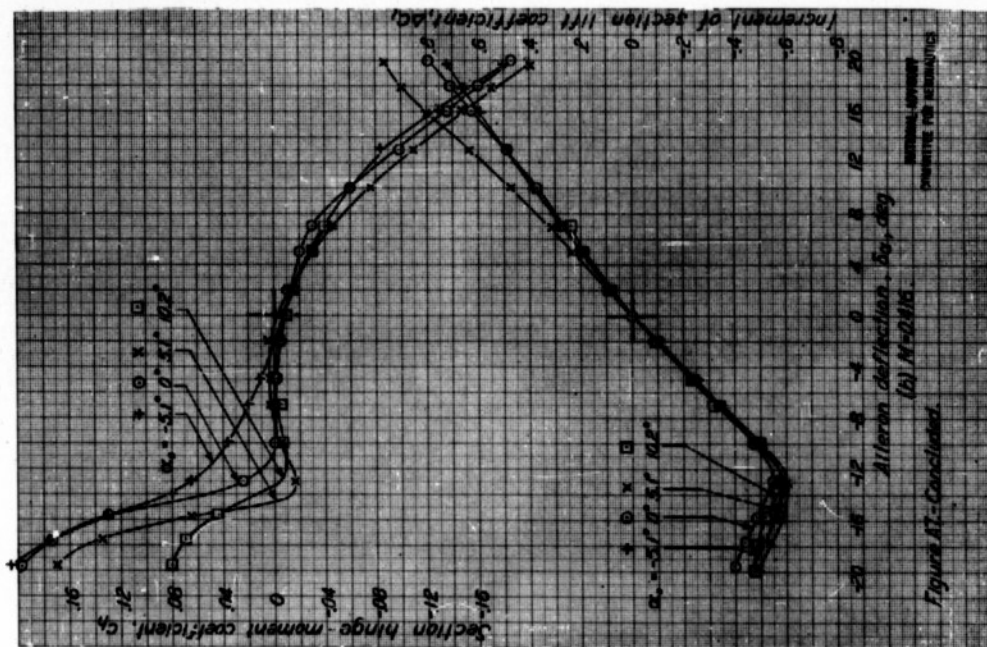


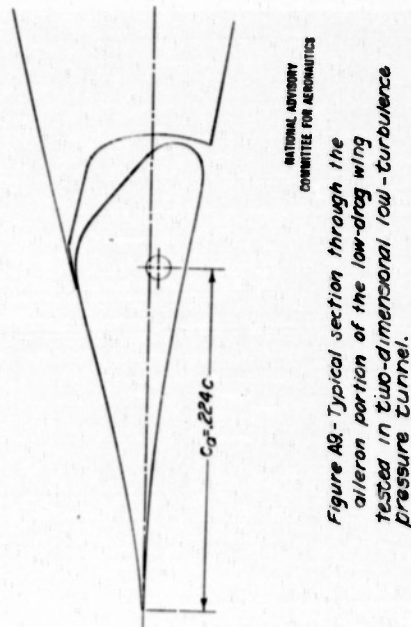
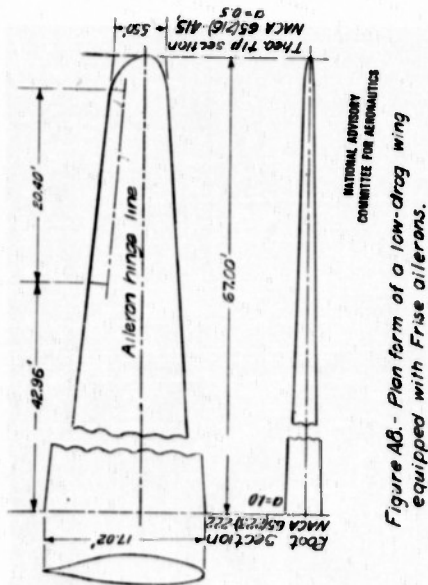
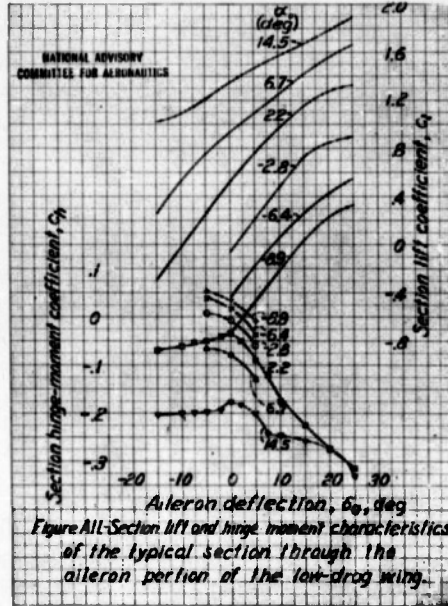
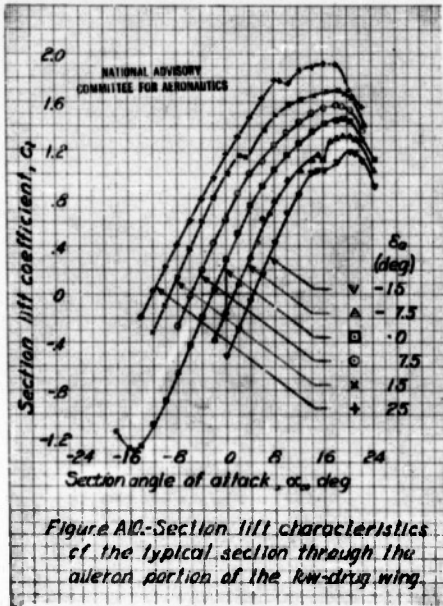
Model A-I

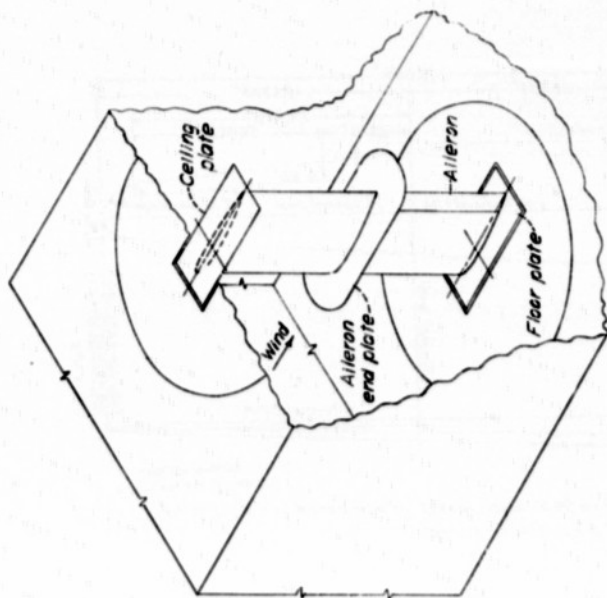
Model A-I



Model A-I







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Figure A12- Two-dimensional test installation and profile of Frise aileron. AAL 7-by 10-foot tunnel.

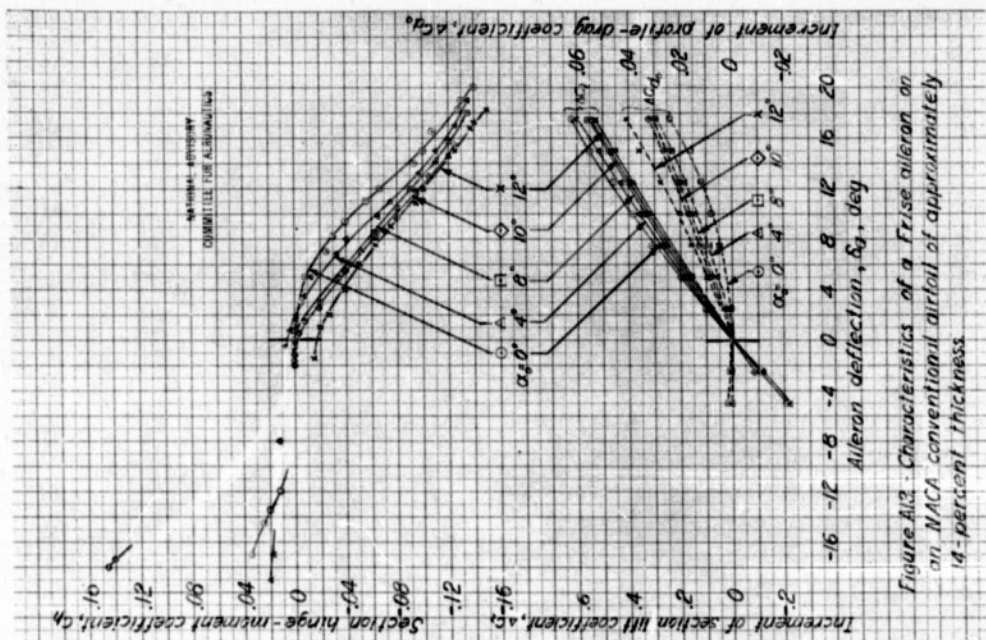
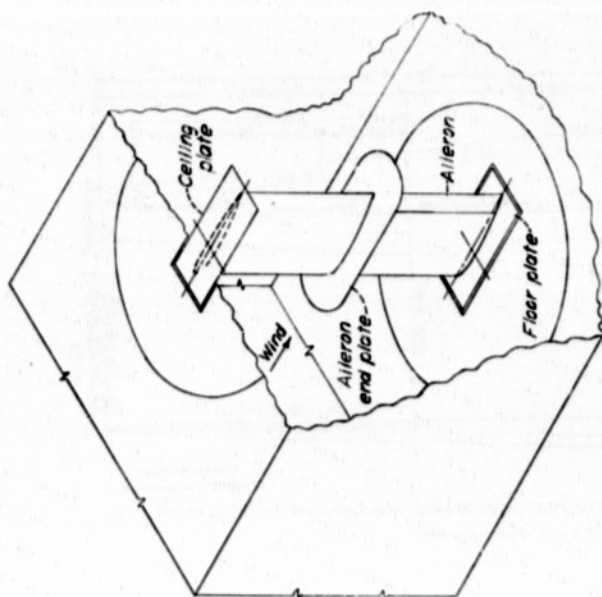


Figure A13: Characteristics of a Frise aileron on an NACA conventional airfoil of approximately 14-percent thickness

Model A-III



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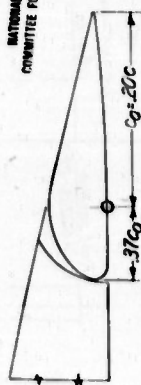


Figure A12- Two-dimensional test installation and profile of Frise aileron, AAL 7-b, 10-foot tunnel.

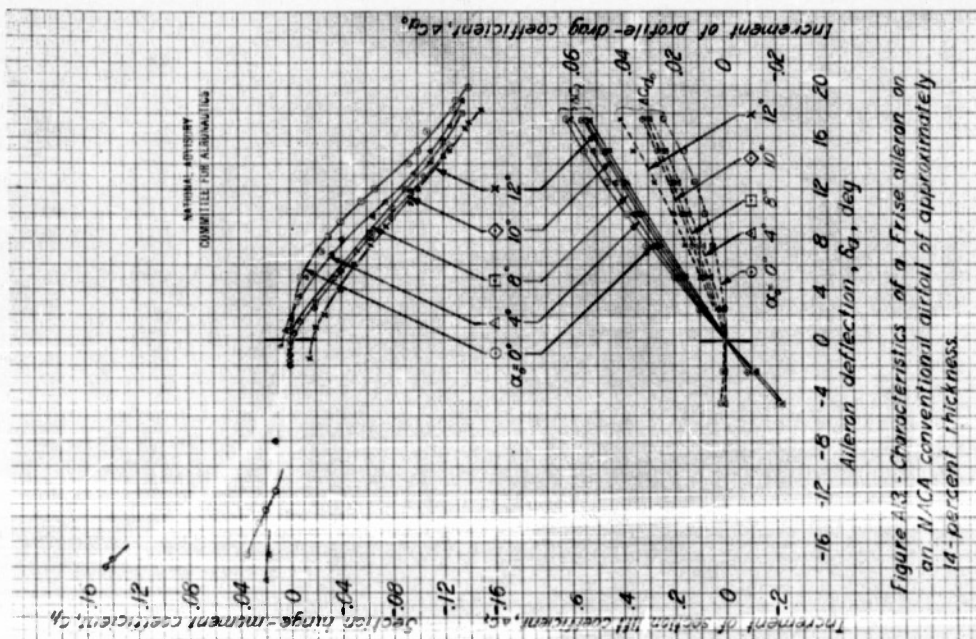


Figure A13- Characteristics of a Frise aileron on an NACA conventional airfoil of approximately 14-percent thickness.

Model A-III

Model A-IV

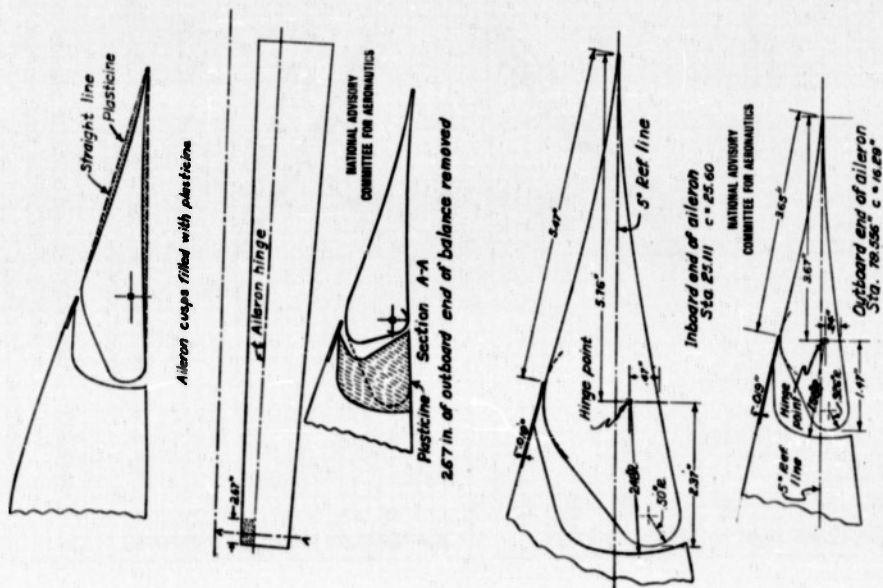


Figure A15. The Frise ailerons tested on the 1/4.5-scale model of a tapered low-drag wing.

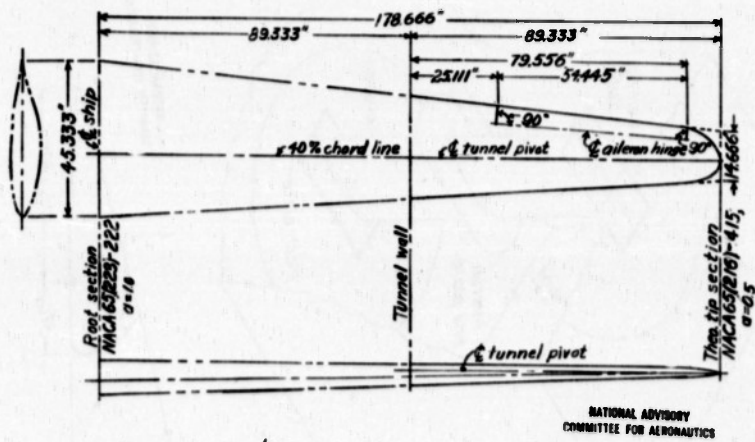


Figure A14 - The $1/4.5$ -scale model of a tapered low-drag wing.
LMAL 7 by 10-foot tunnel.

Model AIV

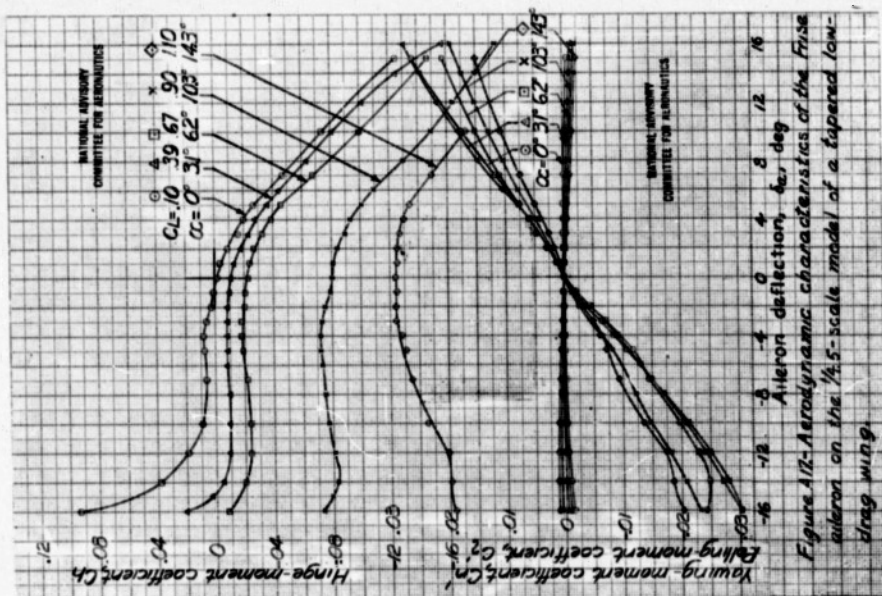


Figure 112- Aerodynamic characteristics of the Frise aileron on the 1/4.5-scale model of a tapered low-drag wing.



Figure 116- Effect of modifications on aerodynamic characteristics of a Frise aileron on the 1/4.5-scale model of a tapered low-drag wing. α , 5.15°; C_{l_r} , 0.665.

Model A-V

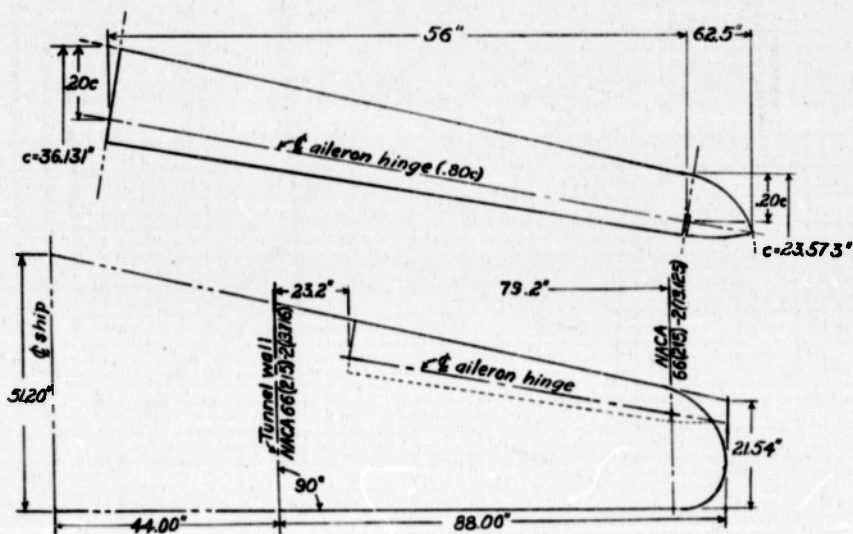
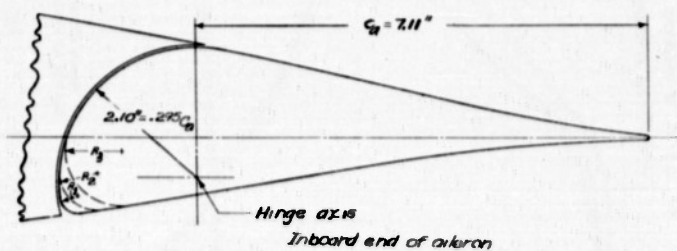


Figure A18.-The 0.4-scale model of a tapered low-drag wing.
LMAL 7 by 10-foot tunnel.



Sym	Inboard radius	Outboard radius	Average radius
R_1	0.303"	0.198"	Original
R_2	606"	.395"	0.500"
R_3	909"	.592"	.750"

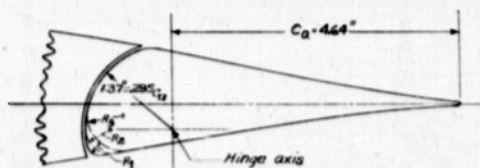
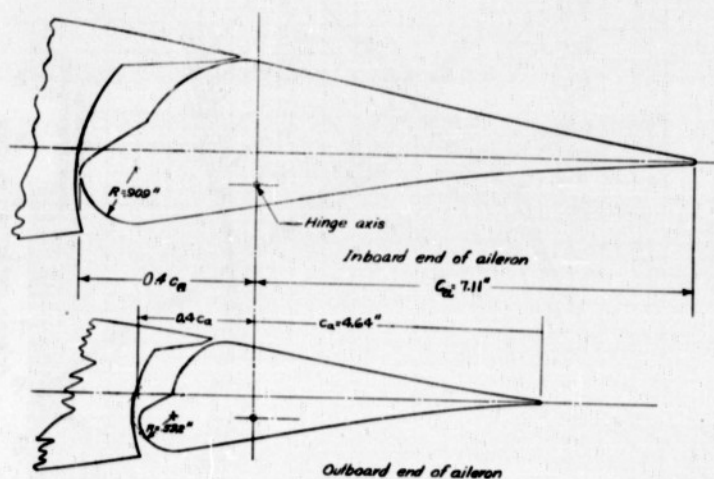
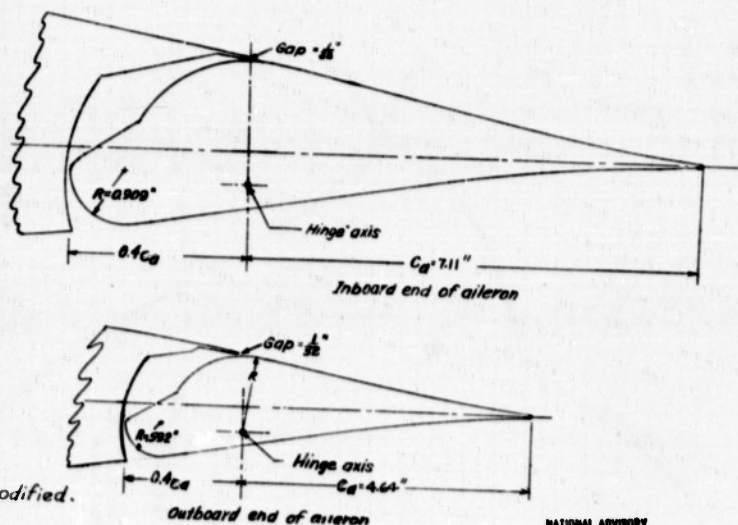


Figure A19.-The 0.295 c_u balance Frise aileron on the 0.4-scale model of a tapered low-drag wing.

Model A-V



(a) Original.

NATIONAL ADVISORY
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(b) Modified.

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICSFigure A20-The $0.40 c_a$ balance Frise aileron on the 0.4-scale model of a tapered low-drag wing.

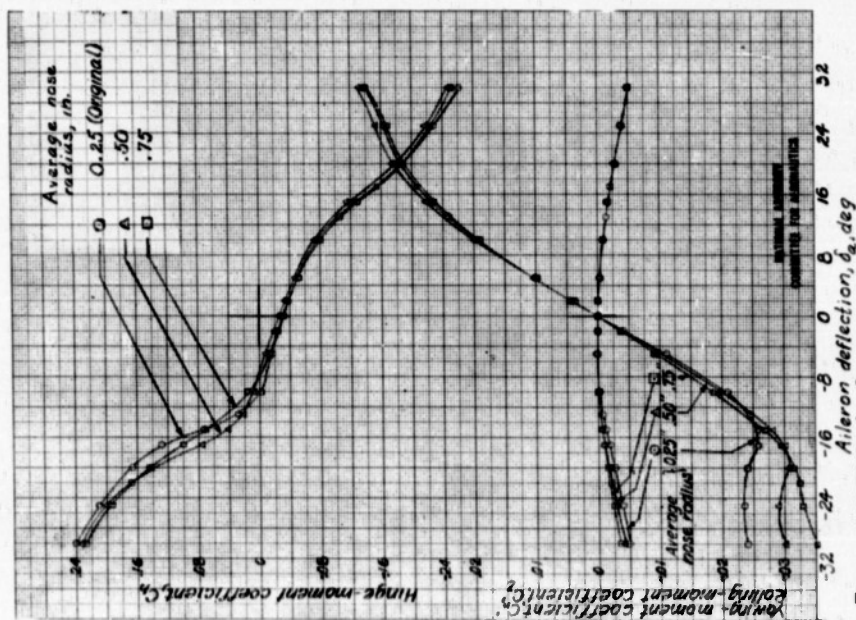


Figure A21.-Effect of nose radius on aerodynamic characteristics of the 0.295 C_0 balance Frise aileron on the 0.4-scale model of a tapered low-drag wing $\alpha, 1^\circ; C_0, 0.17$.

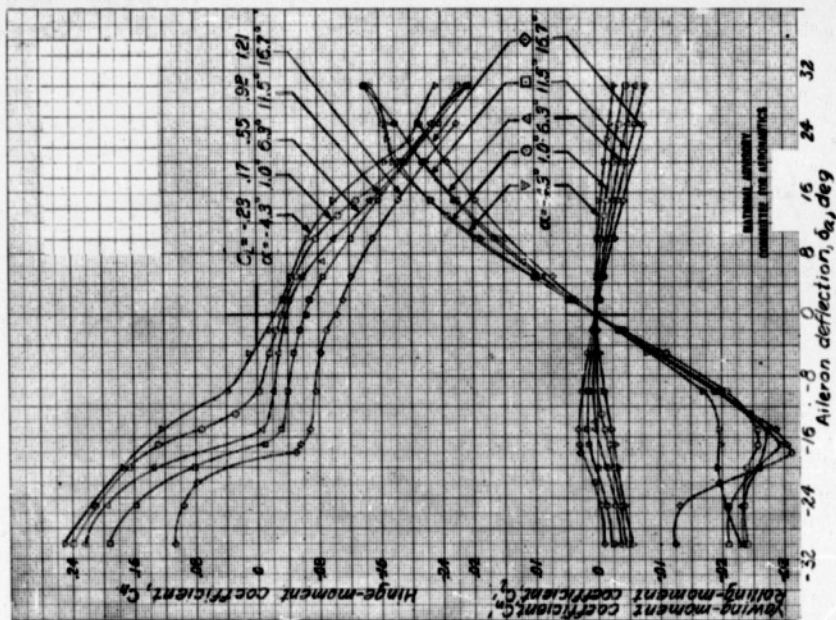
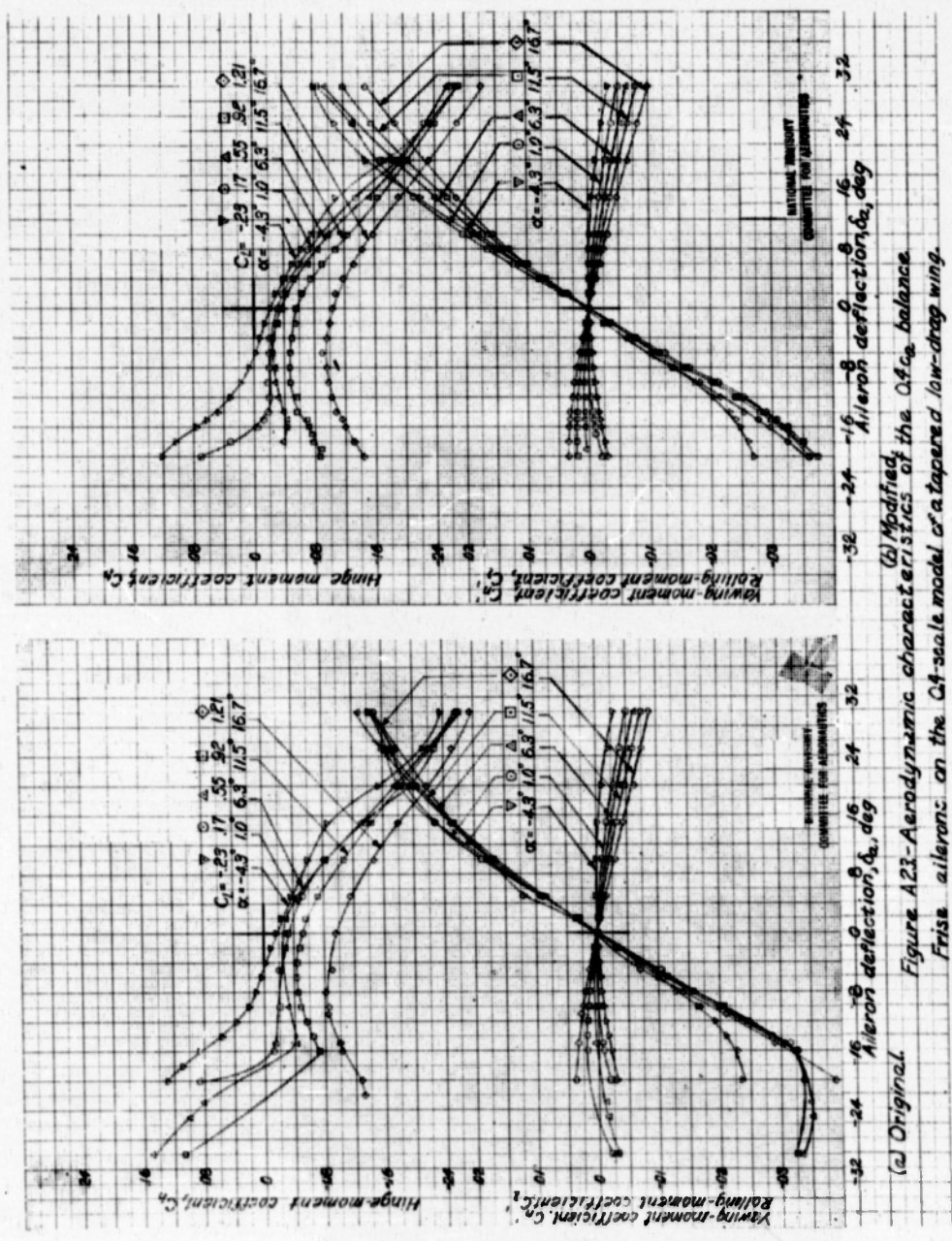


Figure A22.-Aerodynamic characteristics of original 0.295 C_0 balance Frise aileron on the 0.4-scale model of a tapered low-drag wing.

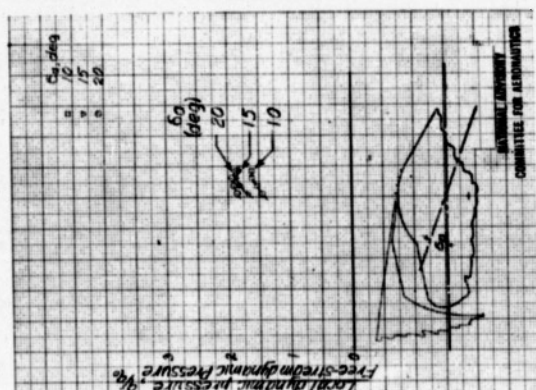
Model A ∇

Model A-V

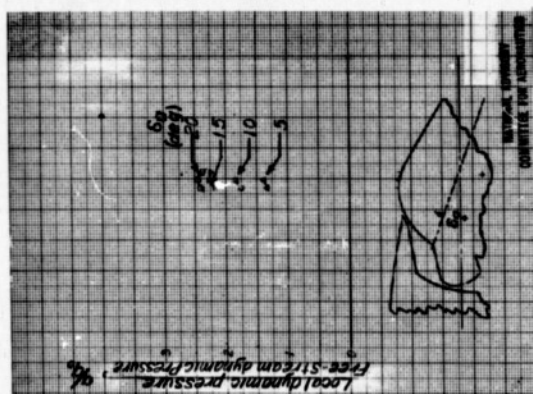


(a) Original. (b) Modified. Figure A23- Aerodynamic characteristics of the A23- Frise aileron on the A23- scale model of a tapered low-drag wing.

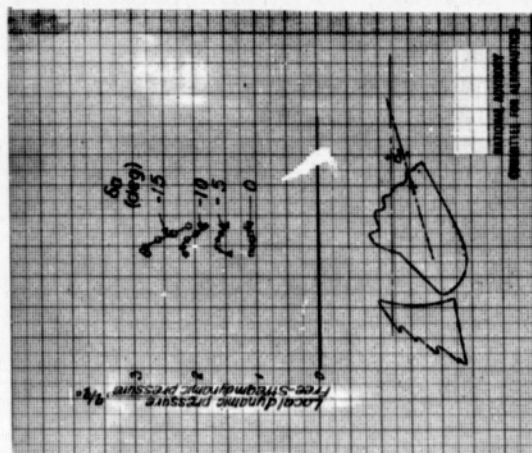
Model A-V



(c) Upper surface, modified.



(b) Upper surface, original.



(a) Lower surface, original.

Figure A24.- Local pressure surveys over the $0.4c_x$ balance Frise ailerons on the 0.4 -scale model of a tapered low-drag wing. $\alpha, 1^\circ; C_L, 0.17$.

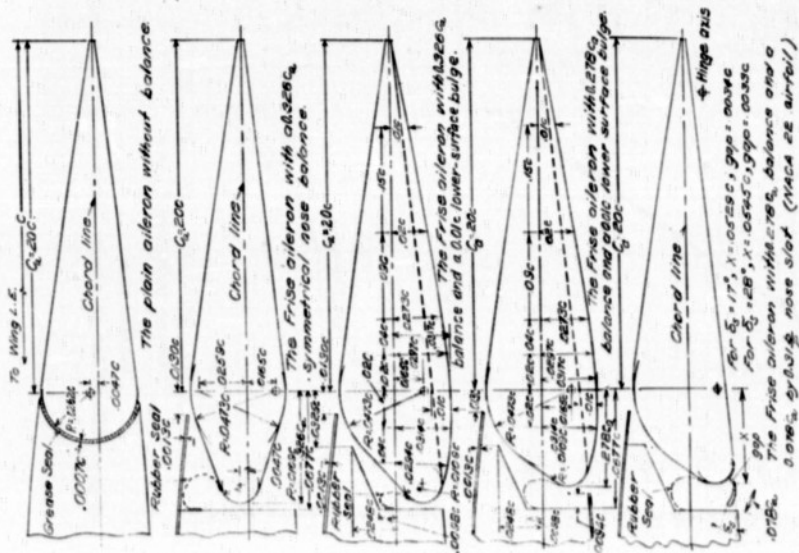


Figure A25-The 0.20c by 0.37% ailerons tested on the 8-foot semispan NACA 23012 airfoil.

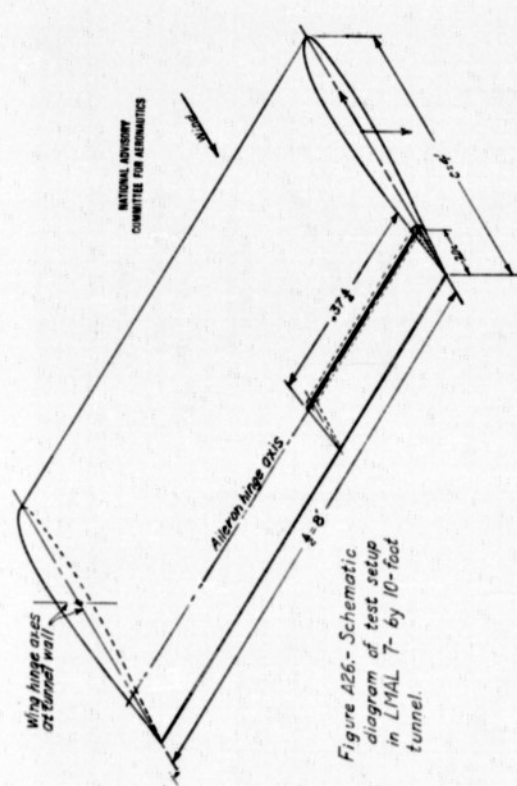


Figure A26-Schematic diagram of test setup in LMAL 7-by-10-foot tunnel.



Figure A27-Tuft action on lower surface of up-deflected Frise aileron, showing cause of oscillation.

Model A-VI

Model A-VI

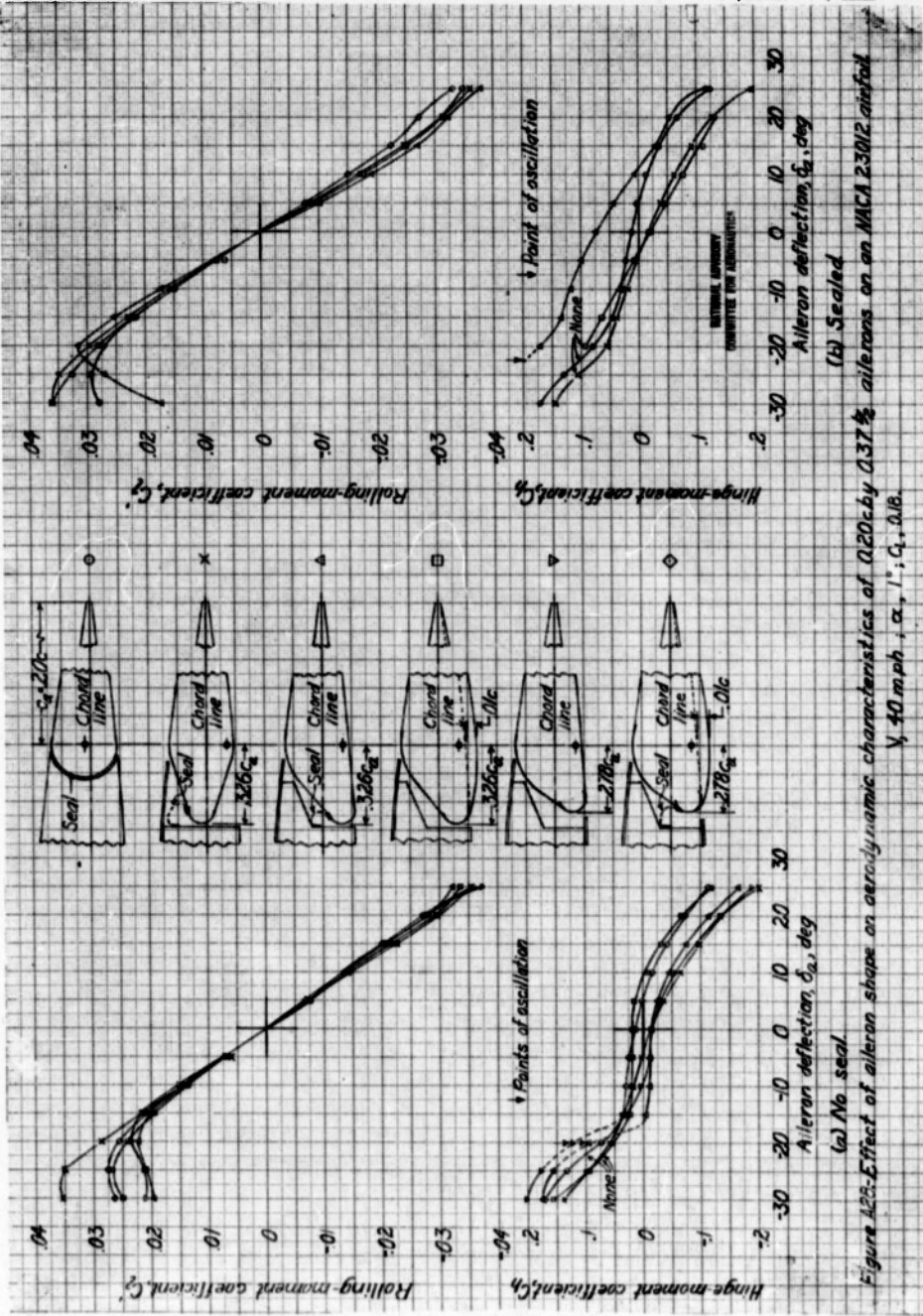


Figure 423—Effect of aileron shape on aerodynamic characteristics of 0.20-inch by 0.37-inch ailerons on an NACA 23012 airfoil
 V , 40 mph; α , 1° ; C_l , 0.16.

Model A-VI

L-419

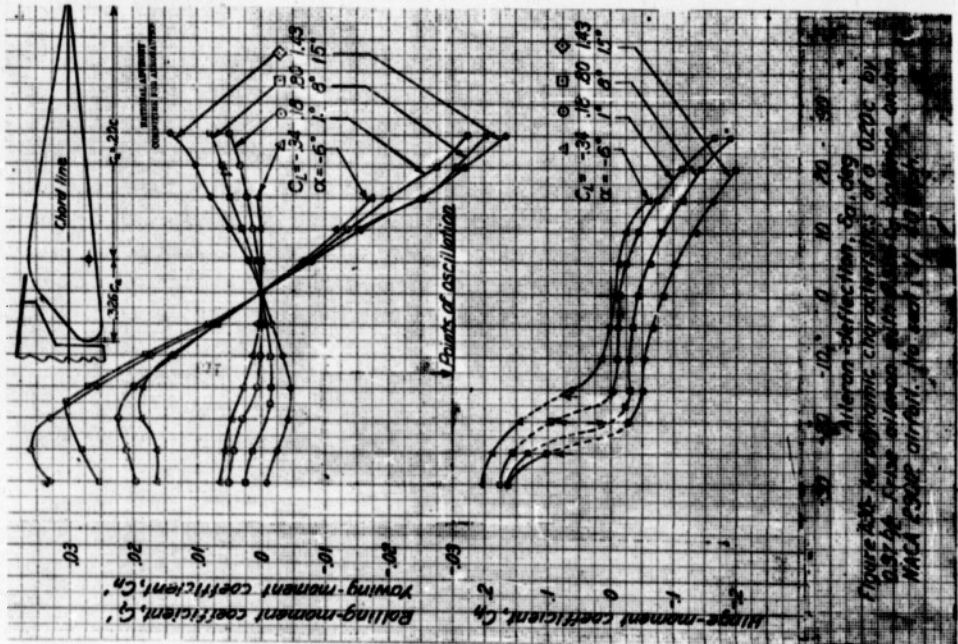


Figure 235: Aerodynamic characteristics of a 0.220c by 0.974c frise aileron with 0.220c balance on an NACA 2304 airfoil. No seal, V, 40 mph.

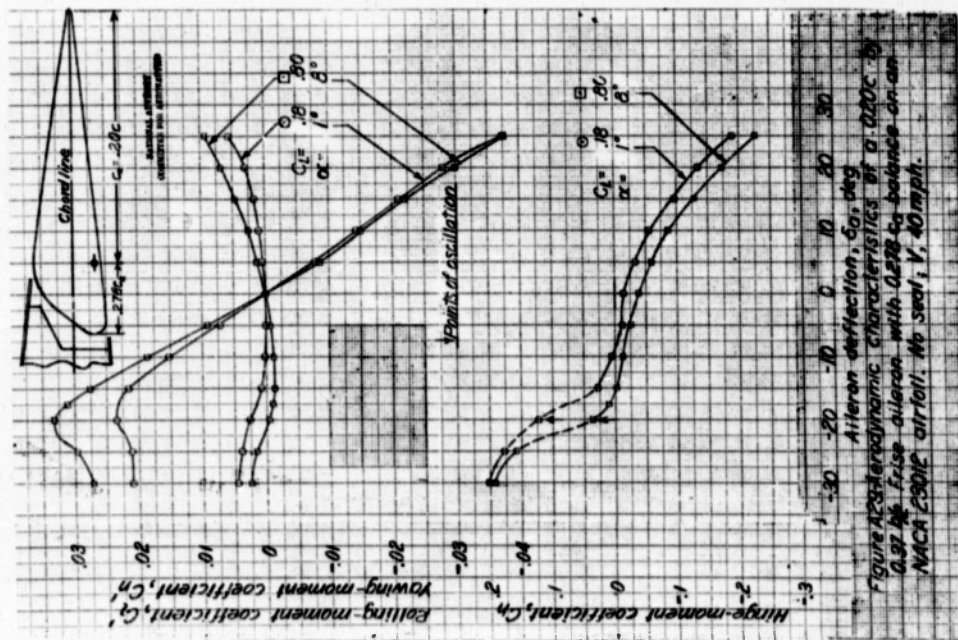
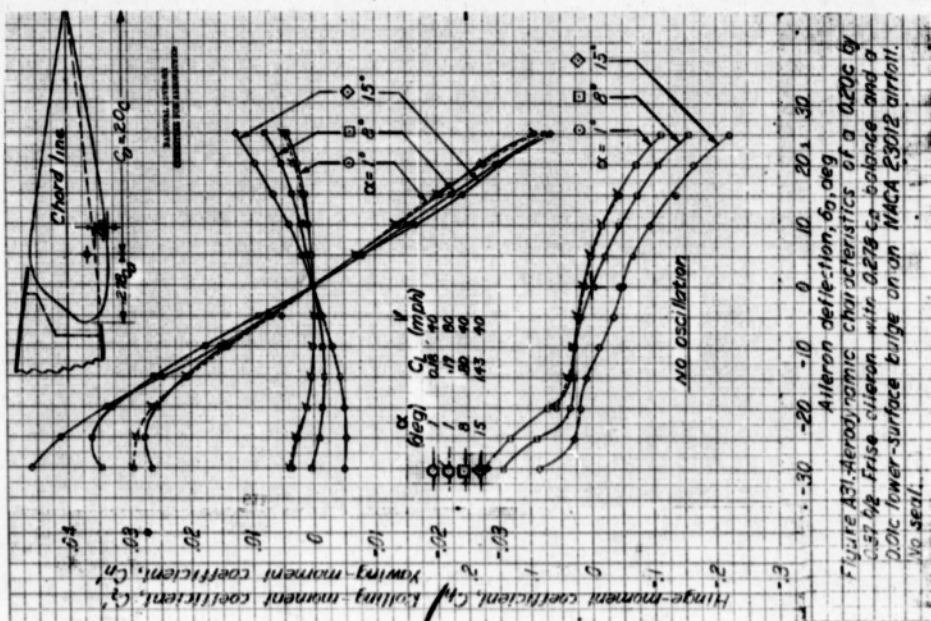
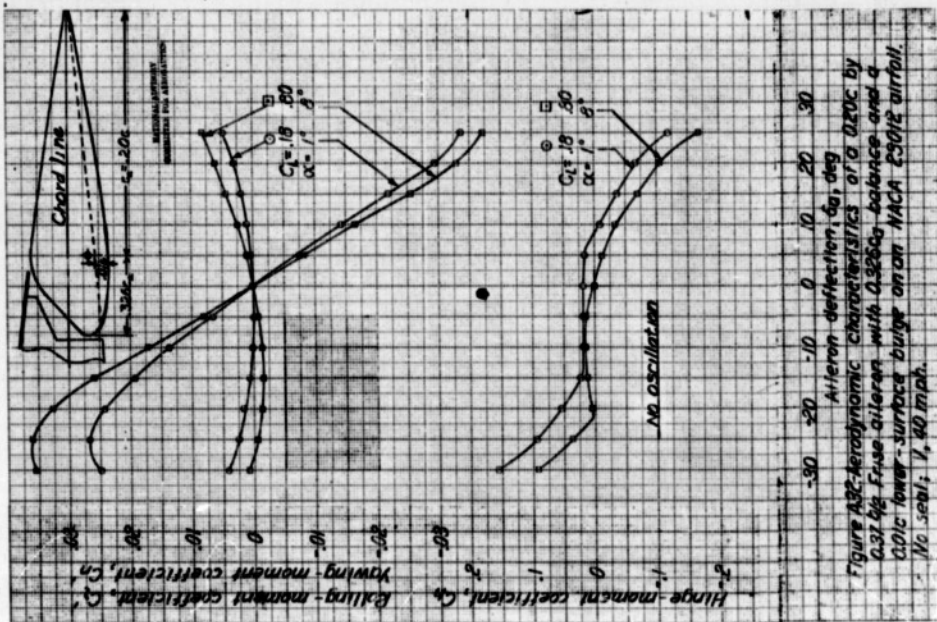


Figure 236: Aerodynamic characteristics of a 0.220c by 0.974c frise aileron with 0.220c balance on an NACA 2304 airfoil. No seal, V, 40 mph.

Model A-VI



Model A-VI

L-419

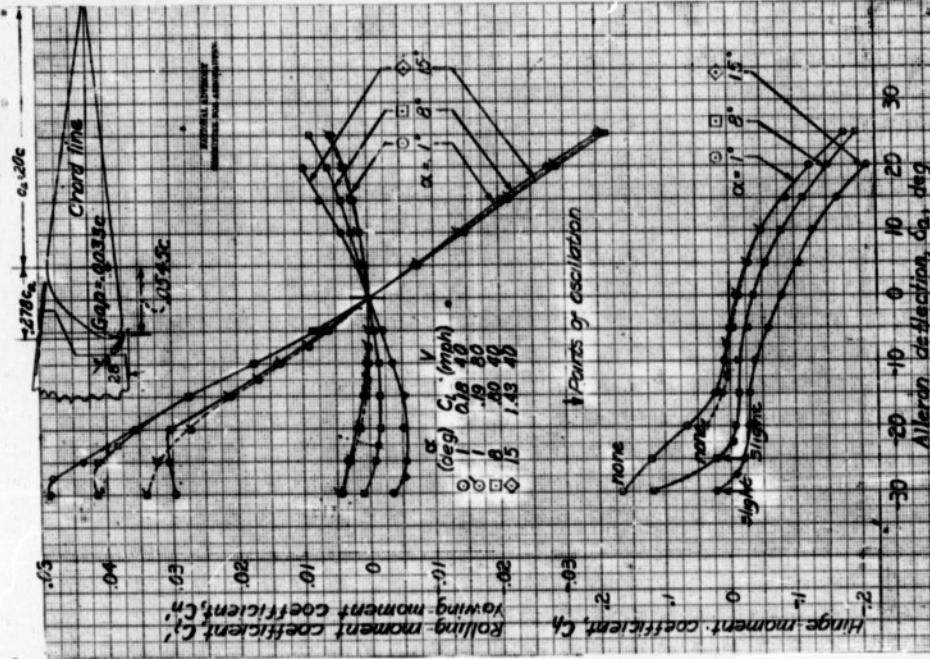


Figure 134. Aerodynamic characteristics of a 0.206 by 0.375 Frise airfoil with 0.278c balance and a centrally located nose slot on an NACA 23012 airfoil. No seal & 28

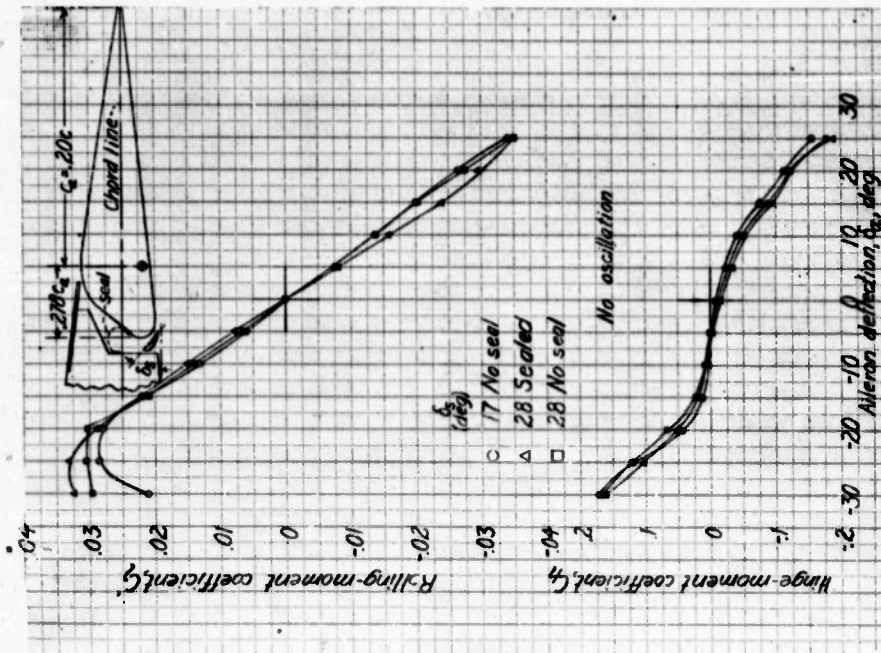
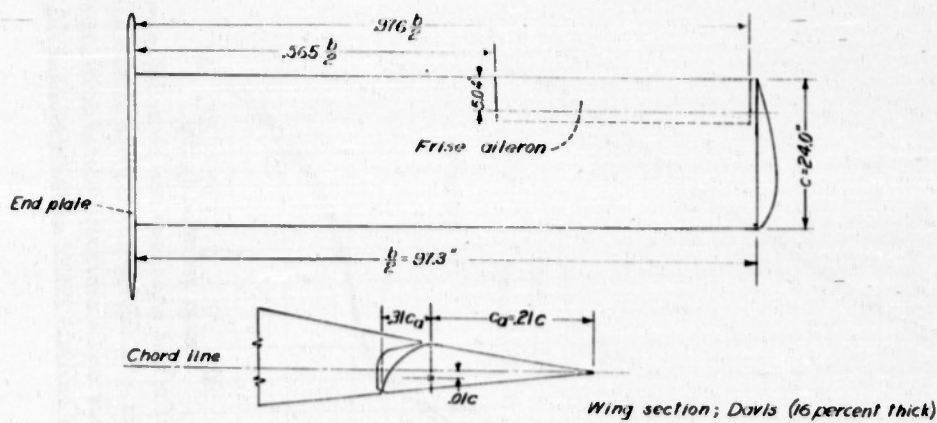
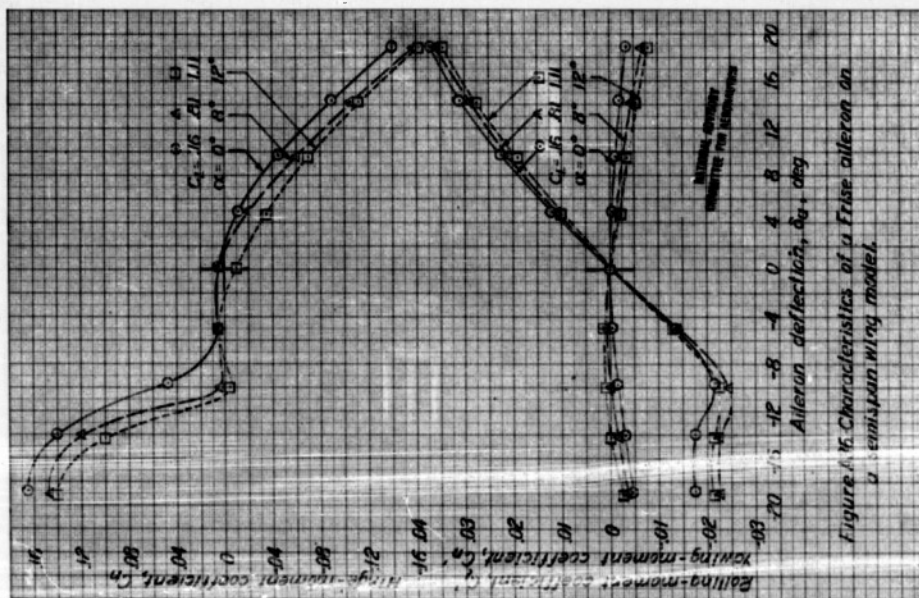


Figure 135. Effect of slot angle and seal on aerodynamic characteristics of a 0.206 by 0.375 Frise airfoil with 0.278c balance and a centrally located nose slot on an NACA 23012 airfoil. V 40 mph; α , 1°; C_l , 0.2

Model A-VII



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Model A-VIII

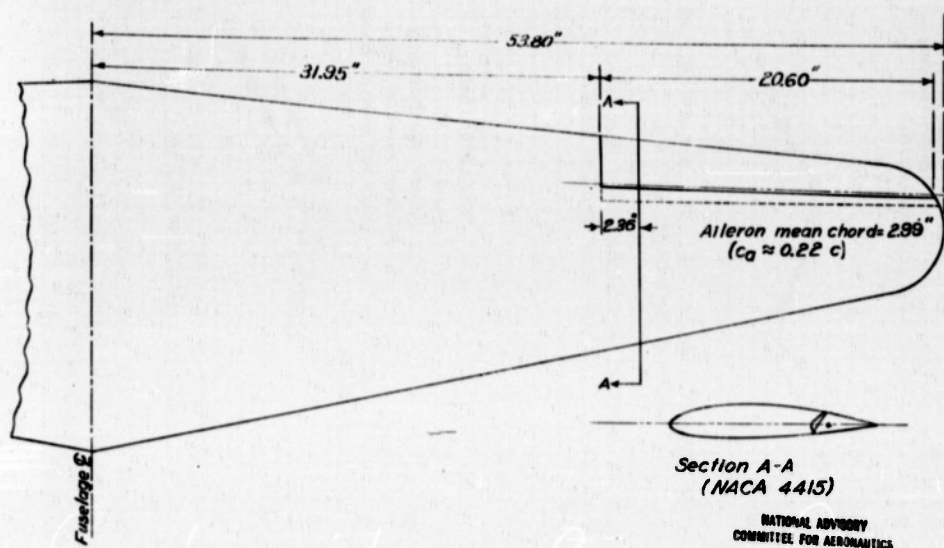


Figure A37-Planform of wing of 1/13-scale airplane model.

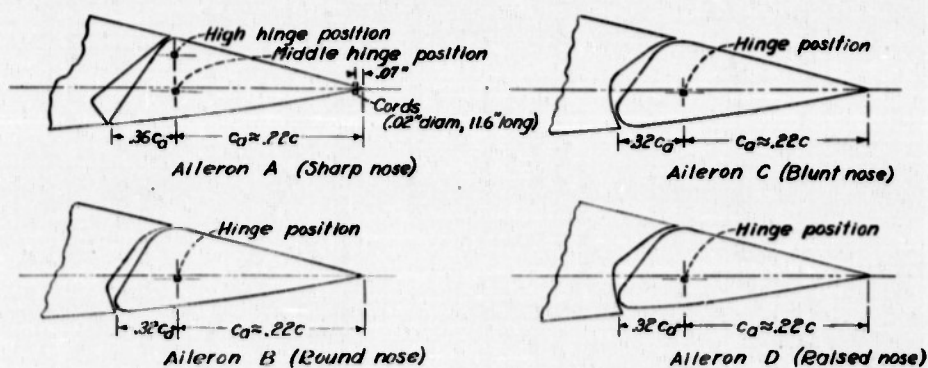
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Figure A38-The various modifications of the aileron of the 1/13-scale airplane model. RAE, 11-foot tunnel.

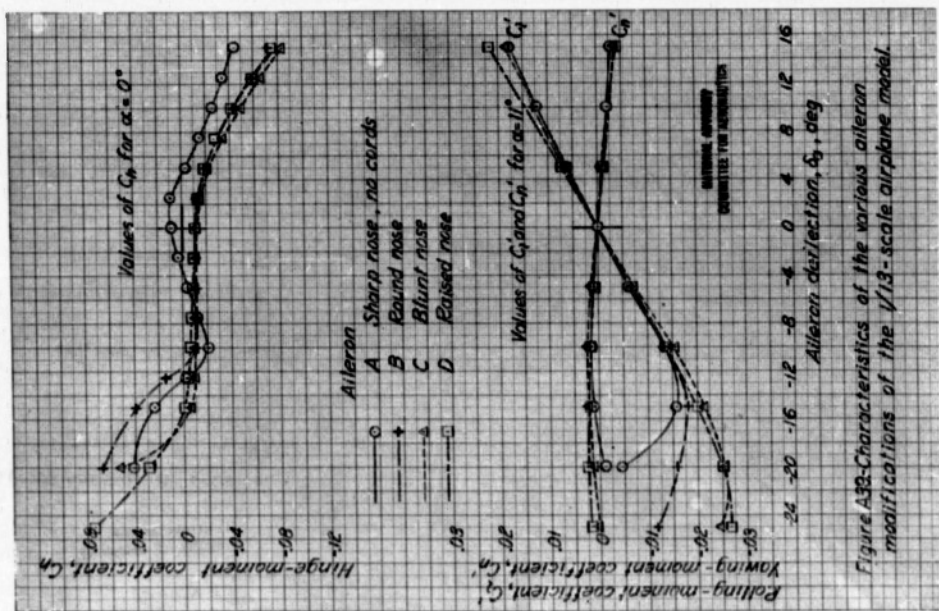


Figure A32-Characteristics of the various aileron modifications of the V13-scale airplane model.

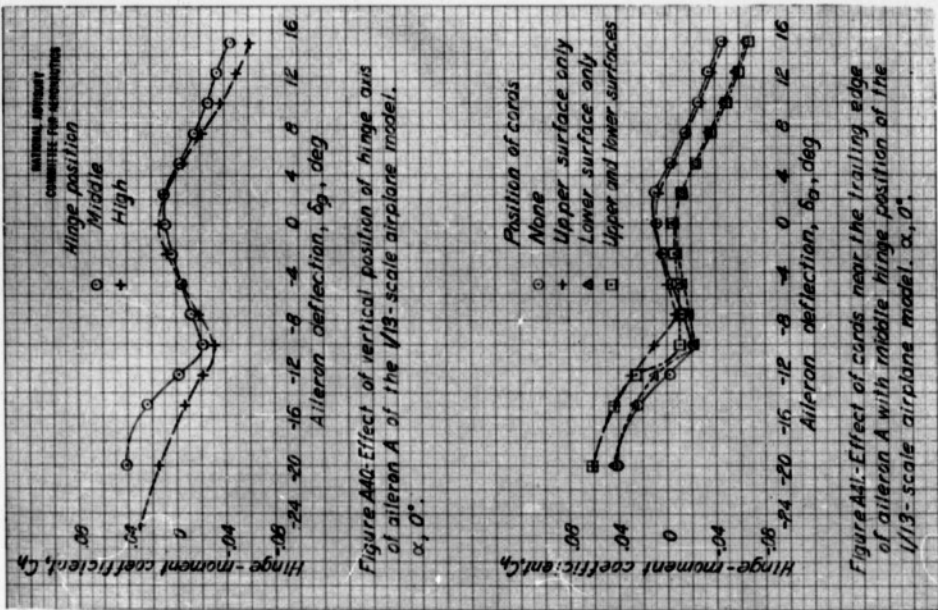


Figure A40-Effect of vertical position of hinge axis of aileron A of the V13-scale airplane model.

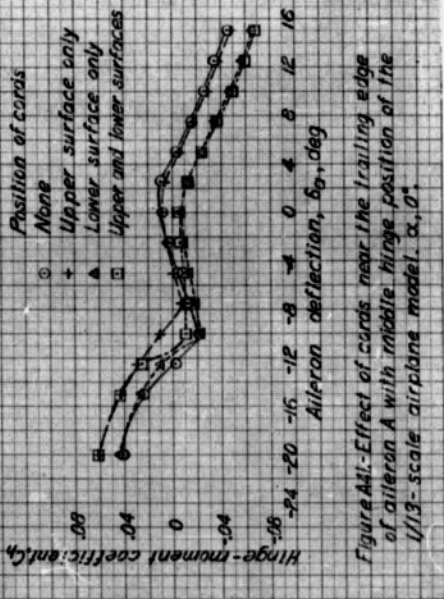


Figure A41-Effect of cords near the trailing edge of aileron A with middle hinge position of the V13-scale airplane model. $\alpha, 0^\circ$.

Model A-X

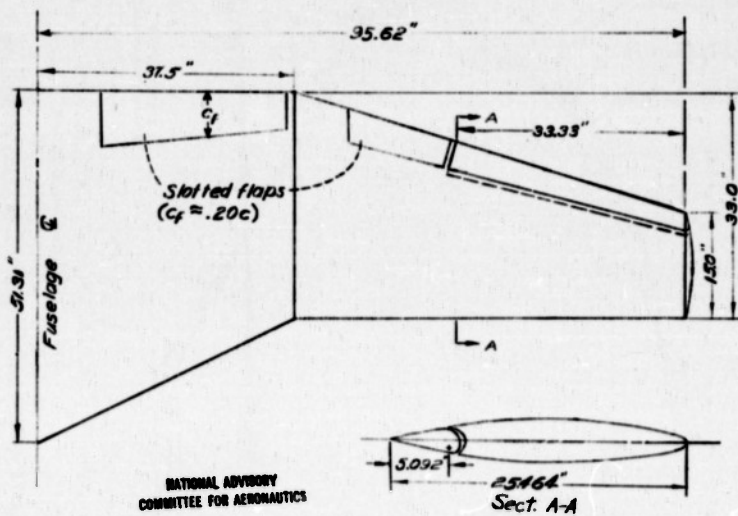


Figure A45. Plan form of wing of 0.375-scale airplane model. NACA 19-foot pressure tunnel.

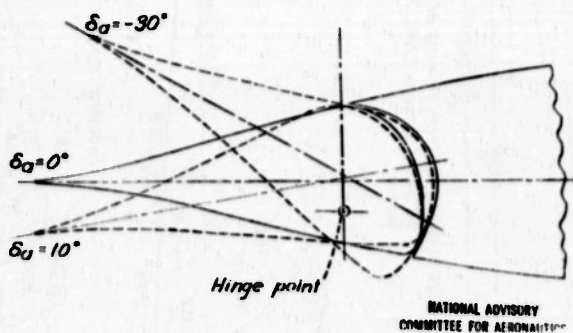


Figure A46. Typical cross section and deflected positions of 0.375-scale airplane model.

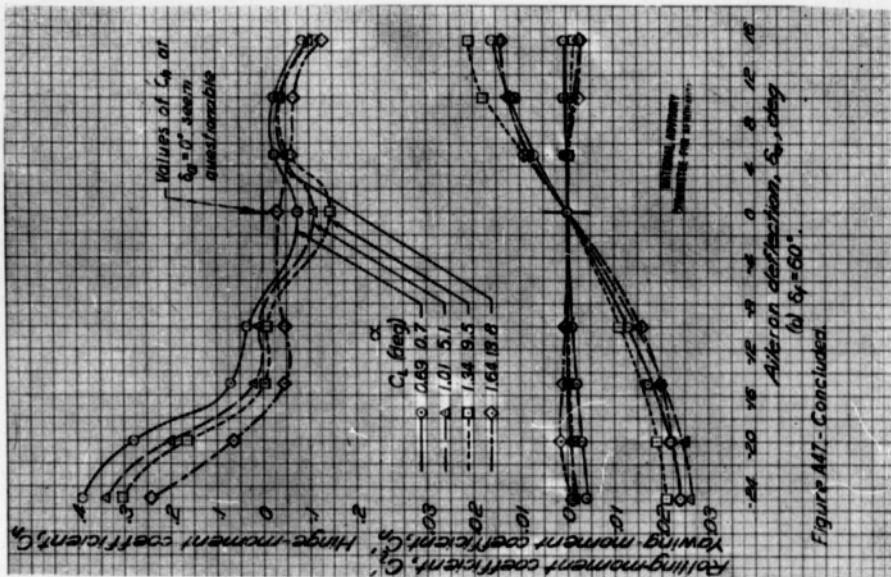


Figure A47 - Concluded

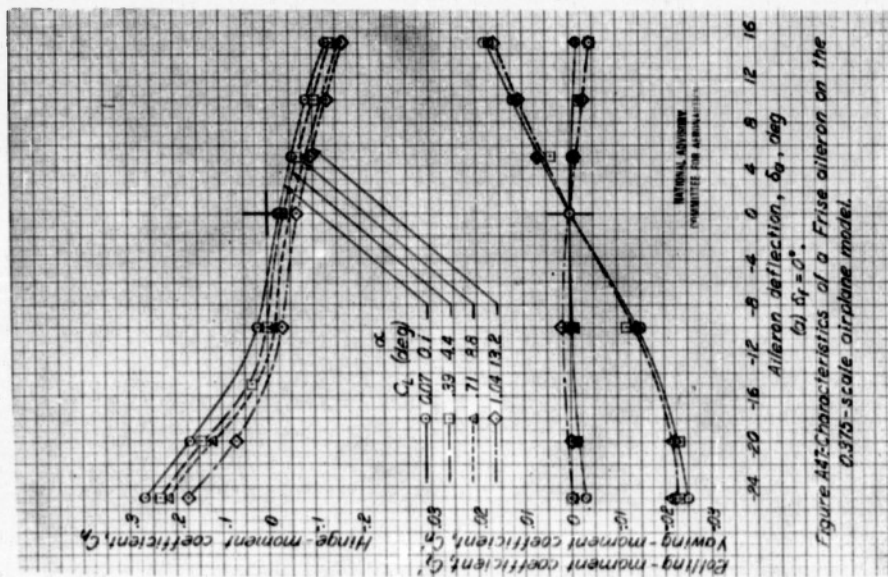


Figure A48: Characteristics of a Frise aileron on the 0.375-scale airplane model

Model A-XI

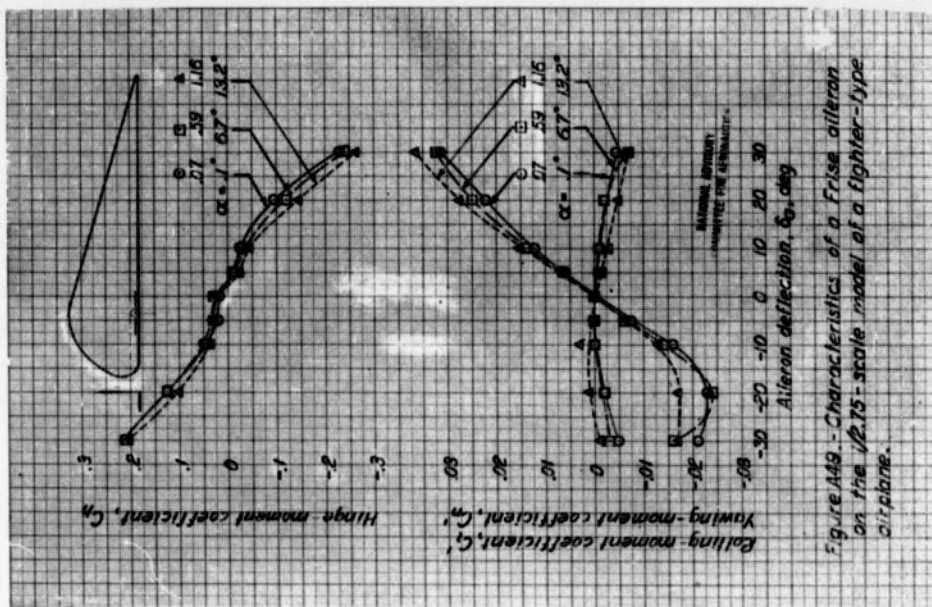


Figure A49.-Characteristics of a Frise aileron on the 1/2.75-scale model at a fighter-type airplane.

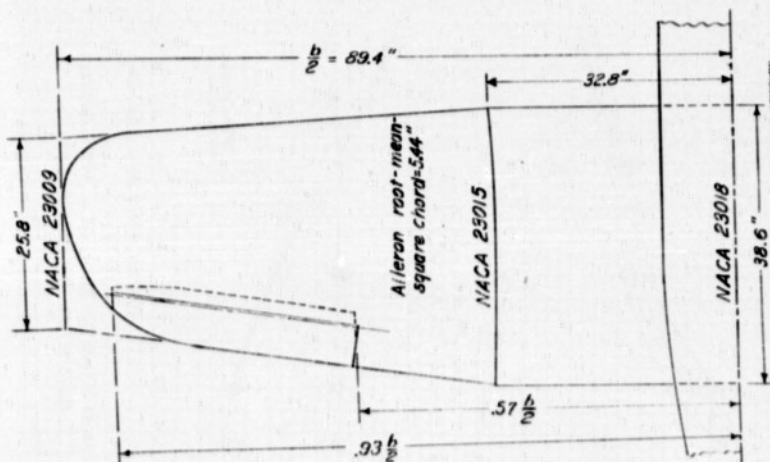
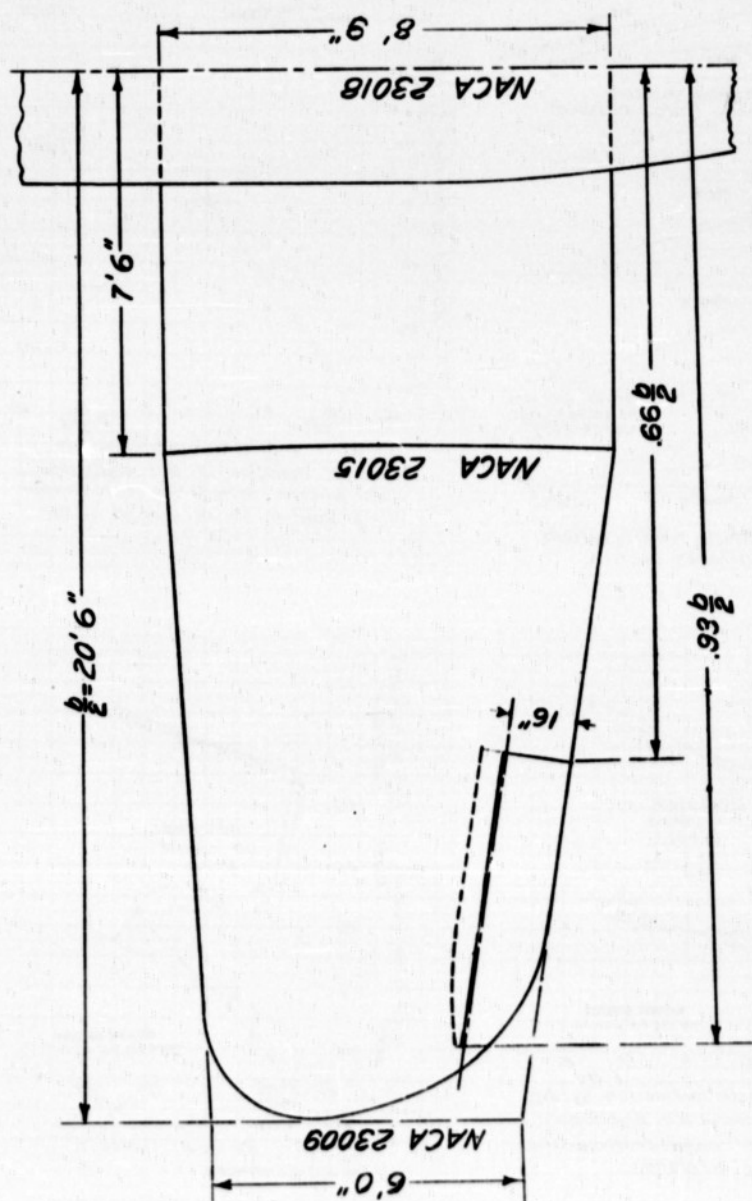


Figure A48.-Plan form of wing of a 1/2.75-scale model of a fighter-type airplane. NACA 14-foot pressure tunnel.

Airplane A-XII



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Figure A50.-Plan form of wing of fighter-type airplane tested in flight at LMAL.

Airplane A-XII

617-1.

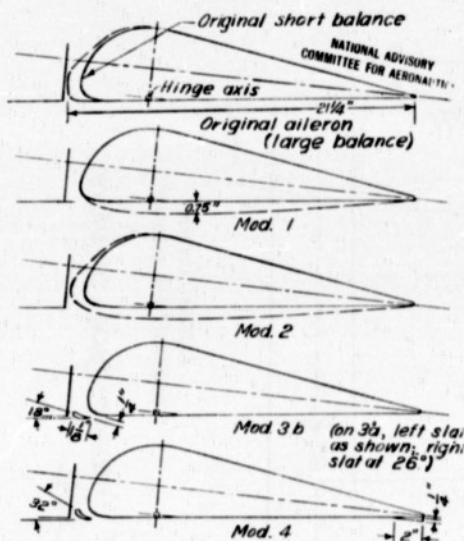


Figure A51.-The various modifications to the aileron section.

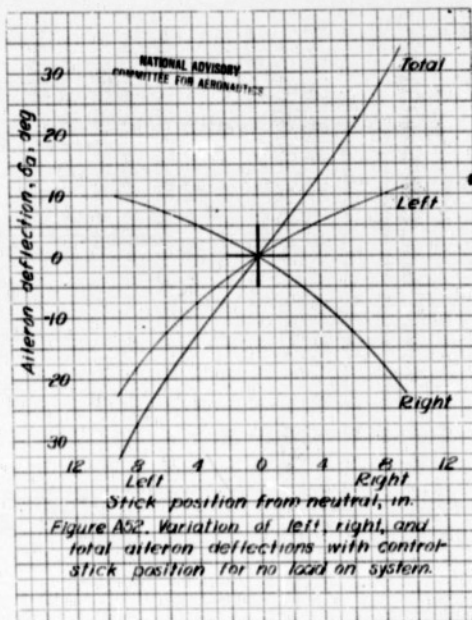


Figure A52.-Variation of left, right, and total aileron deflections with control stick position for no load on system.

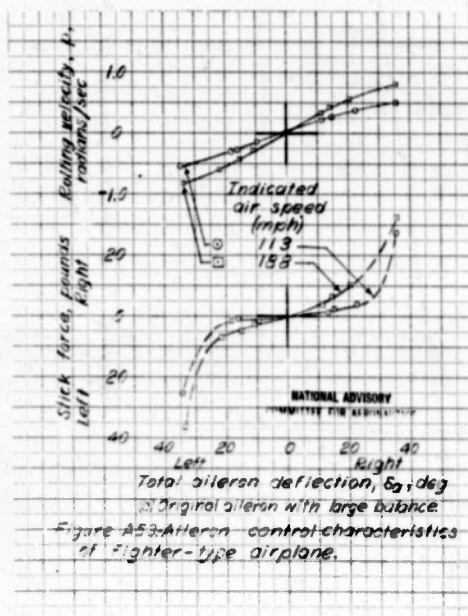


Figure A53.-Aileron control characteristics of fighter-type airplane.

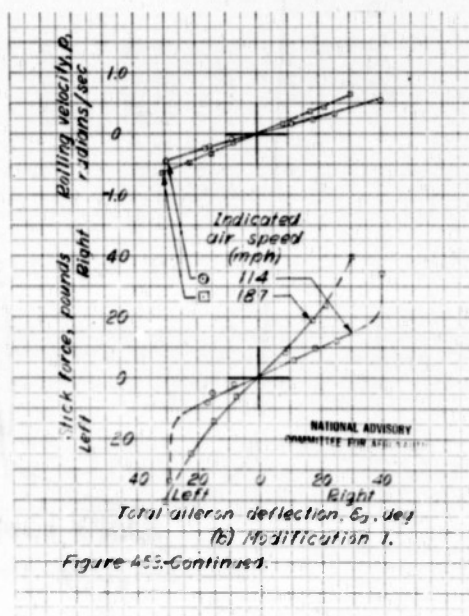


Figure A53.-Continued.

Airplane AXII

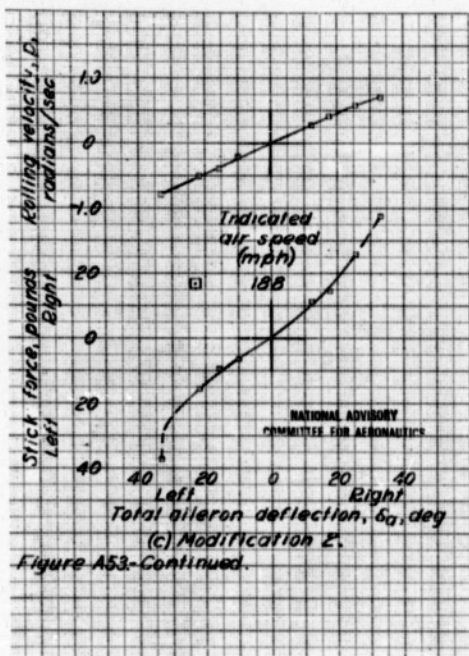


Figure A53-Continued.

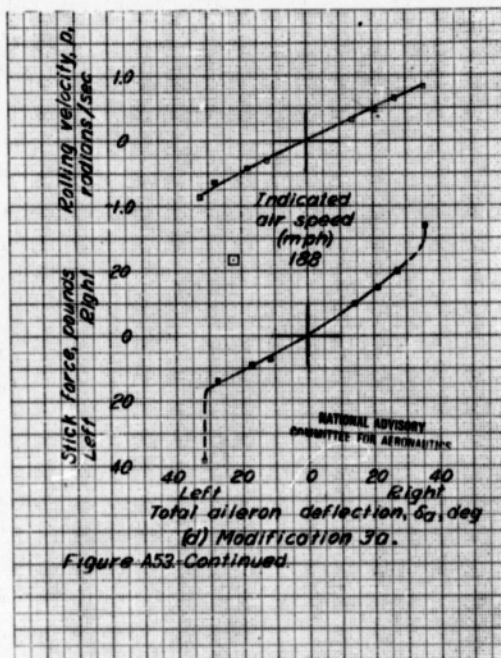


Figure A53-Continued.

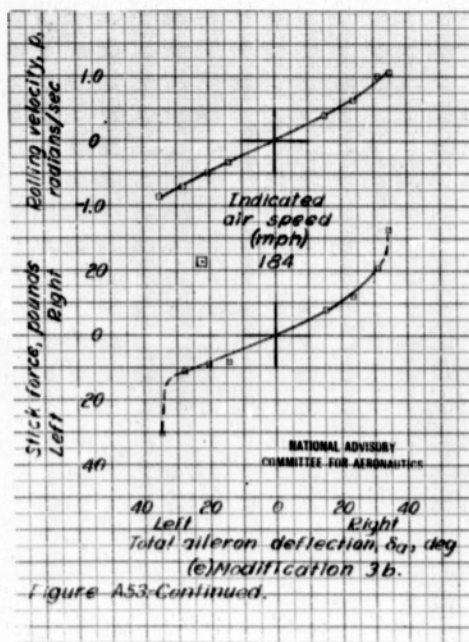


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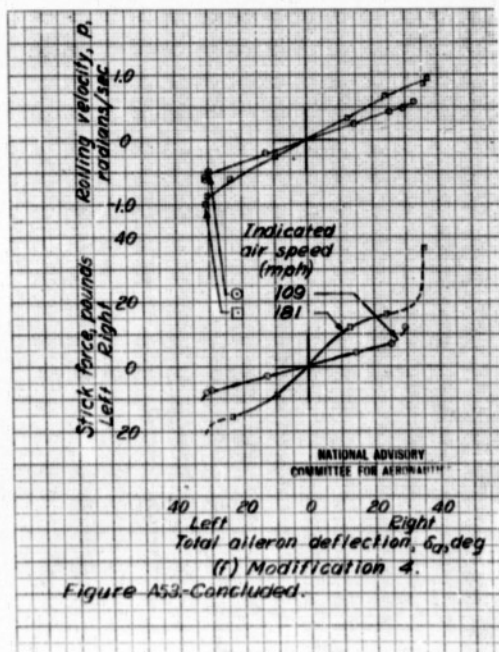
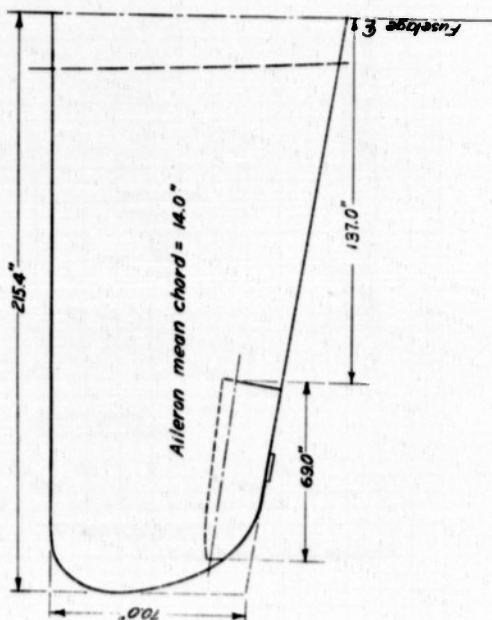


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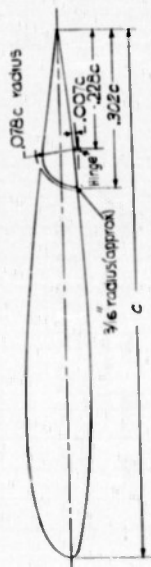


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Figure A54.-Wing plan form and typical aileron section of a light scout-type airplane tested in flight at A.L.

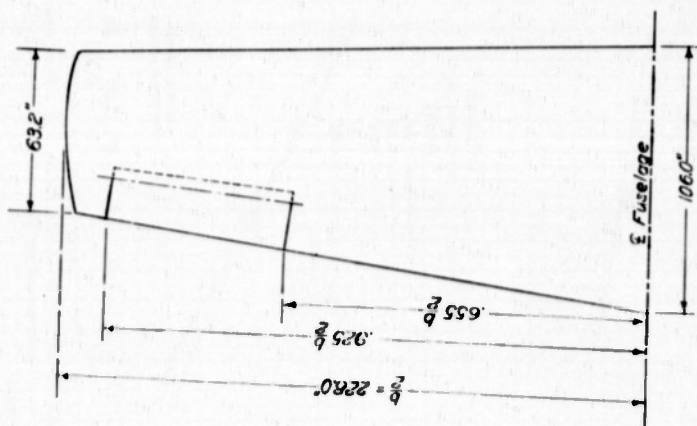


Airplane A-54



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Figure 457. Typical section through aileron portion of wing of fighter-type airplane. NACA 230-series airfoil.



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Figure 455. Plan view of wing of fighter-type airplane tested in flight at L.M.A.L.

Airplane AXIV

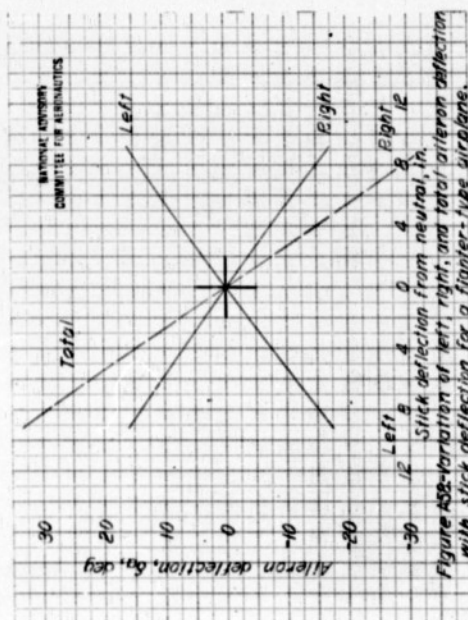
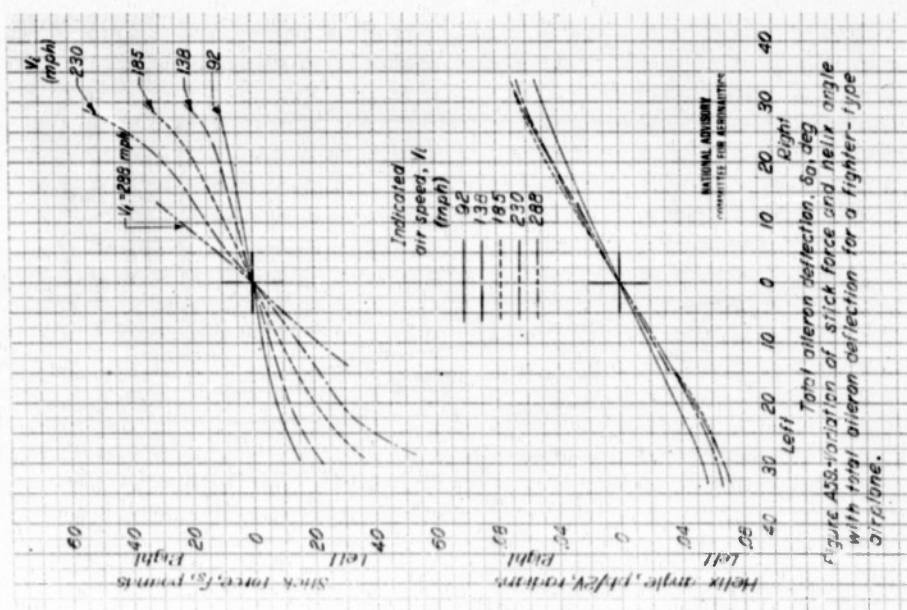
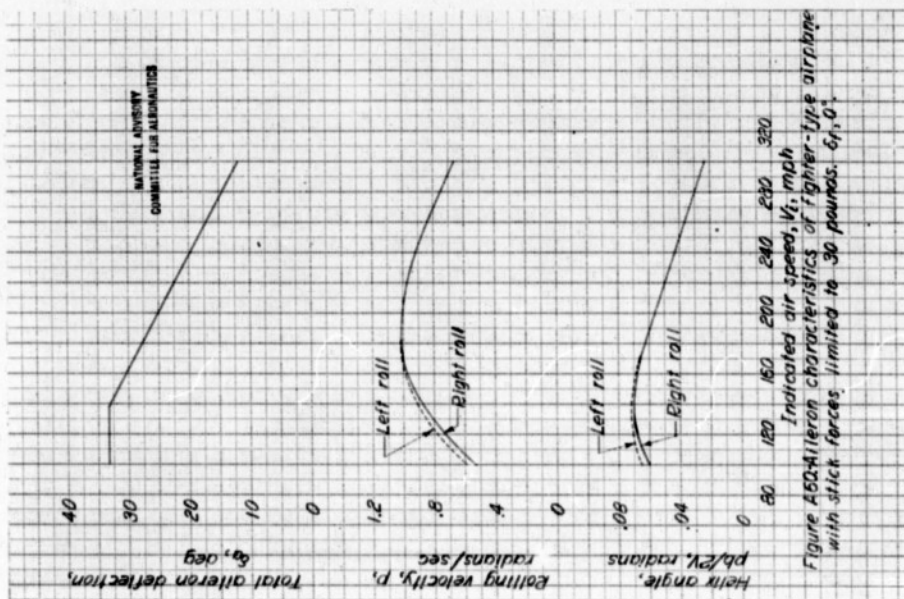
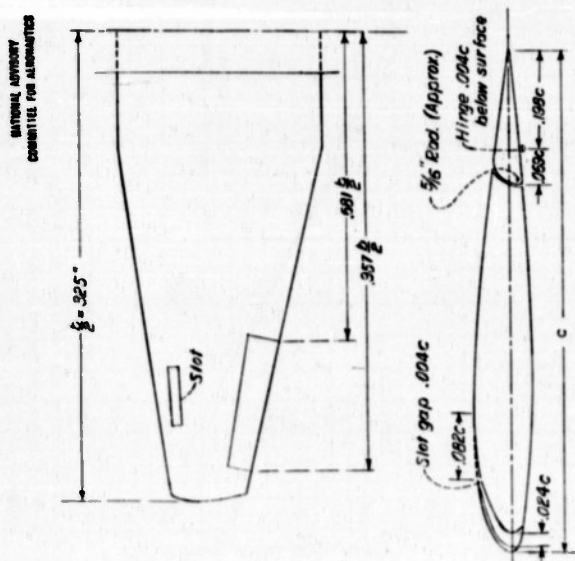
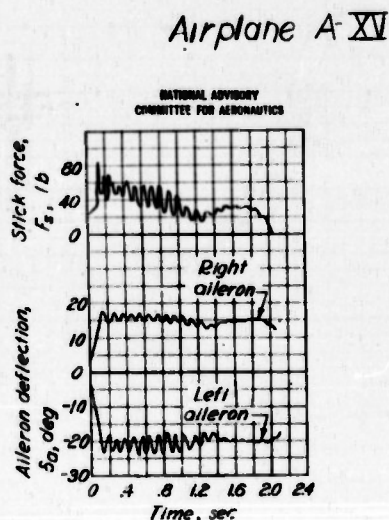
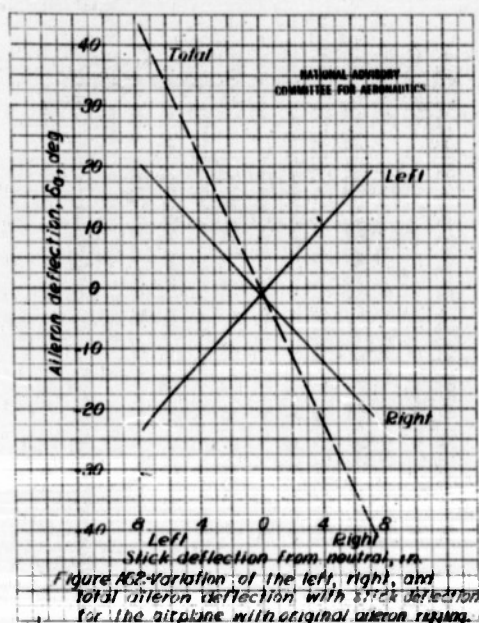


Figure 458. Variation of left, right, and total aileron deflection with stick deflection for a fighter-type airplane.

Airplane A-XIV





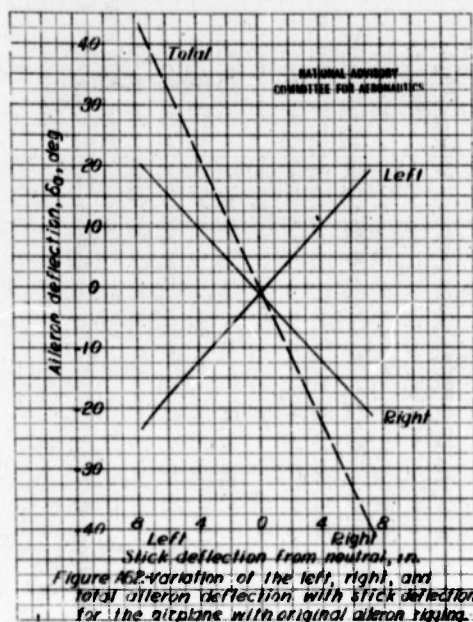
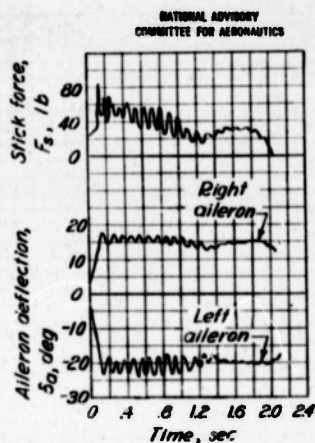
Airplane A^{XV}

Figure A63: Time history for an abrupt full left aileron deflection with original aileron rigging. Level flight; wing slots open; V_i , 120 mph; δ_f , 0°.

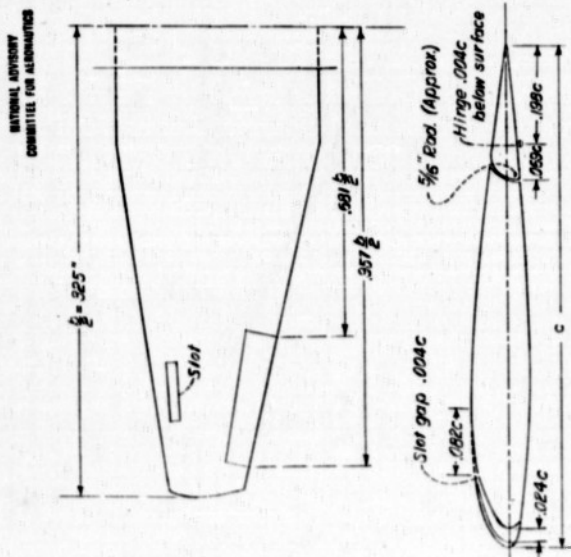
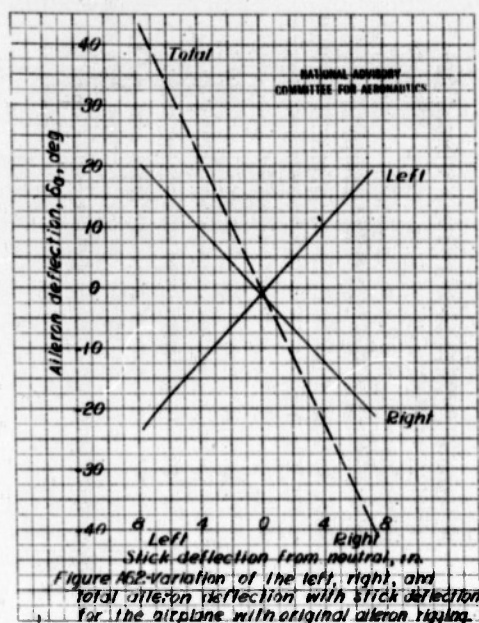
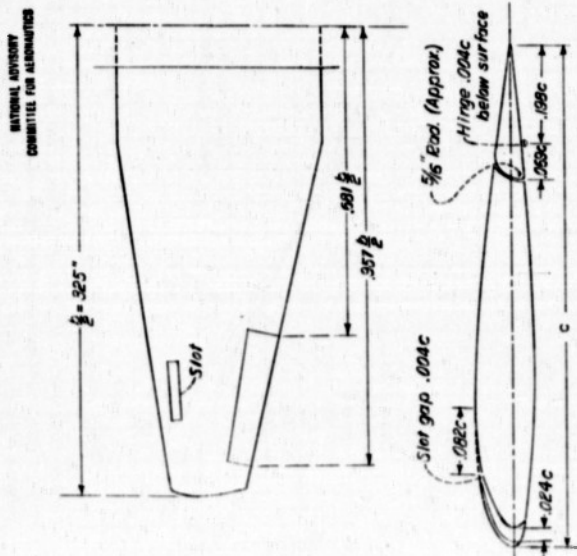
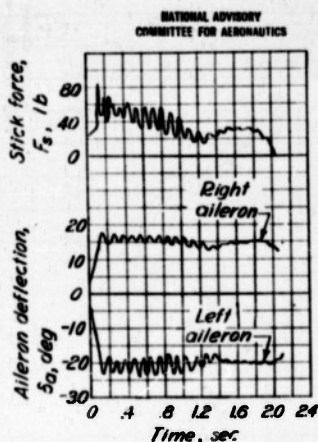


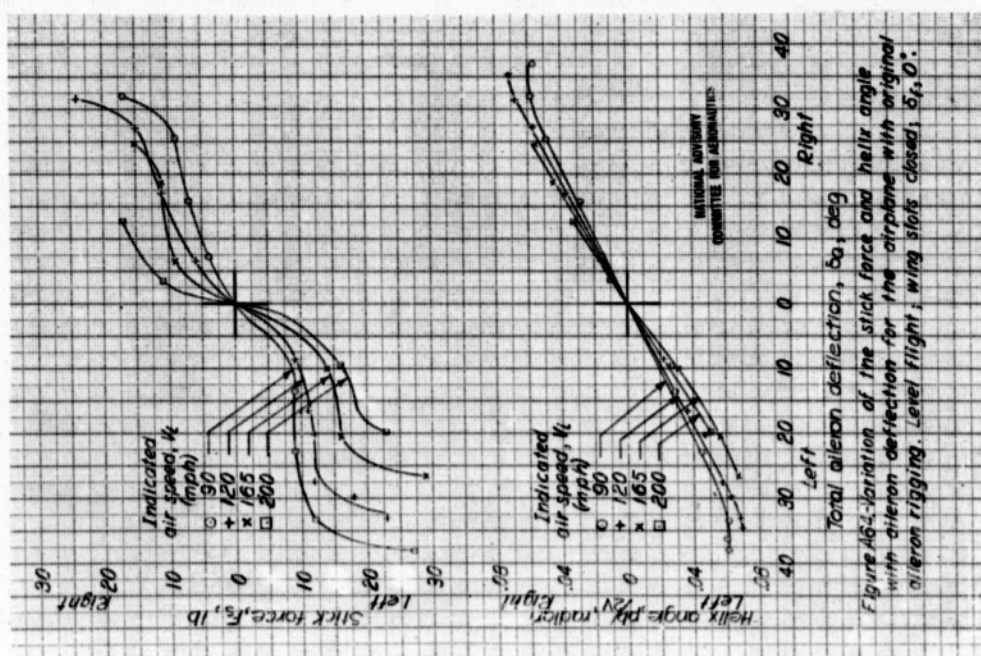
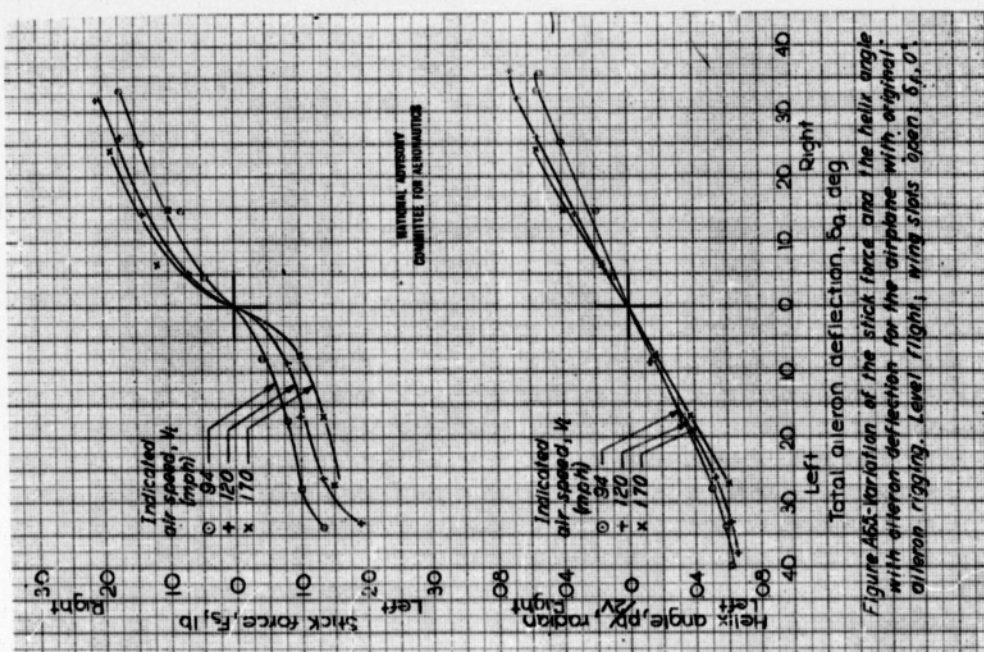
Figure A64: Plan form of wing and typical section through the aileron portion of the wing of an airplane tested in flight at LMAL.



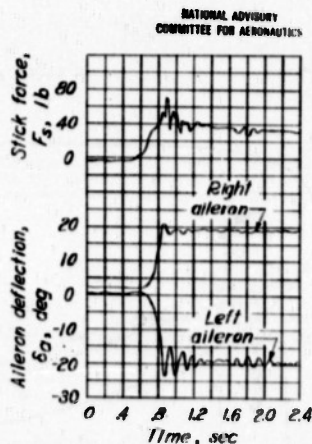
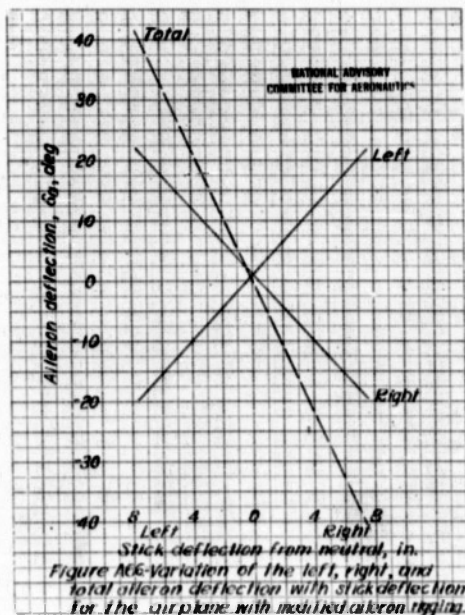
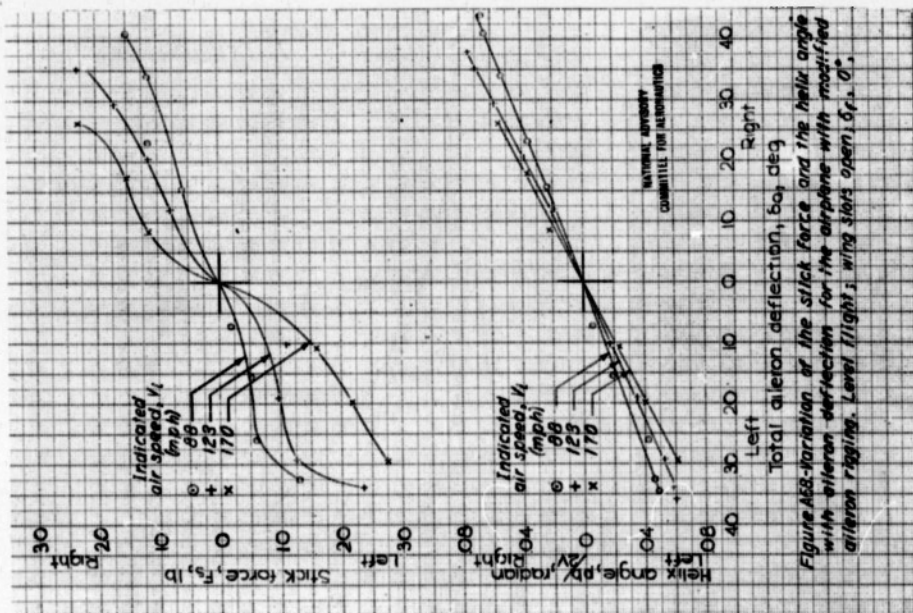
Airplane A XV



Airplane A-XV



Airplane A-XV



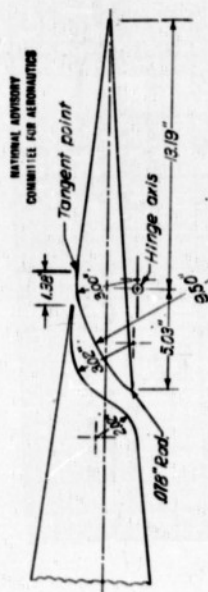


Figure 470-Details of the original aileron of section A.

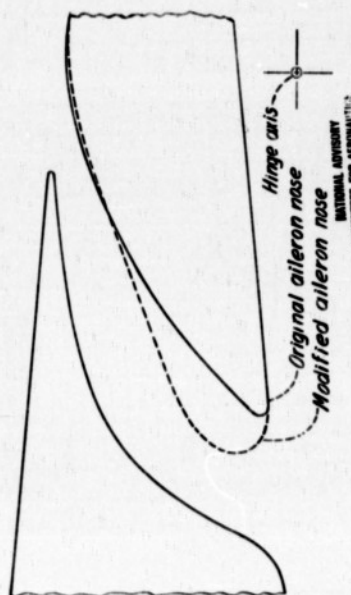


Figure 471-Original nose and modified nose of the aileron of the pursuit-type airplane.

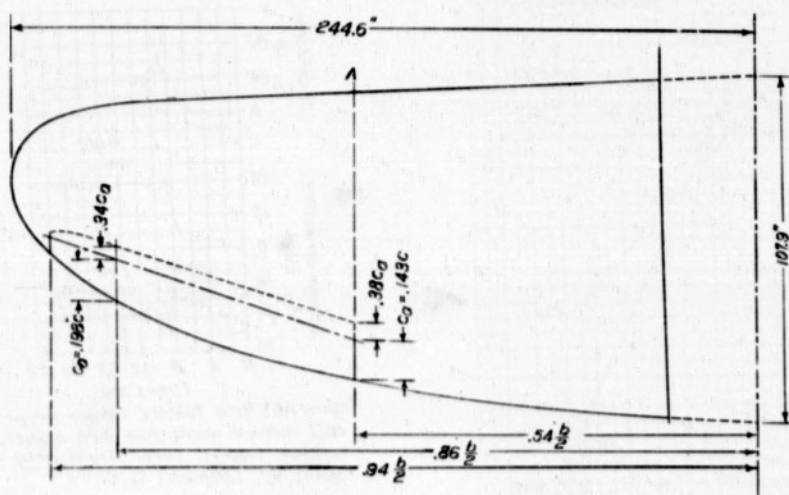
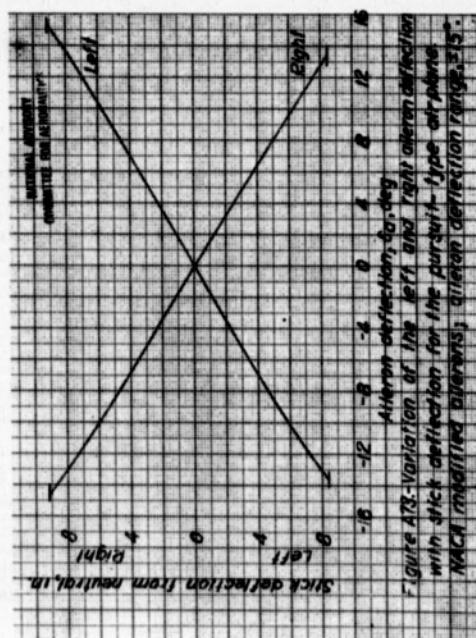
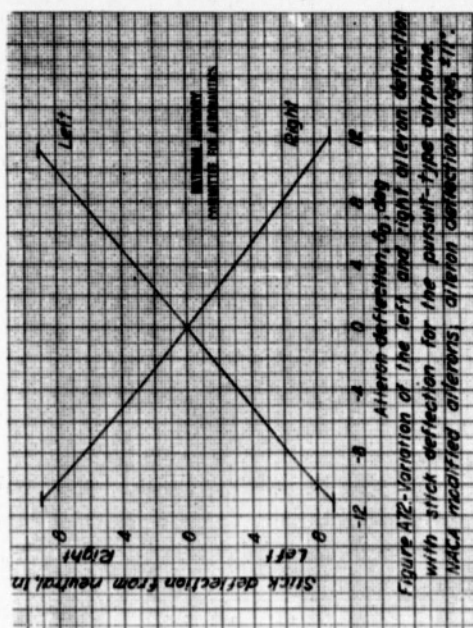
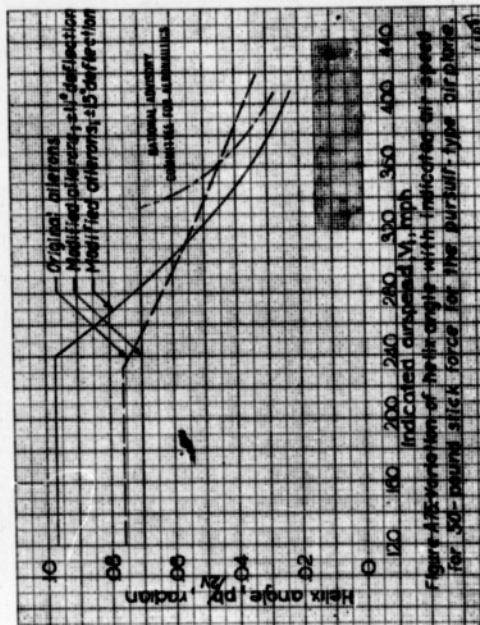
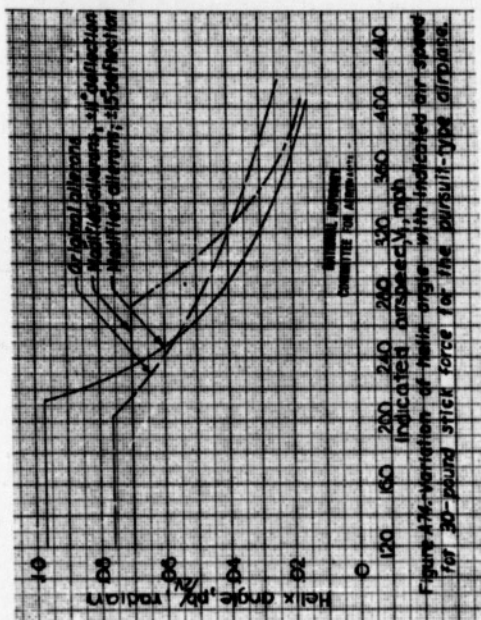


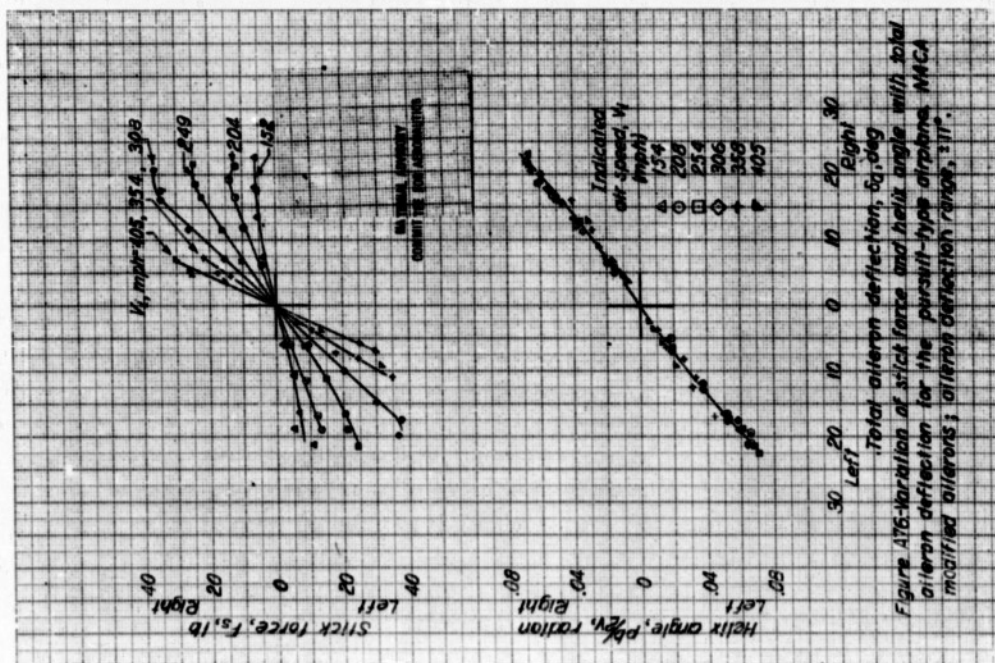
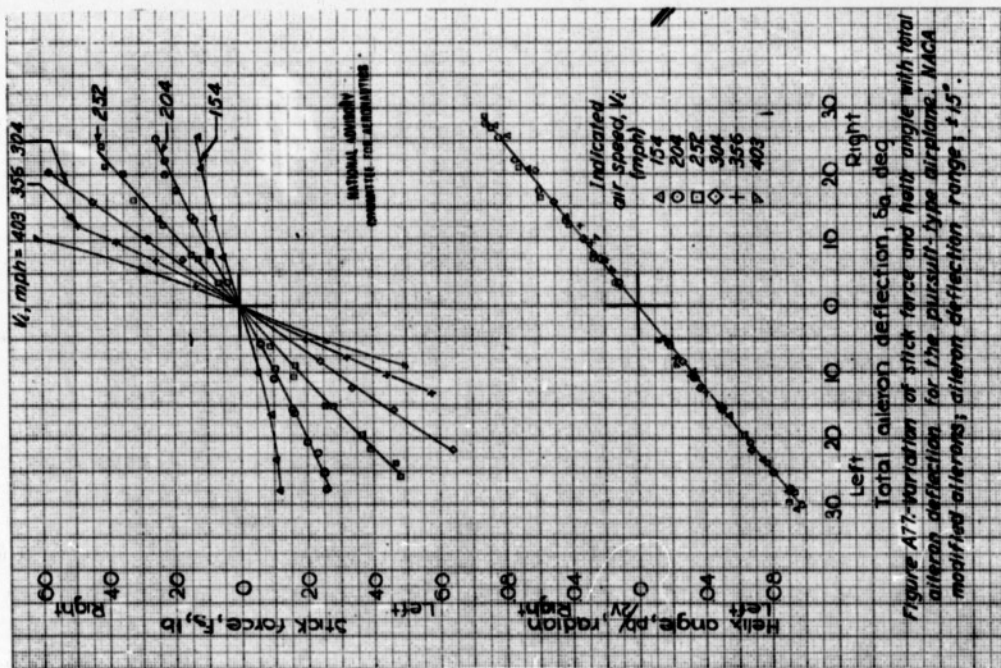
Figure A63-Plan form of wing of pursuit-type airplane tested in flight at LMAL.

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Airplane A-XVI



Airplane A-XVI



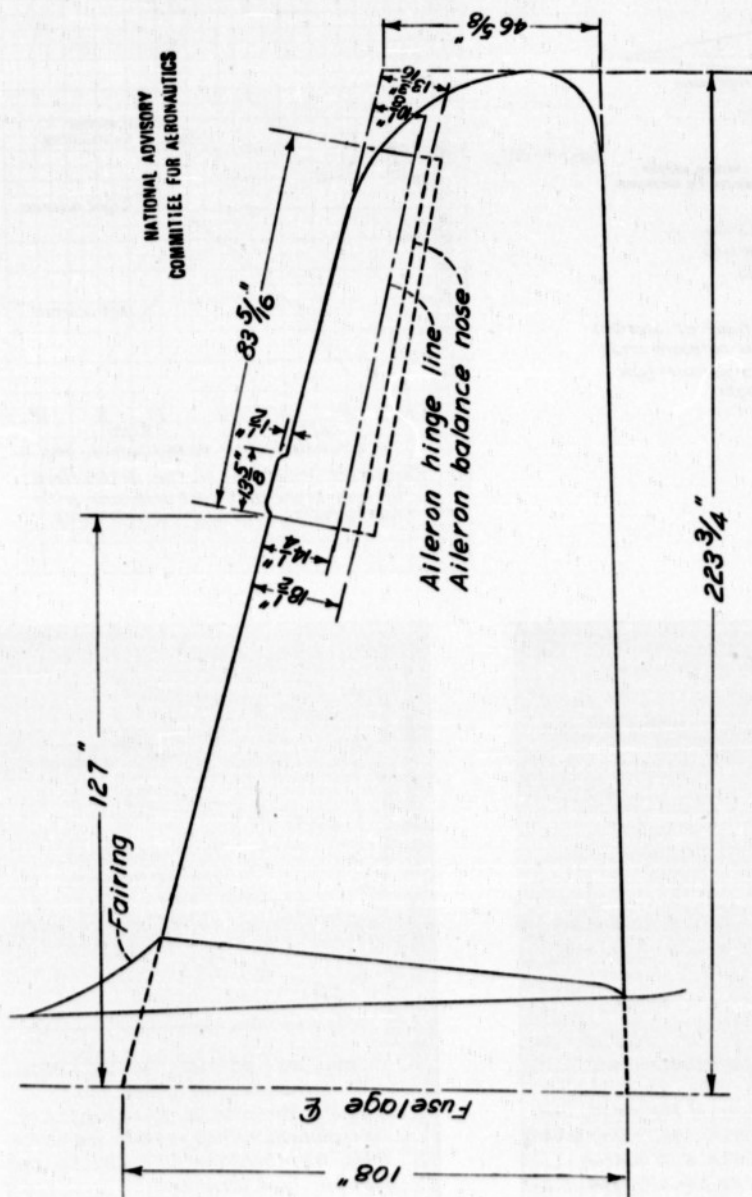
Airplane A-XVII

Figure A18-Plan form of the wing of a pursuit-type airplane tested in flight at LMAL.

Airplane A-XVII

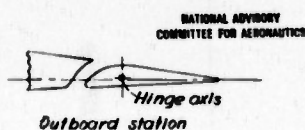
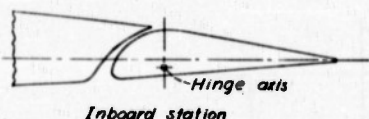


Figure A79.-Aileron sections at stations near the inboard and outboard ends of the aileron of the pursuit-type airplane tested in flight.

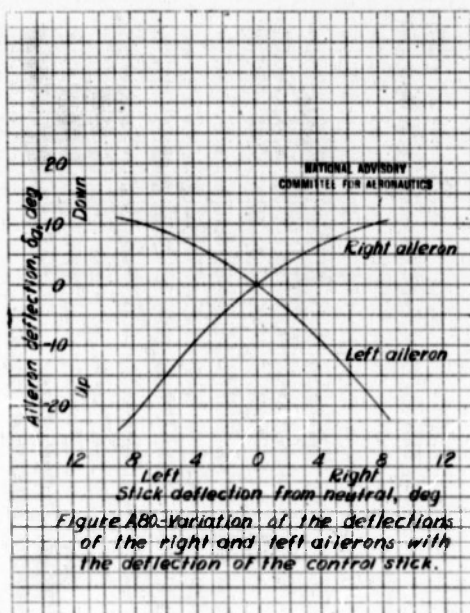


Figure A80.-Variation of the deflections of the right and left ailerons with the deflection of the control stick.

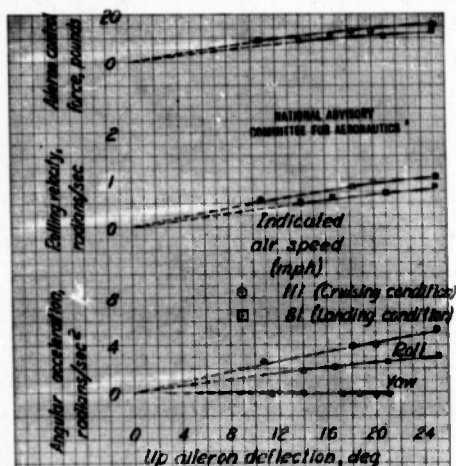


Figure A81.-Variation of the rolling and yawing acceleration, the rolling velocity and the stick force with aileron deflection for the pursuit-type airplane.

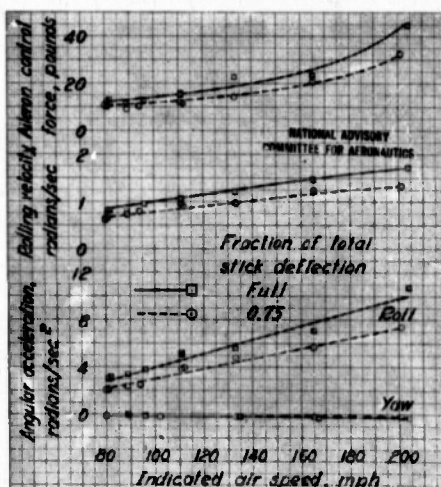
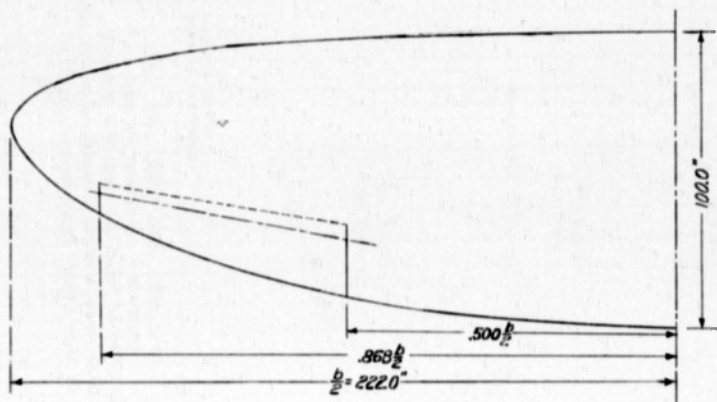


Figure A82.-Variation of rolling and yawing acceleration, rolling velocity and stick force with indicated air speed for the pursuit-type airplane.

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Airplane A-XVIII



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Figure A83. Plan form of wing of Supermarine Spitfire airplane tested in flight at LMAL.

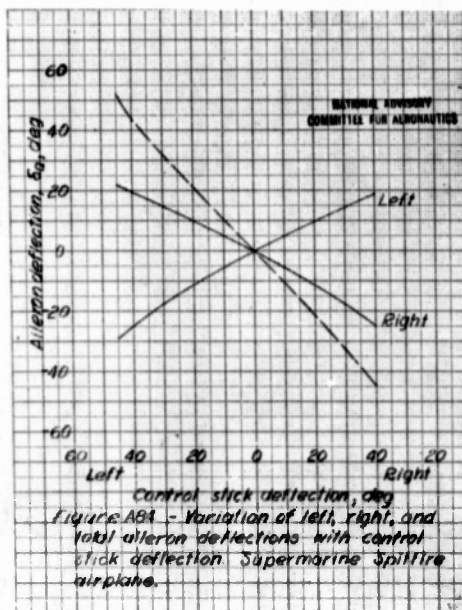


Figure A84. Variation of left, right, and total aileron deflections with control stick deflection. Supermarine Spitfire airplane.

Airplane A-XVIII

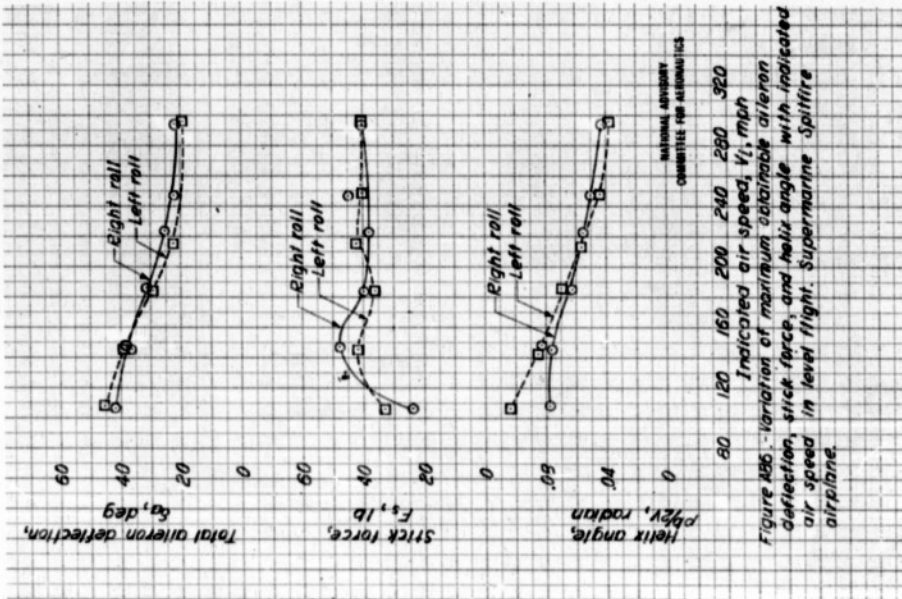


Figure 285. Variation of maximum obtainable aileron deflection, stick force, and helix angle with indicated air speed in level flight. Supermarine Spitfire airplane.

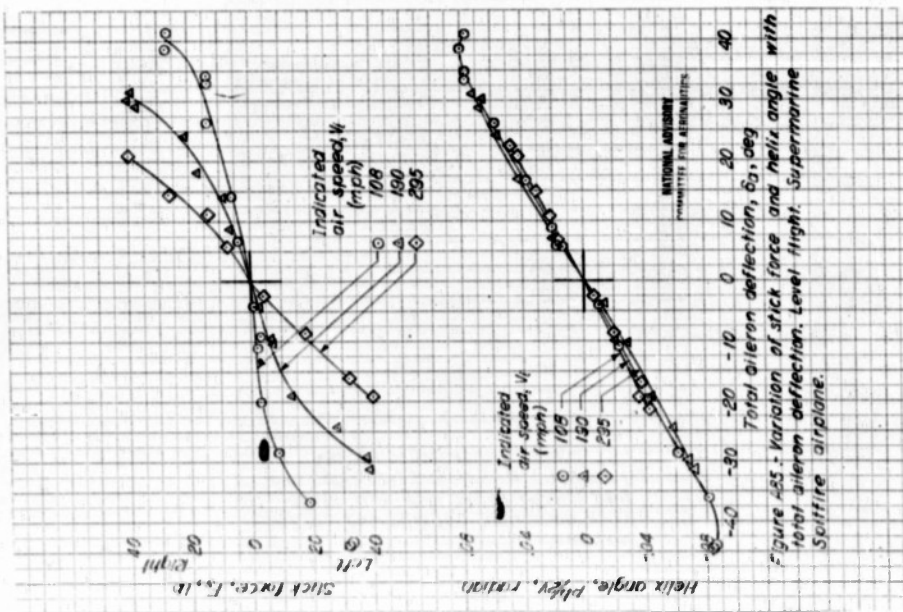


Figure 285. Variation of stick force and helix angle with total aileron deflection. Level flight. Supermarine Spitfire airplane.

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Model B-I

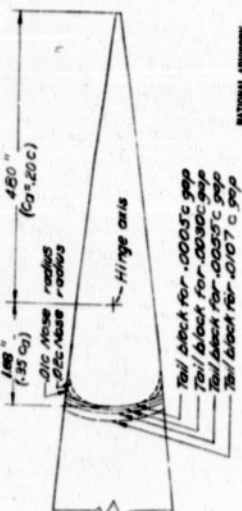
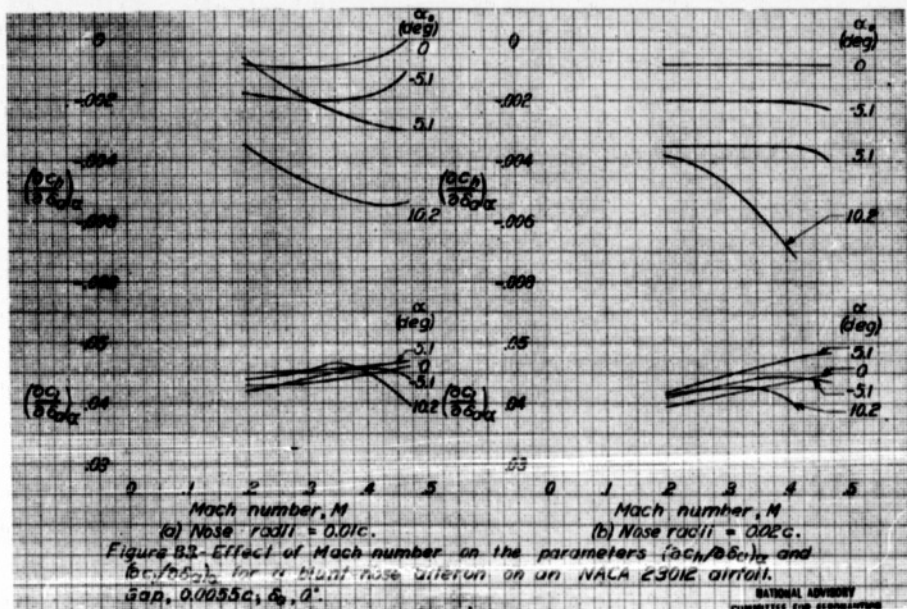


Figure B1. Airfoil section of NACA 23012 airfoil showing modifications to the nose radii and gap. NACA stability tunnel.

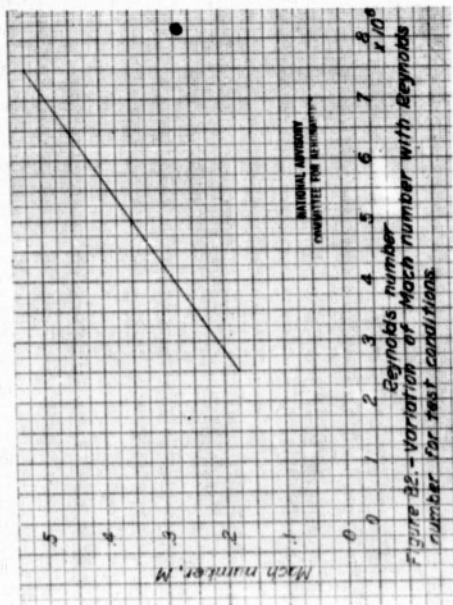
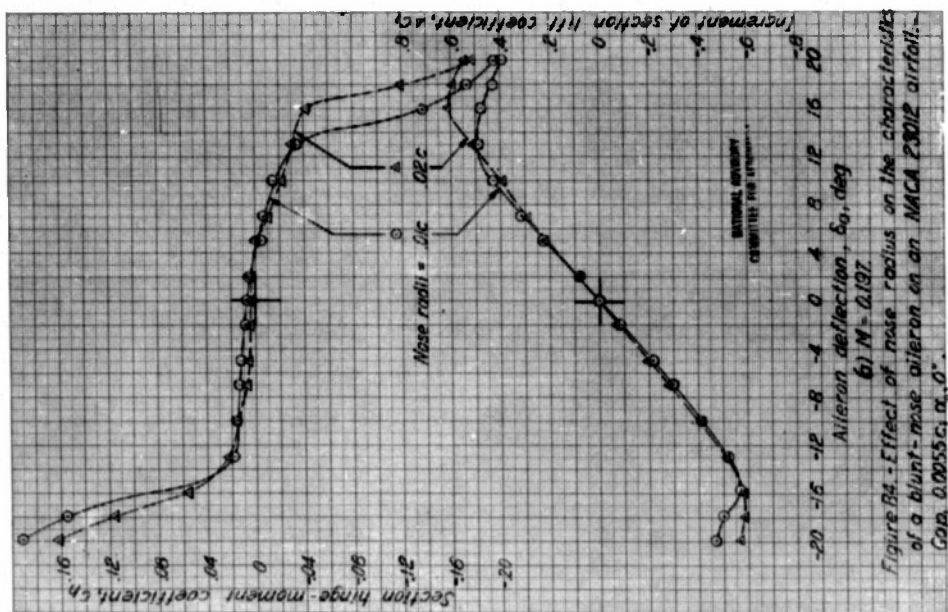
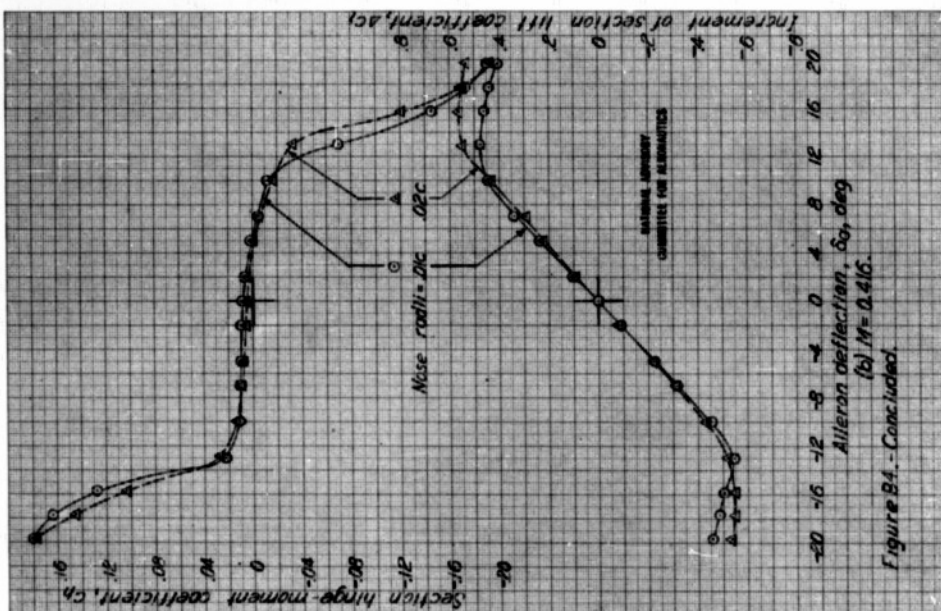


Figure B2. Variation of Mach number with Reynolds number for test conditions.

Model B-I



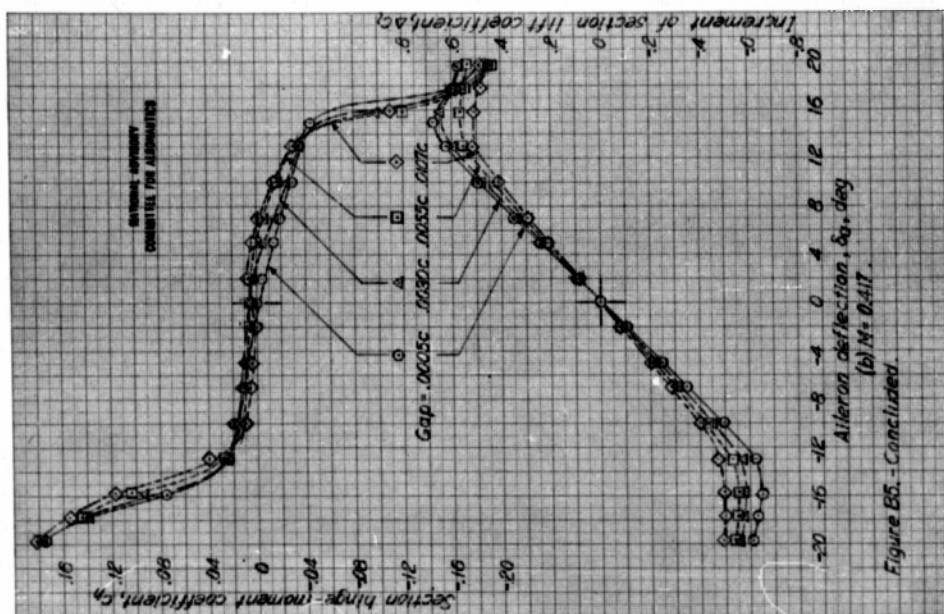


Figure B5. - Continued.

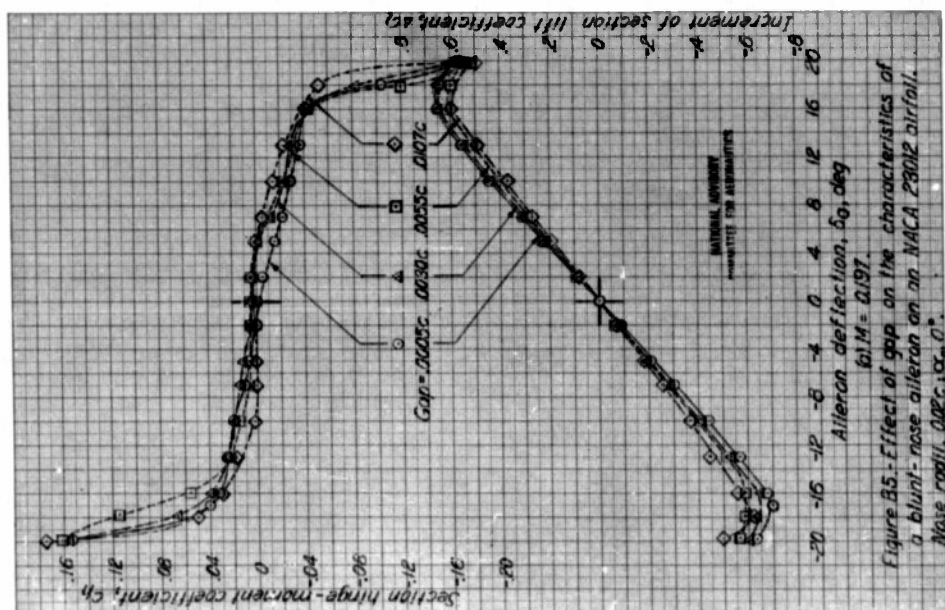


Figure B5. - Effect of gap on the characteristics of a blunt-nose aileron on an NACA 28012 airfoil. Note: radii, 0.02c, 0.05c.

Model B-I

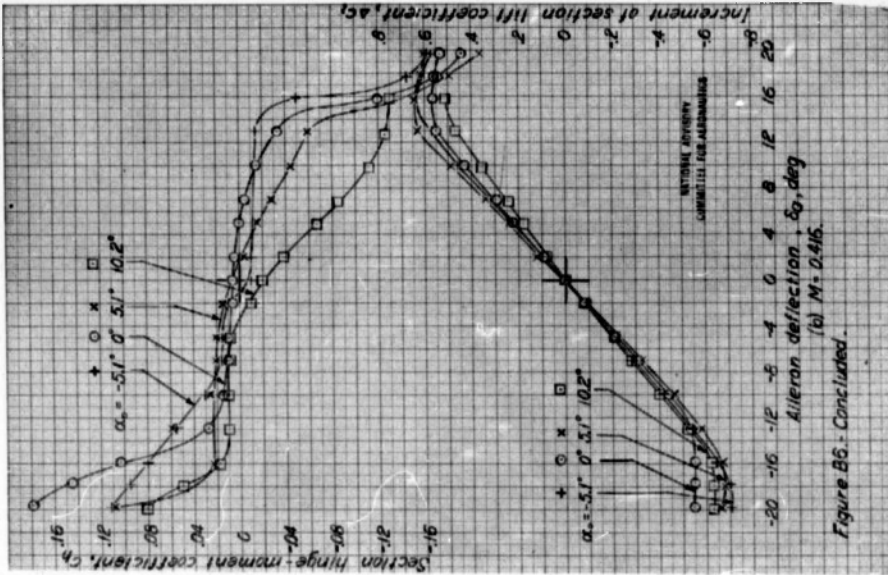


Figure B6. - Continued.

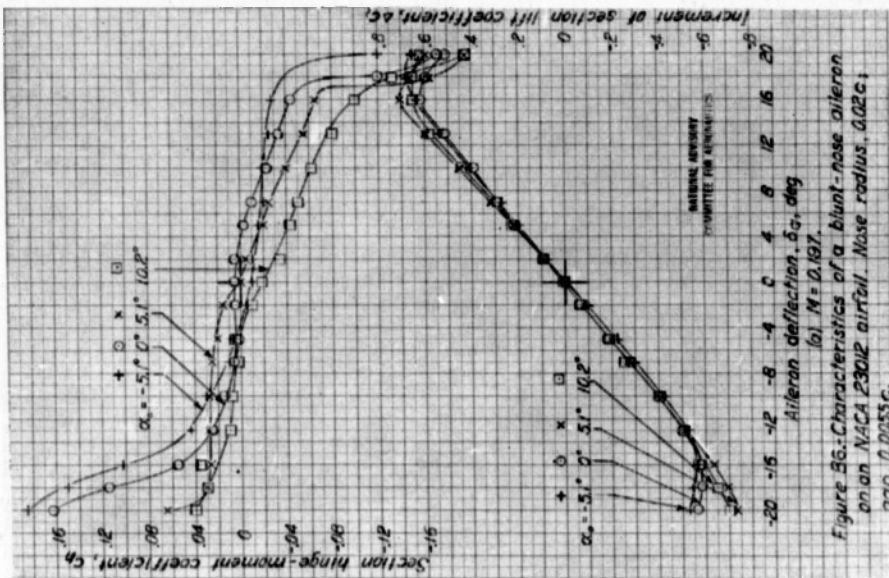


Figure B6. - Characteristics of a blunt-nose aileron on an NACA 23012 airfoil. Nose radius, 0.02c; gap, 0.0055c.

Model B-1

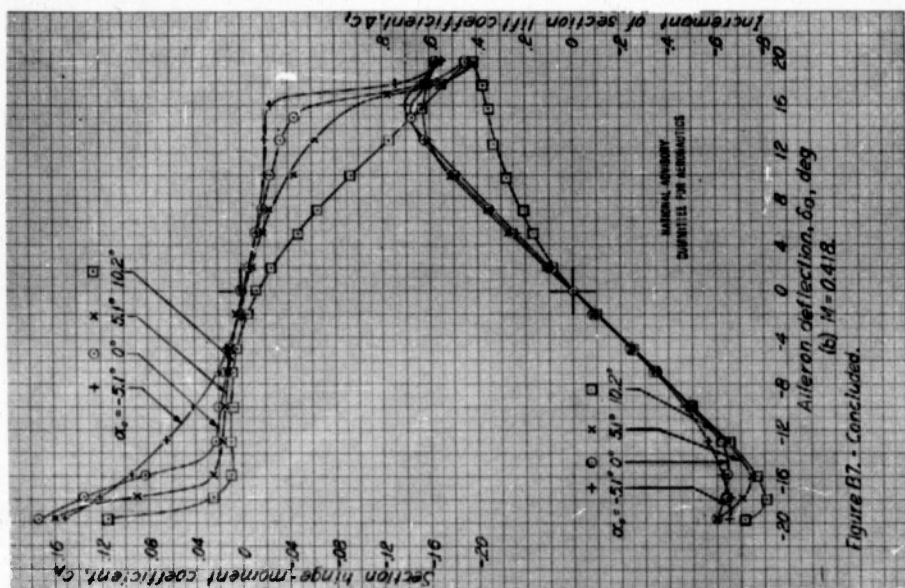


Figure B7. - Continued.

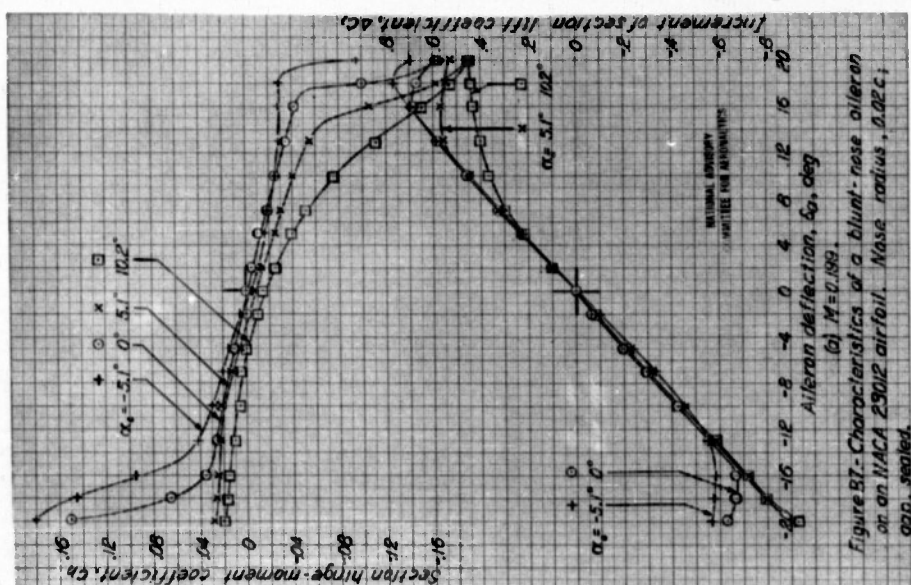


Figure B7. - Characteristics of a blunt-nose airfoil on an NACA 25012 airfoil. Nose radius, 0.02 c; gap, sealed.

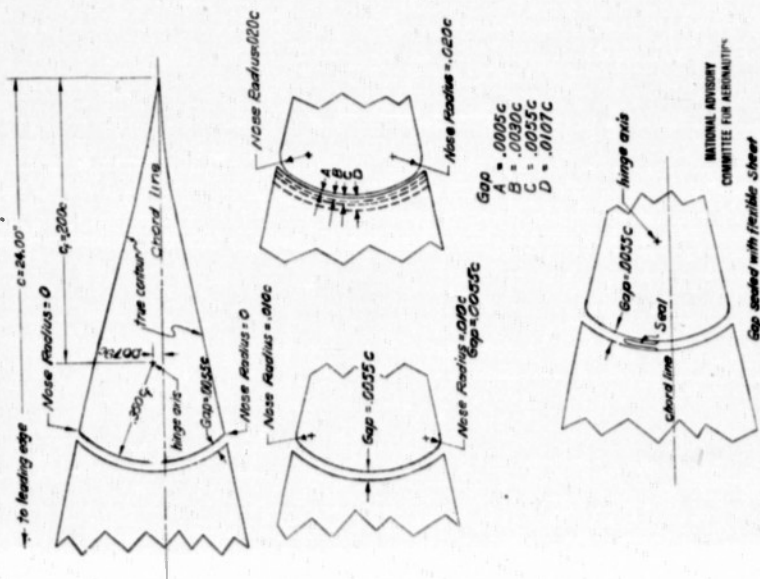


Figure 8B.- The various modifications of a blunt-nose airfoil on an NACA 66E15-216, $\alpha=1.0$ airfoil section tested in two-dimensional flow. NACA stability tunnel.

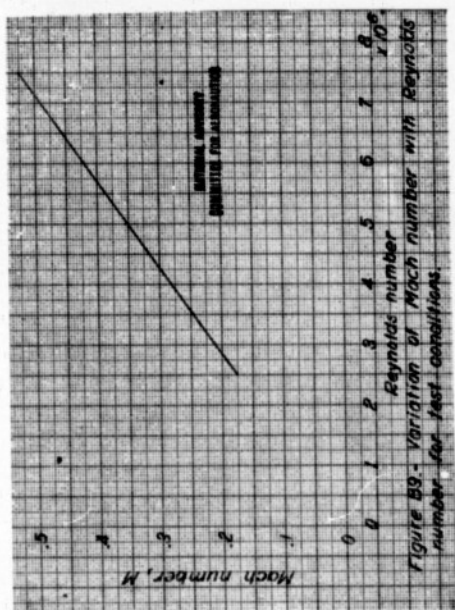


Figure 89.- Variation of Mach number with Reynolds number for test conditions.

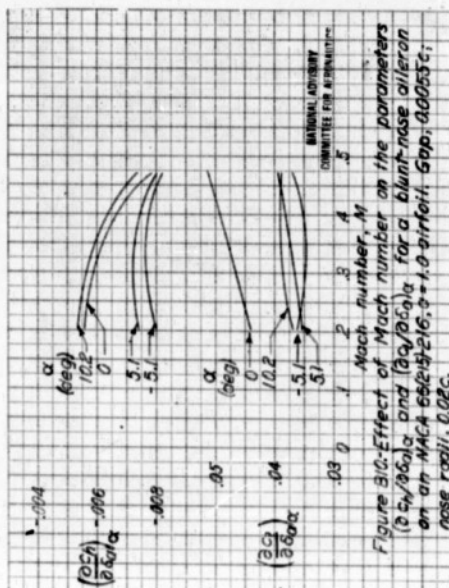
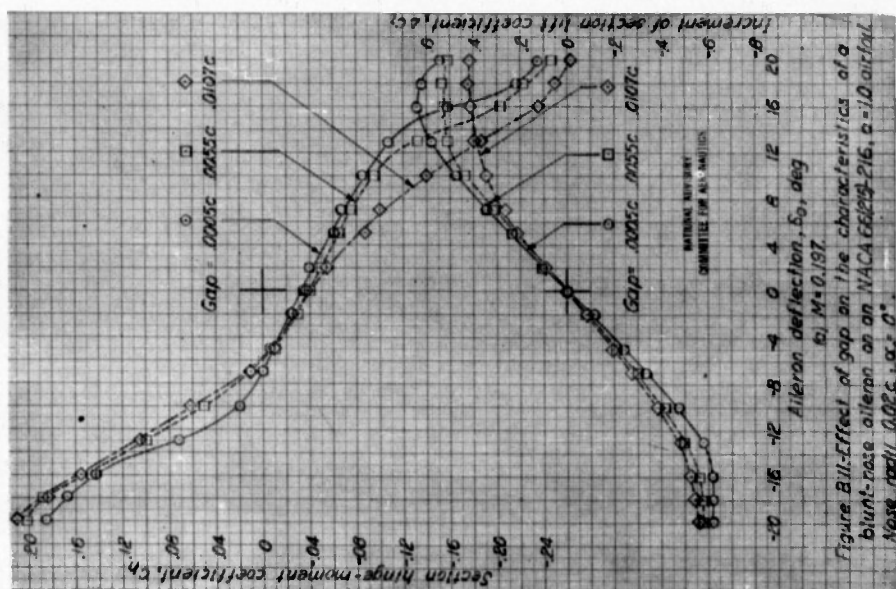
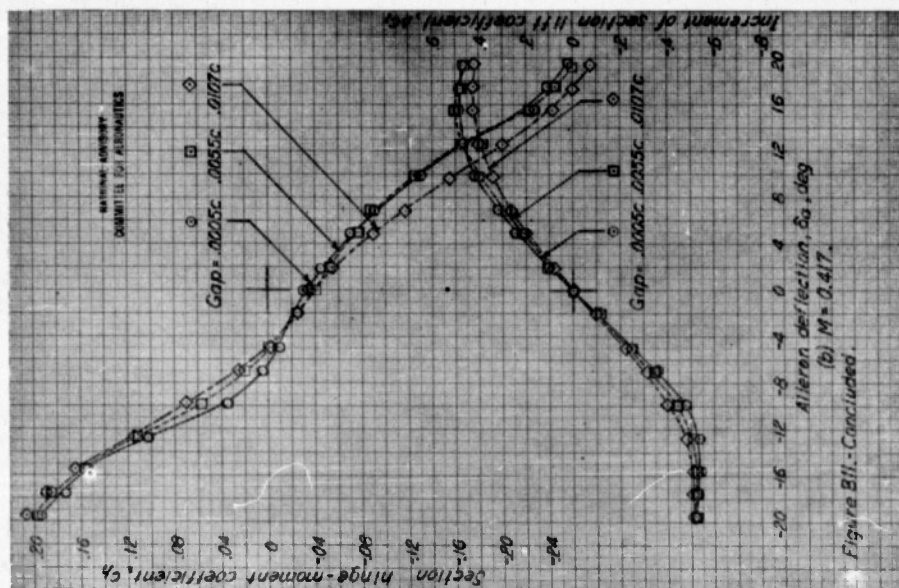


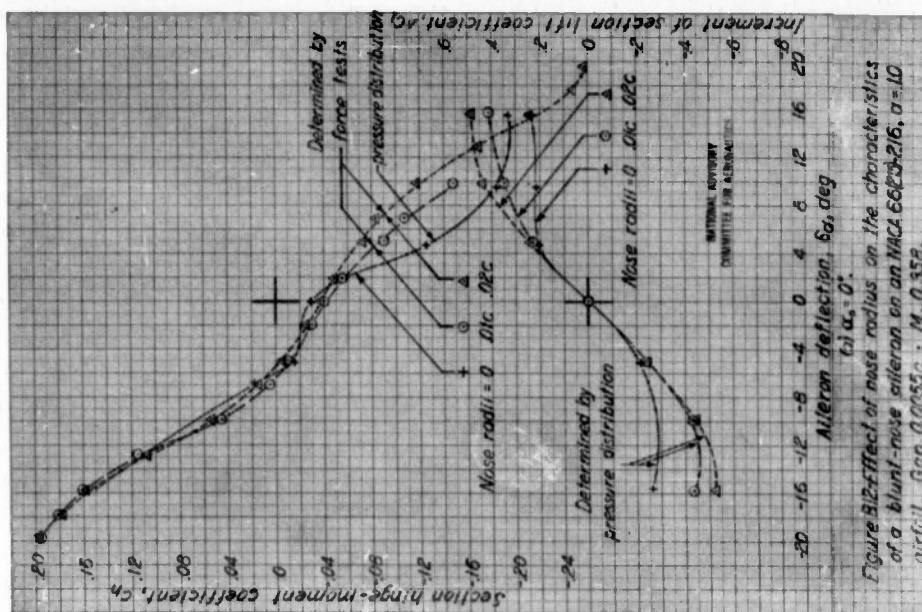
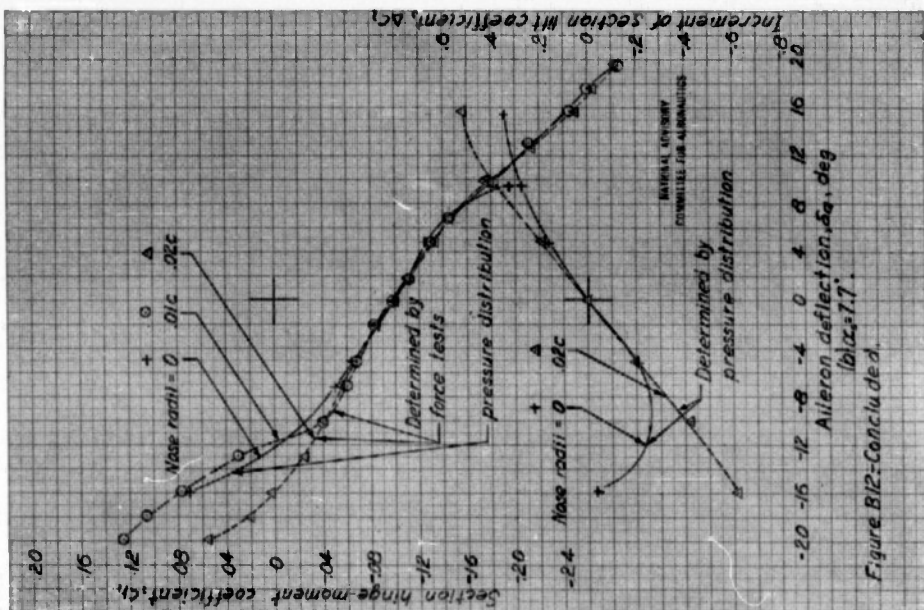
Figure 90.- Effect of Mach number on the parameters $\frac{\partial \alpha}{\partial \alpha}$ and $\frac{\partial \alpha}{\partial \alpha}$ for a blunt-nose airfoil on an NACA 66E15-216, $\alpha=1.0$ airfoil. Gap, 0.005C; nose radii, 0.02C.

Model B- II

Model B-II



Model B II



Model B- II

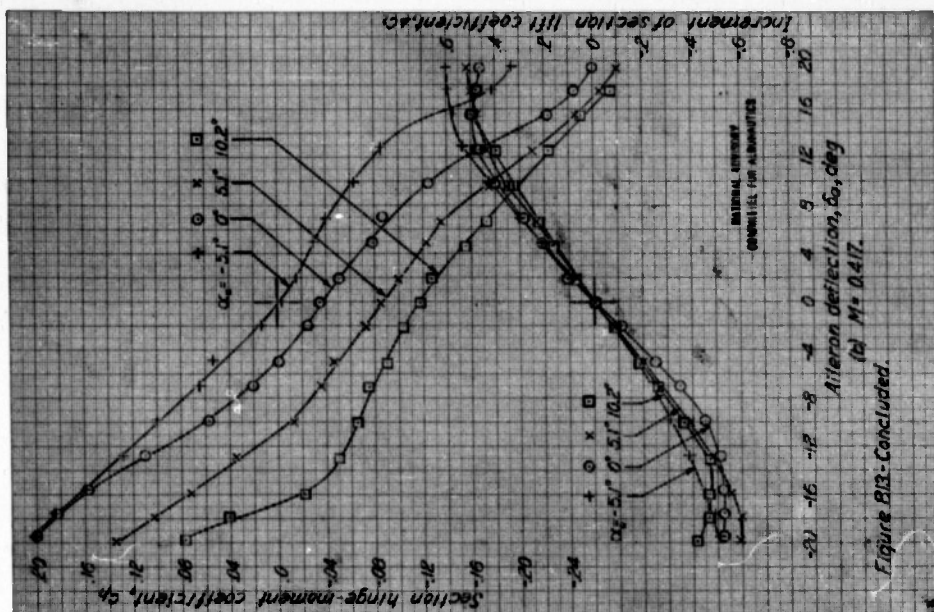
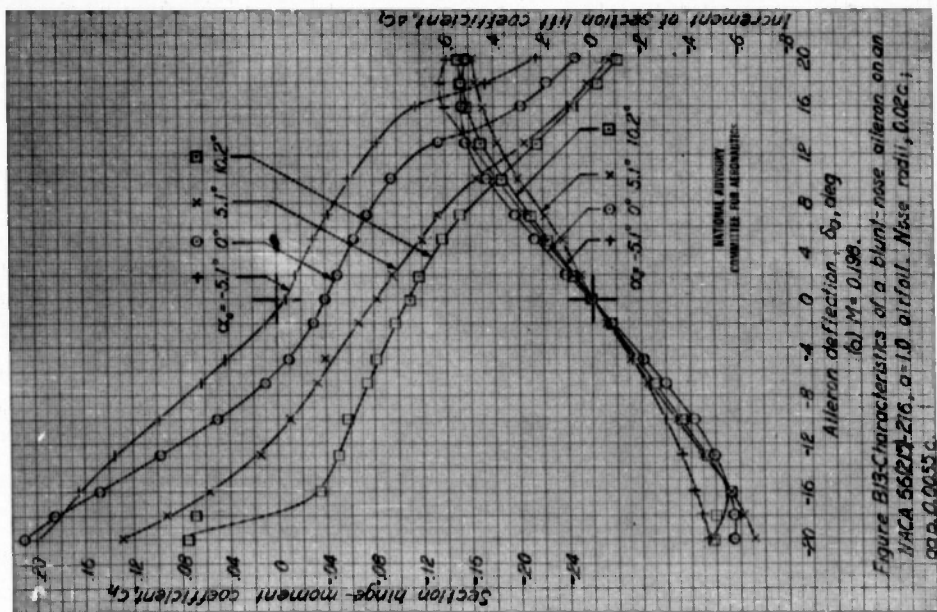
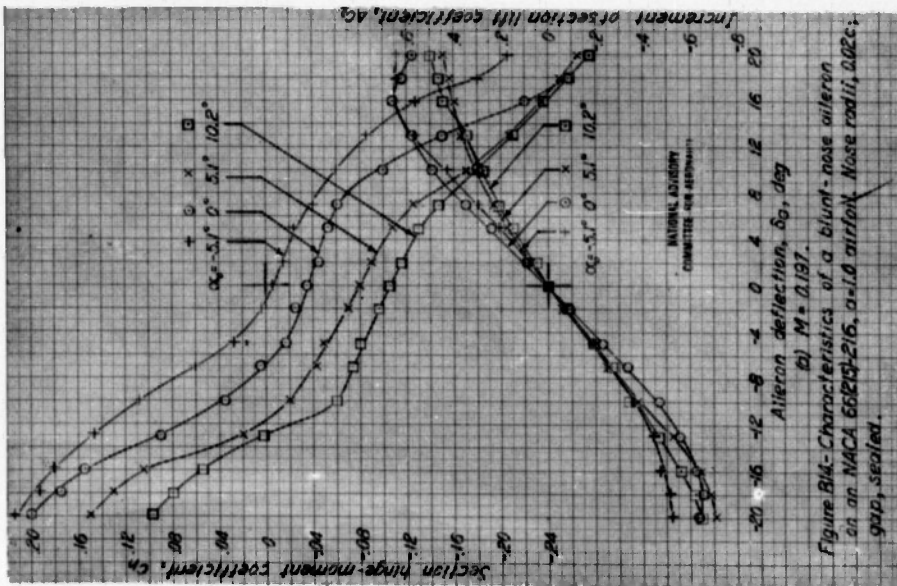
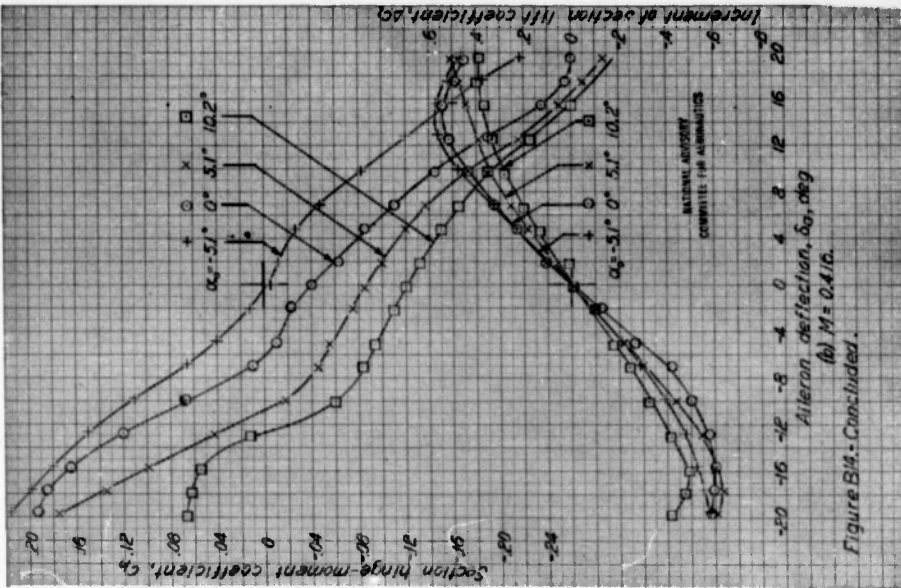


Figure B13- Concluded.

Figure B13- Characteristics of a blunt-nose airfoil on an NACA 661215-216, $\alpha = 1.0$ airfoil. Nose radii, 0.02c; gap, 0.0053c.

Model B- II



Model B-III

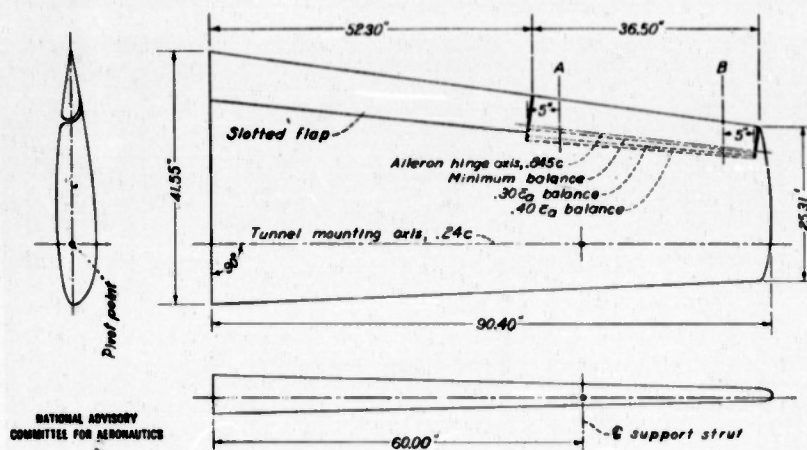


Figure B15 - Semispan model of tapered wing.
LMAL 7-by-10-foot tunnel.

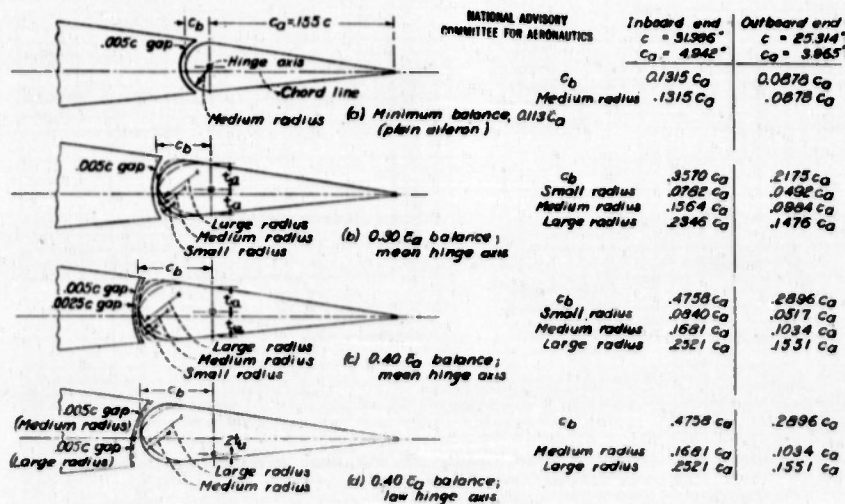


Figure B16 The various $0.155c$ by 0.405 b/c ailerons tested
on the tapered-wing model.

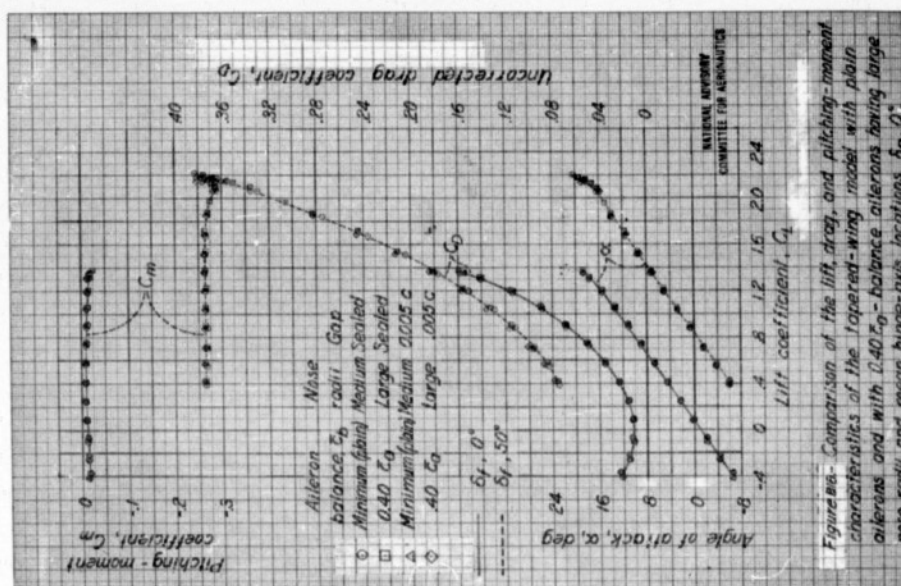


Figure B16- Comparison of the lift, drag, and pitching-moment characteristics of the tapered-wing model with plain ailerons and with 0.40E0-balance ailerons having large nose radii and mean hinge-axis locations $5a, 0^\circ$.

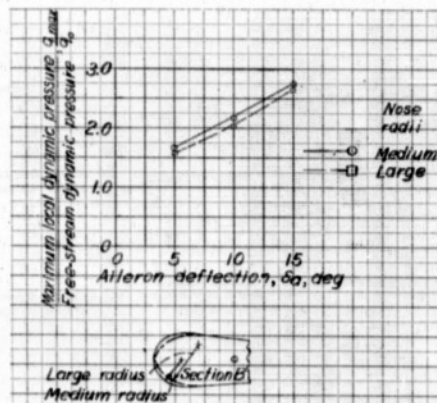
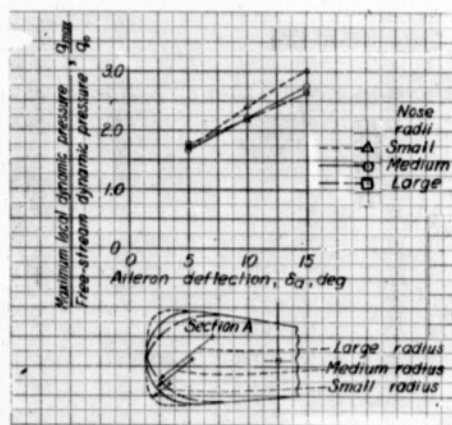
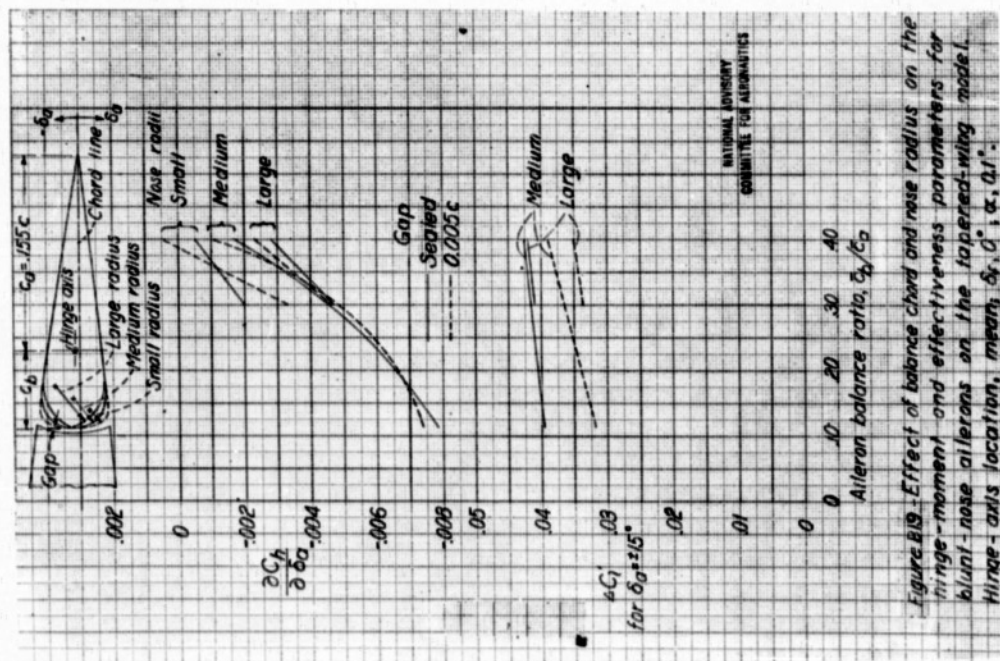
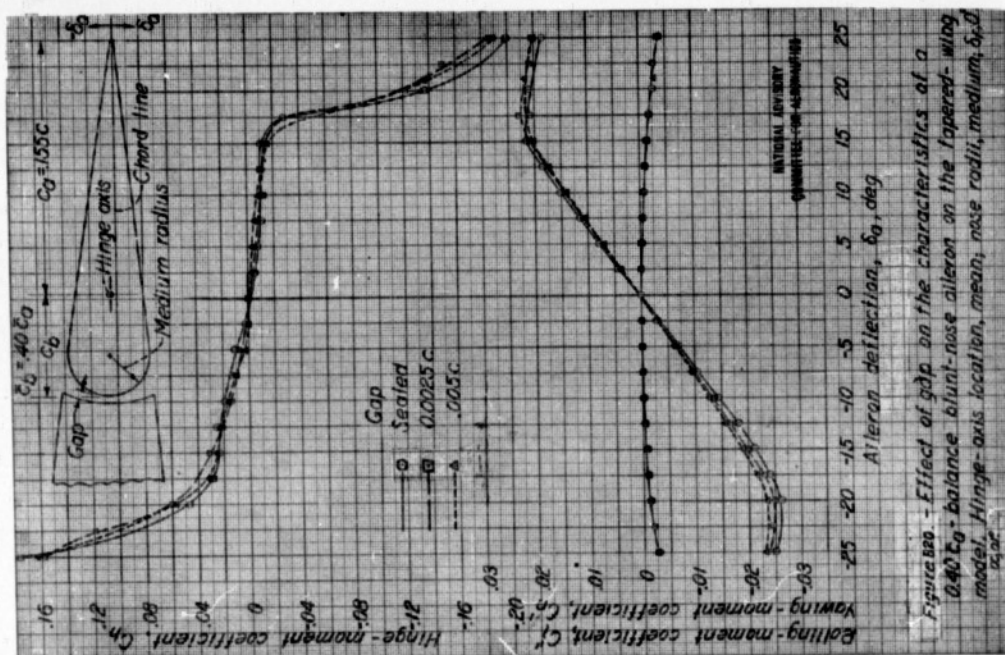
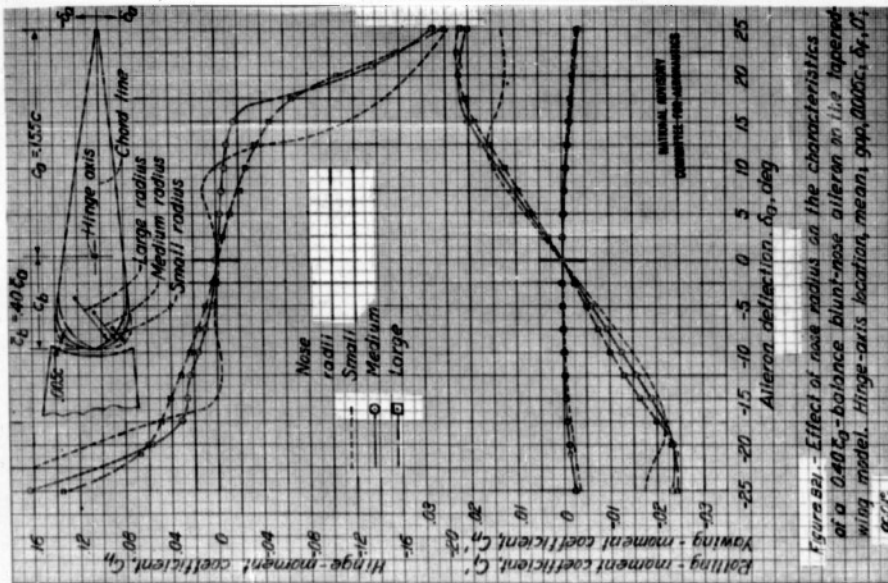
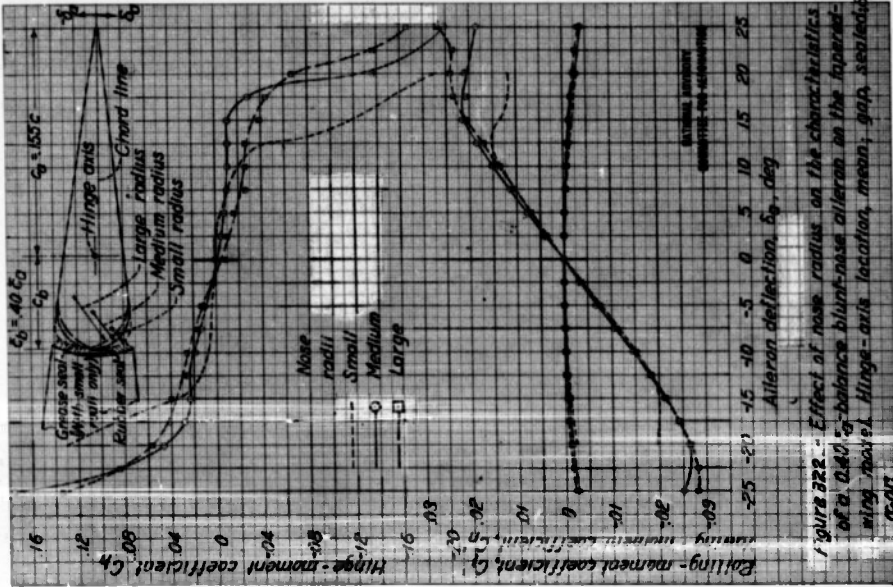


Figure B17- Effect of nose radius on the peak dynamic pressures over the nose (at sections A and B of figure B16) of a 0.40E0-balance blunt base aileron on the tapered wing model. Hinge-axis location, mean, gap, 0.005c; $\delta_f, 0^\circ$; $\alpha, 0^\circ$.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS



Model B-III



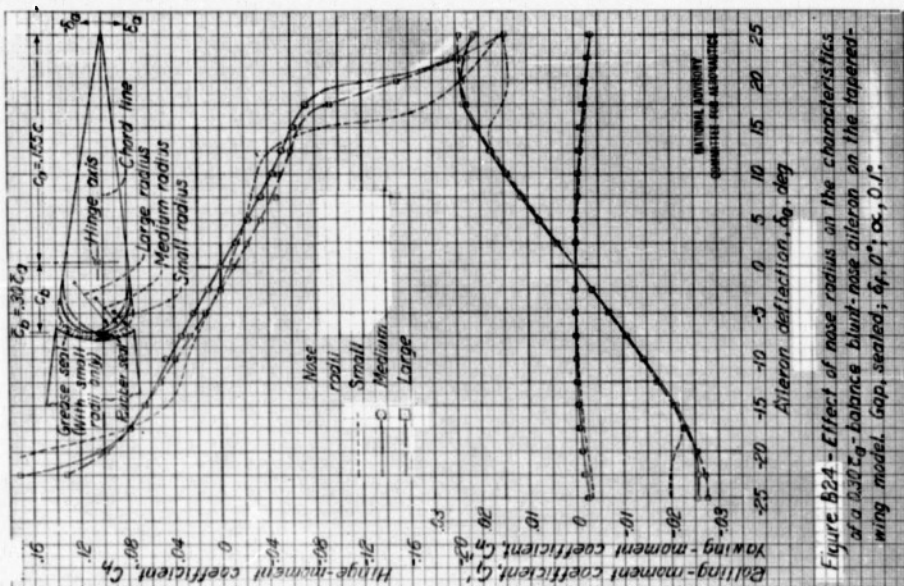


Figure B24 - Effect of nose radius on the characteristics of a 0.305-g balance blunt-nose aileron on the tapered-wing model. Gap, sealed; $\delta_f, 0^\circ$; $\alpha, 0.1^\circ$.

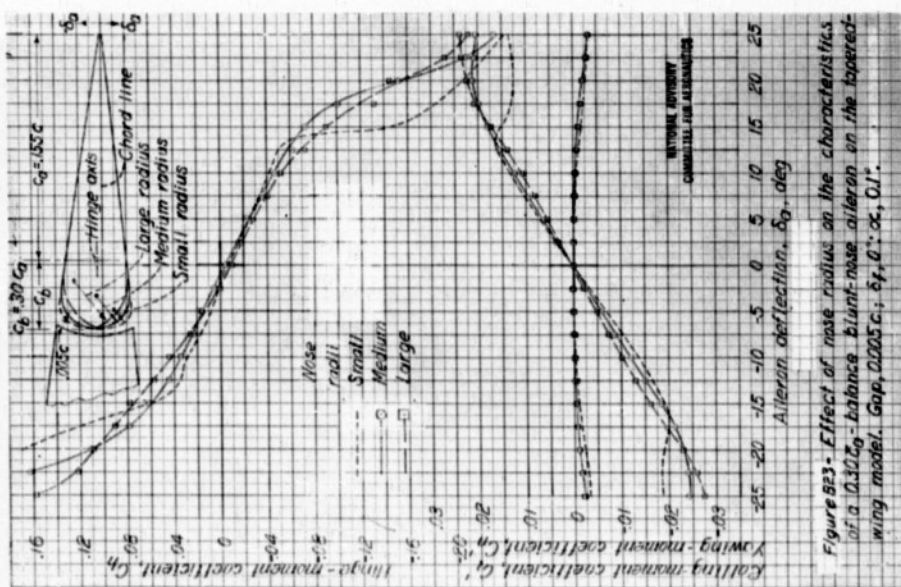


Figure B23 - Effect of nose radius on the characteristics of a 0.405-g balance blunt-nose aileron on the tapered-wing model. Gap, 0.005 in; $\delta_f, 0^\circ$; $\alpha, 0.1^\circ$.

Model B-III

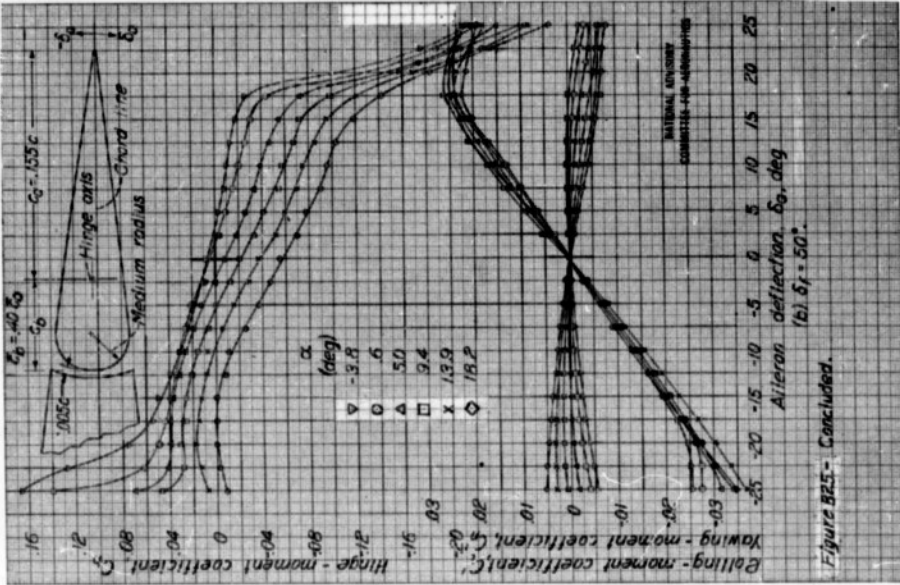


Figure B25- Concluded.

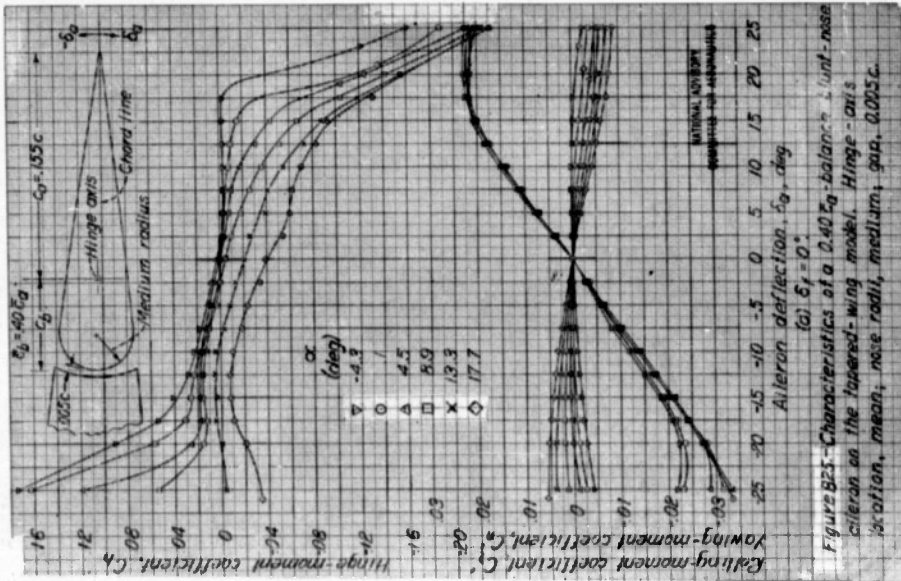


Figure B25- Characteristics of a 0.40 b_0 -balance, blunt-nose aileron on the tapered-wing model. Hinge-axis location, mean; nose radii, medium; gap, 0.005 c.

Model B-III

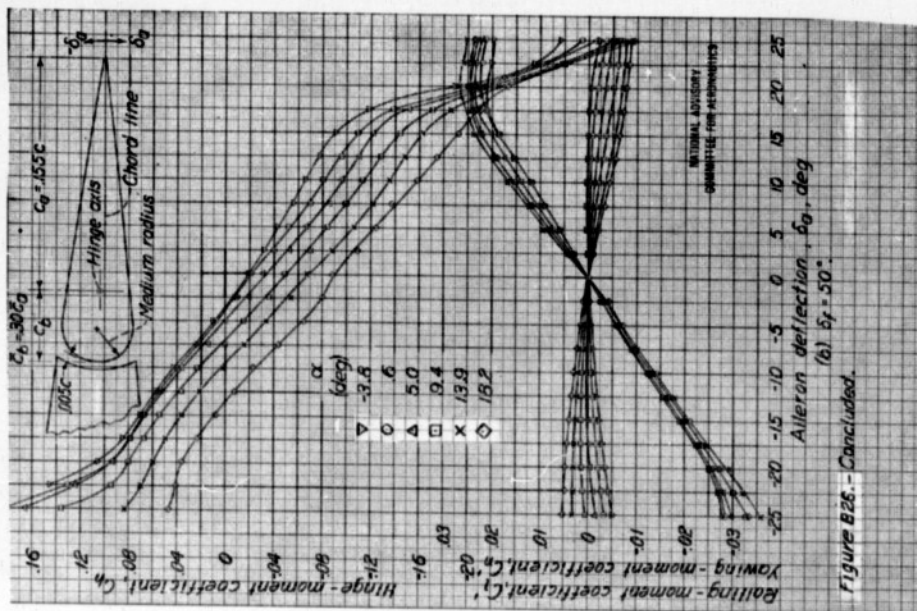


Figure B25. - Concluded.

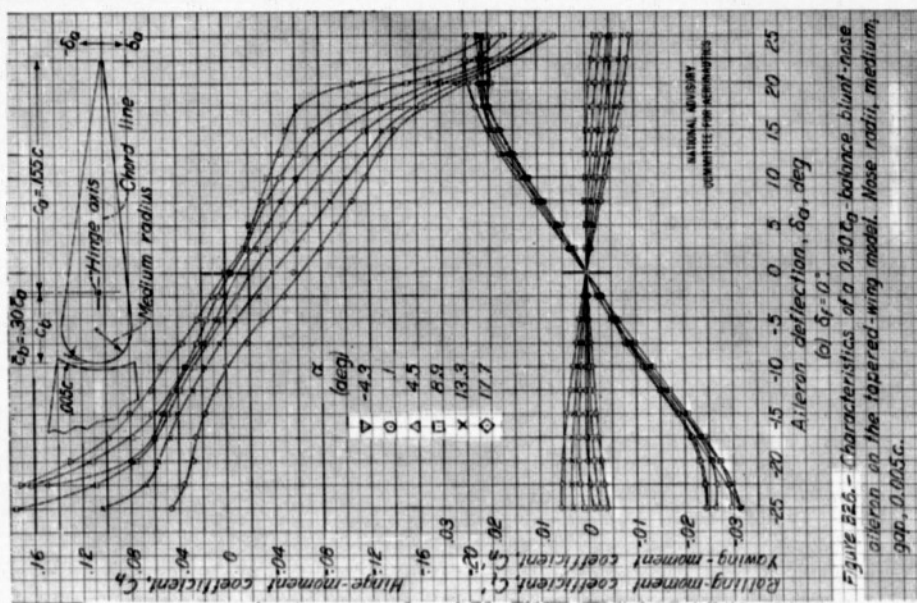


Figure B26. - Characteristics of a 0.30 to balance blunt-nose alleron in the tapered-wing model. Nose radii, medium gap, 0.005C.

Model B-III

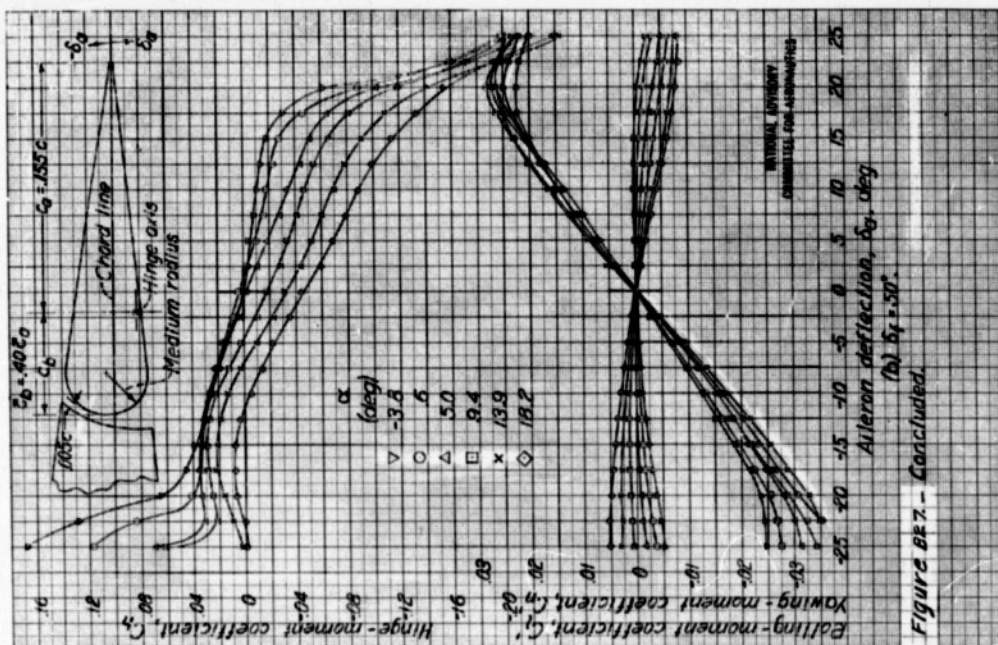


Figure B27. - Concluded.

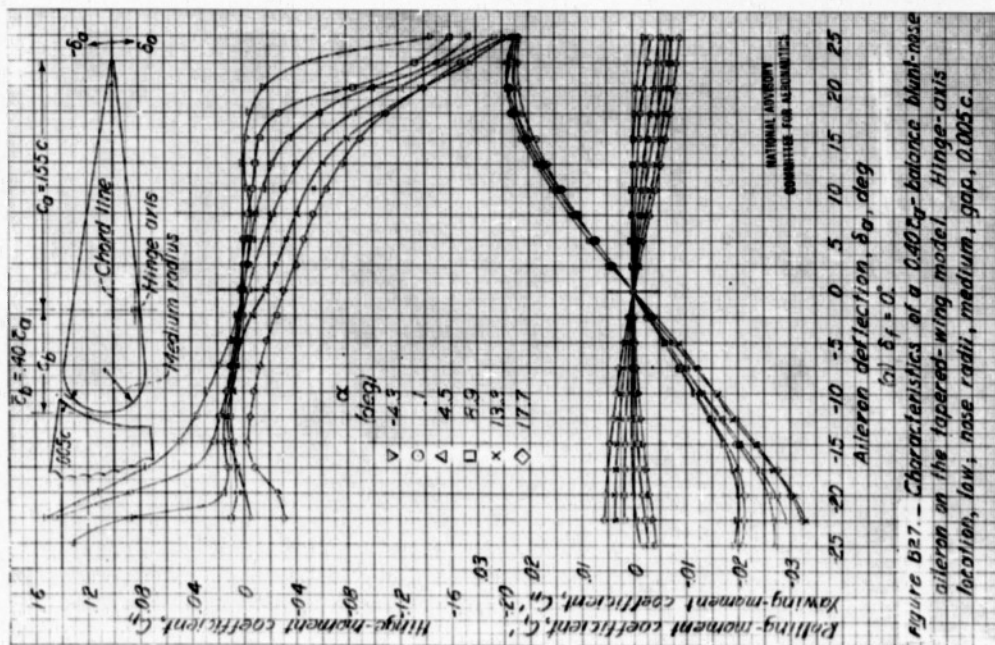
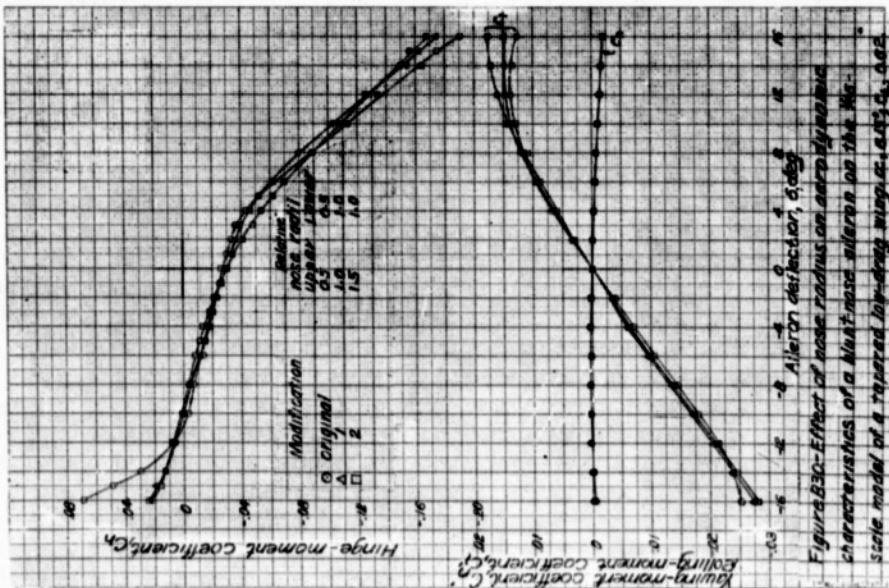
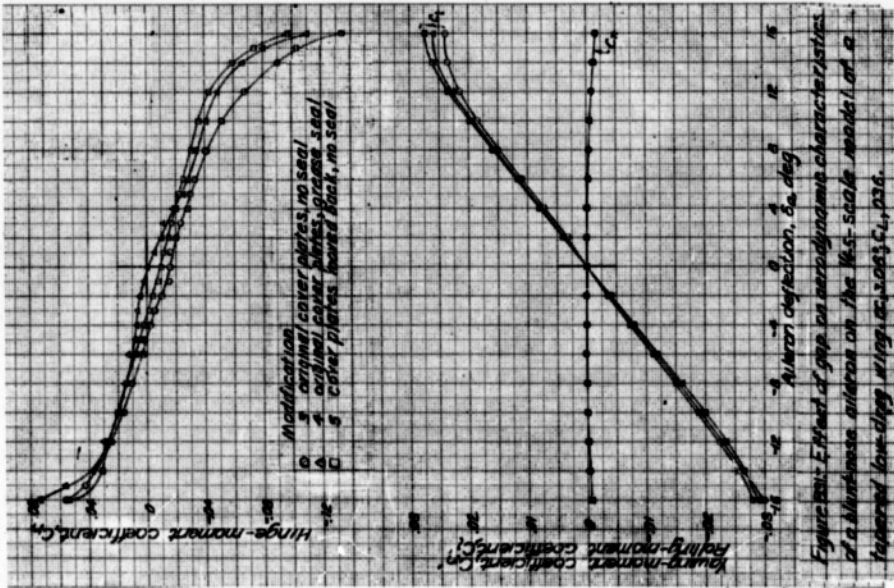
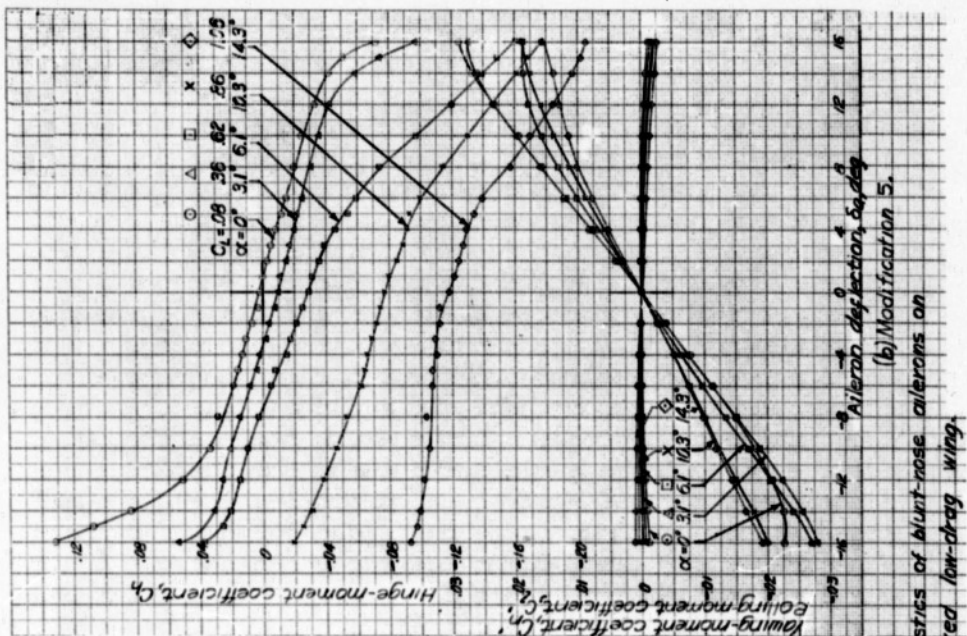
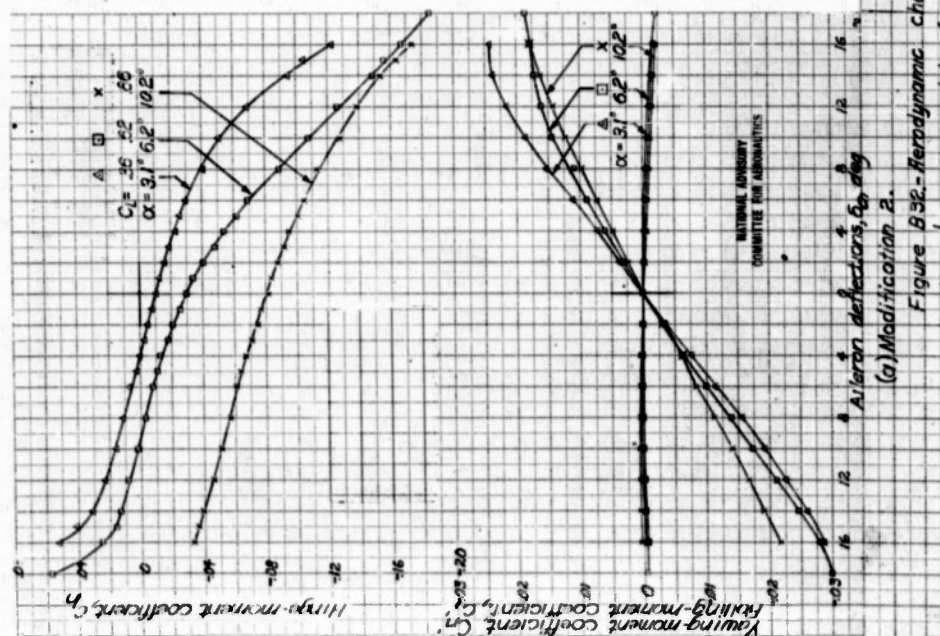


Figure B27. - Characteristics of a 0.405-g balance blunt-nose aileron on the tapered-wing model. Hinge-axis location, low; nose radii, medium; gap, 0.005 c.

Model B-IV





Model B-IV

Figure B32.- Aerodynamic characteristics of blunt-nose ailerons on the 1.5-scale model of a tapered low-drag wing.

Model B- V

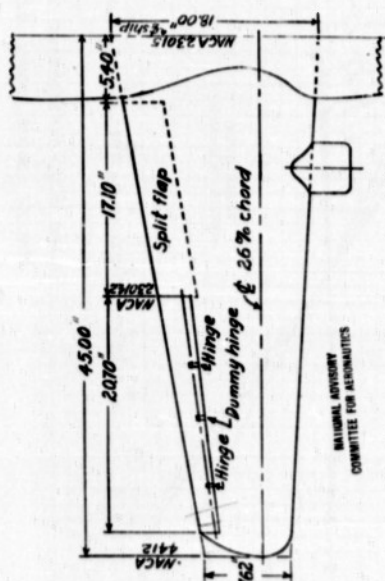


Figure 533.—Plan view of wing for the 0.075-scale model of an airplane. LHAL 7-by-10-foot tunnel.

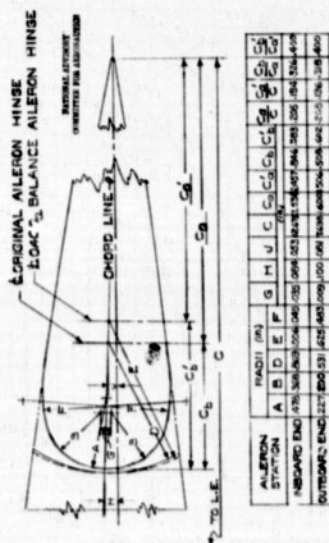


FIGURE B 34—Details of ailerons tested, on the 0075 scale model of an airplane.

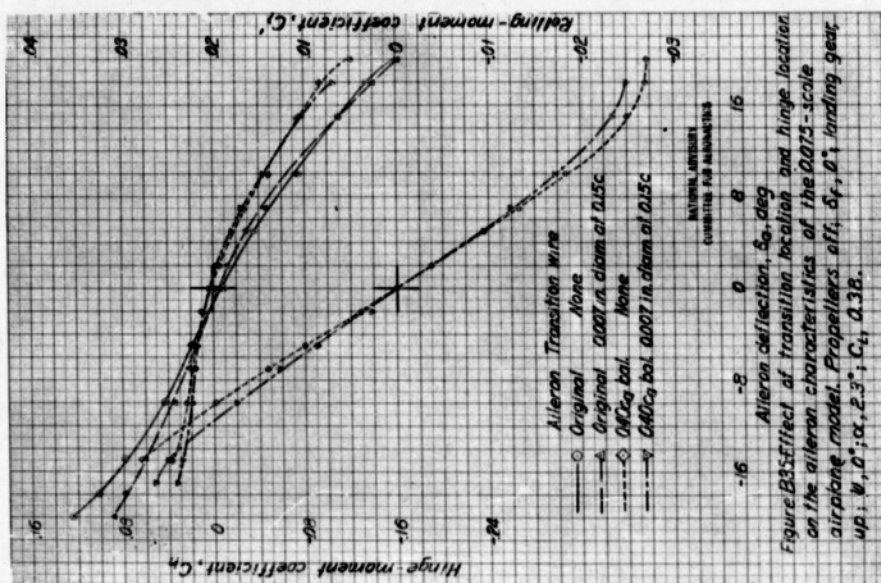


Figure 8. Effect of transition location and hinge location on the airplan characteristics of the D215-scale airplane model. Propellers: eff., δ_f , δ^* ; landing gear: up, ψ , δ^* ; α , 2.3° ; C_{D_i} , 0.38.

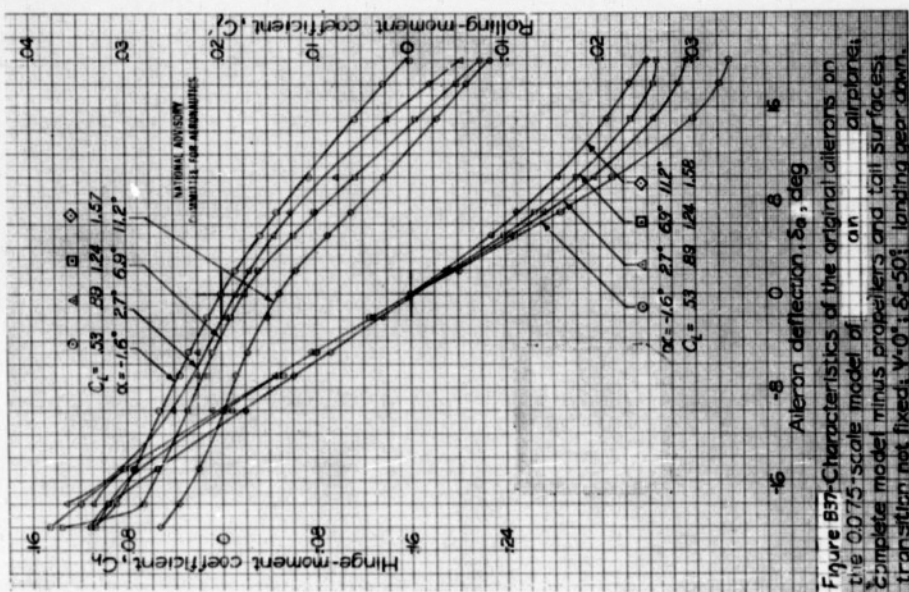


Figure 837-Characteristics of the original ailerons on the 0.075-scale model of an airplane; complete model minus propellers and tail surfaces; transition not fixed; $V=0$; $\delta_a=0$; landing gear down.

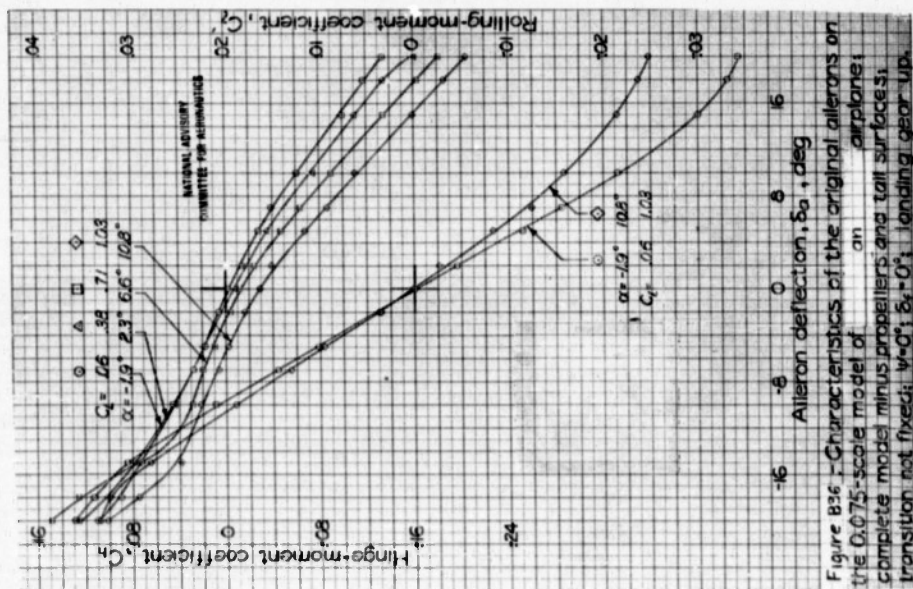


Figure 836-Characteristics of the original ailerons on the 0.075-scale model of an airplane; complete model minus propellers and tail surfaces; transition not fixed; $V=0$; $\delta_a=0$; landing gear up.

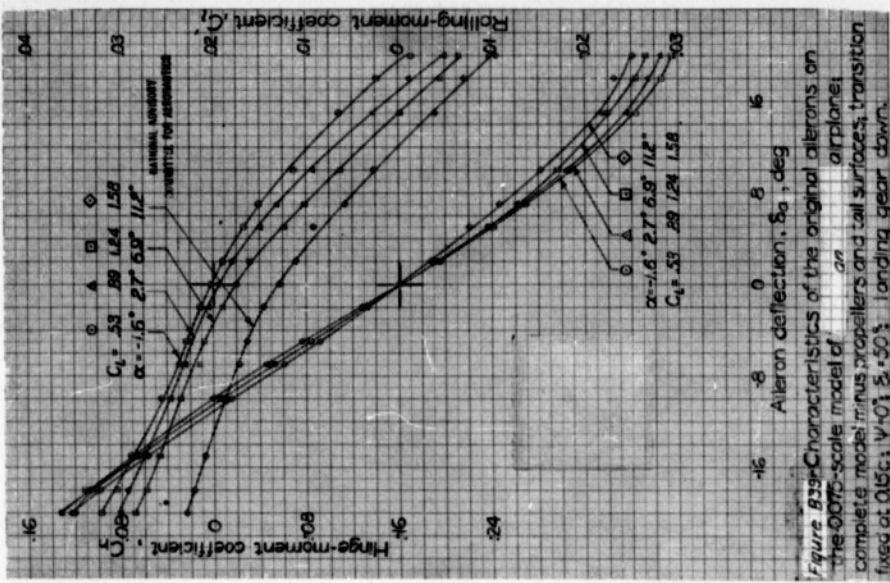


Figure B39-Characteristics of the original ailerons on the 0.075-scale model of the complete model minus propellers and tail surfaces, transition fixed at 0.15c; V=0; $\delta=0^\circ$; landing gear down.

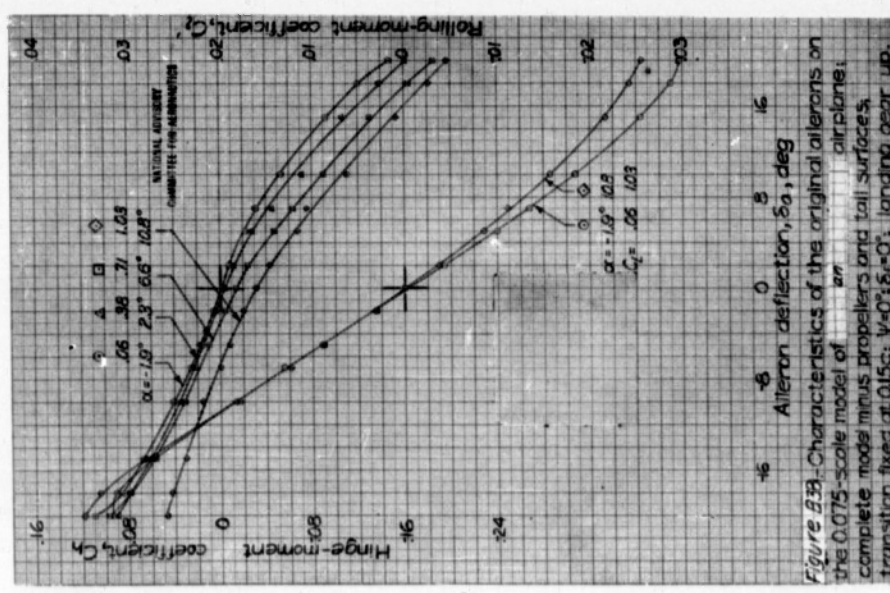


Figure B39-Characteristics of the original ailerons on the 0.075-scale model of the complete model minus propellers and tail surfaces, transition fixed at 0.15c; V=0; $\delta=0^\circ$; landing gear up.

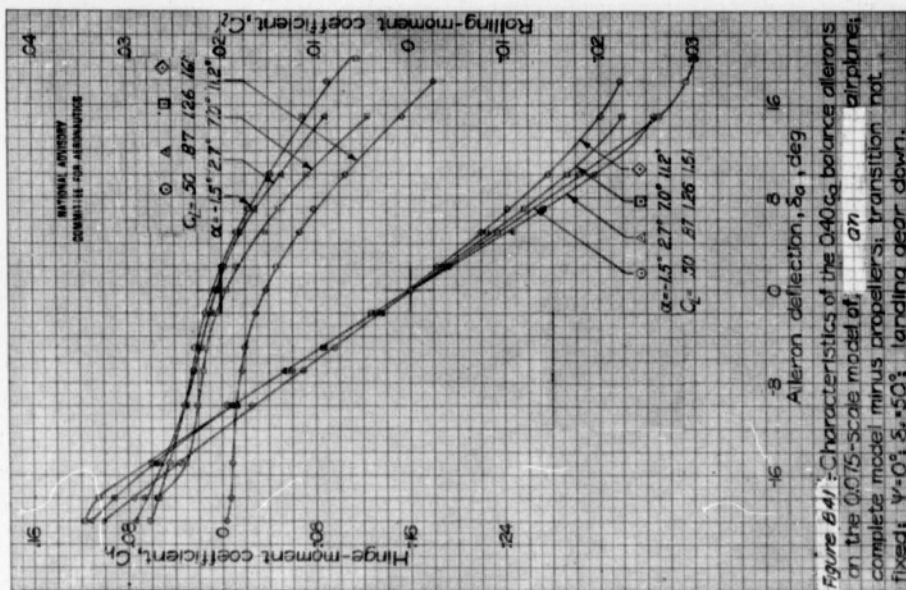
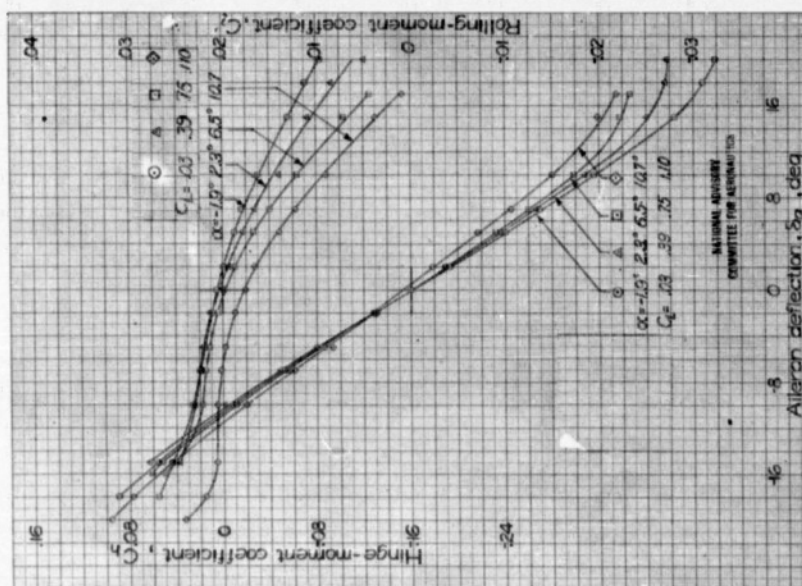


Figure B40-Characteristics of the 0.40Ca balance ailerons on the 0.075-scale model of an airplane; complete model minus propellers; transition not fixed; $\psi=0^\circ$; $\delta_1=0^\circ$; landing gear up.



Model B-V

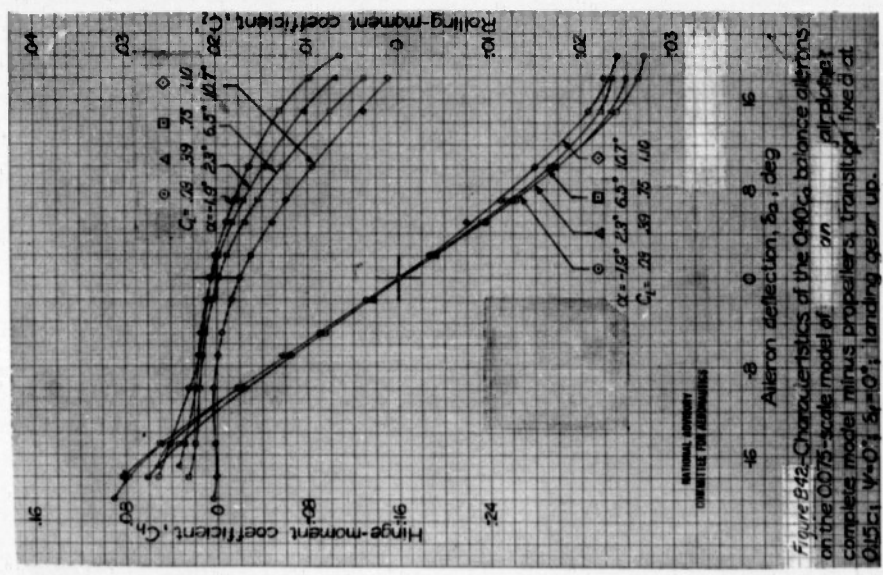


Figure 842—Characteristics of the 040C6 balance ailerons on the 00751-scale model of an airplane complete model minus propellers, transition fixed at 0.15c; $V=0^\circ$; $\delta_r=0^\circ$; landing gear up.

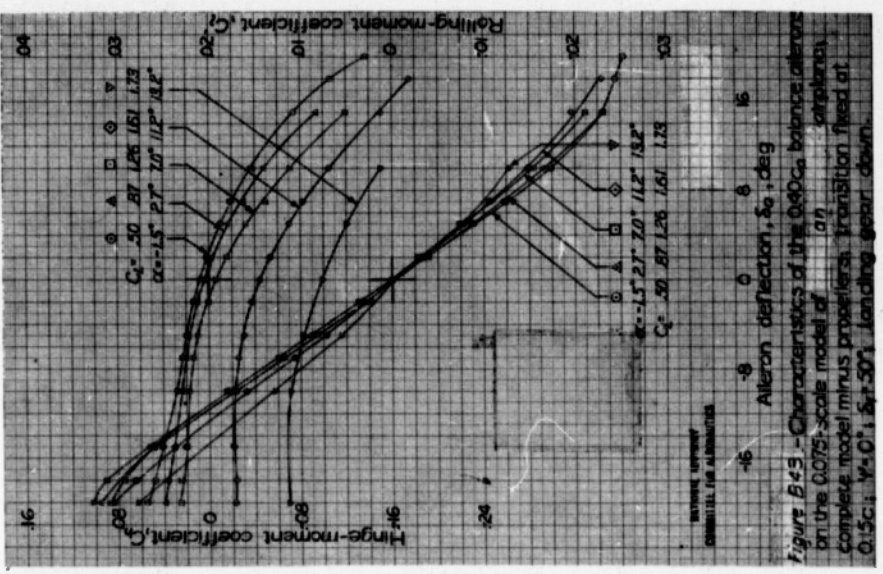


Figure 843—Characteristics of the 040C6 balance ailerons on the 00751-scale model of an airplane complete model minus propellers, transition fixed at 0.15c; $V=0^\circ$; $\delta_r=50^\circ$; landing gear down.

Model B-V

Model C-I

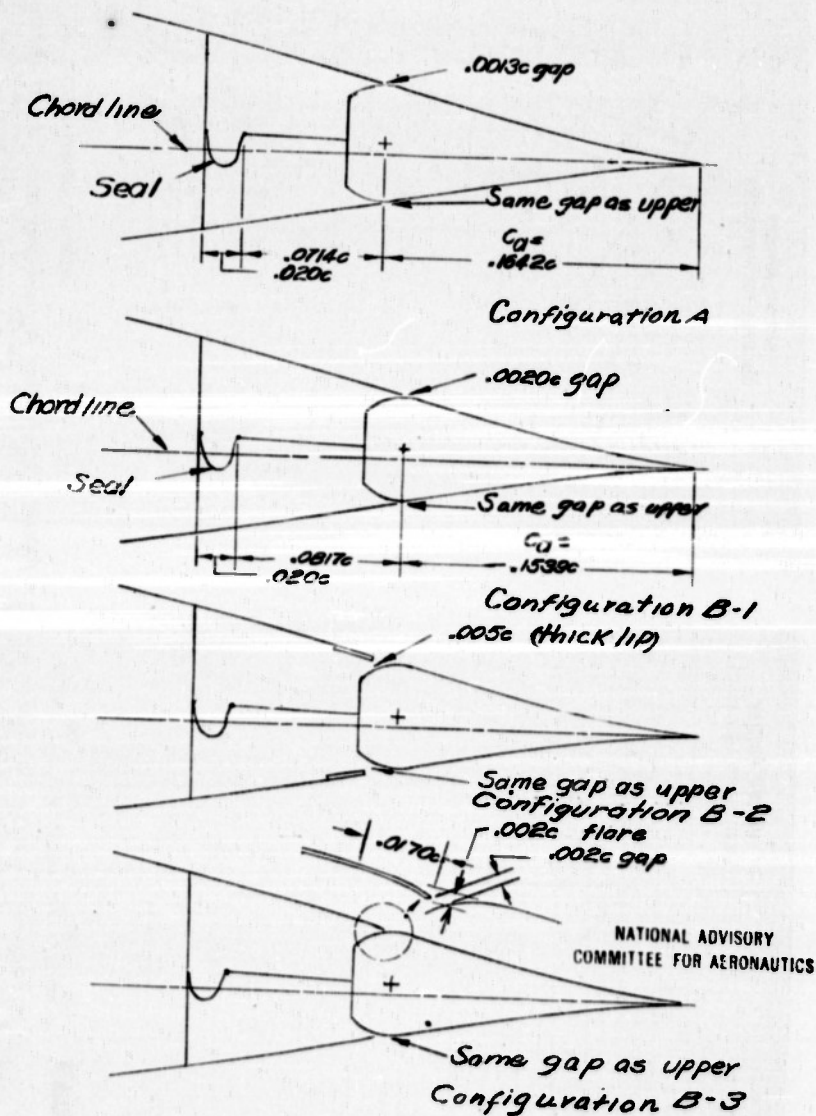
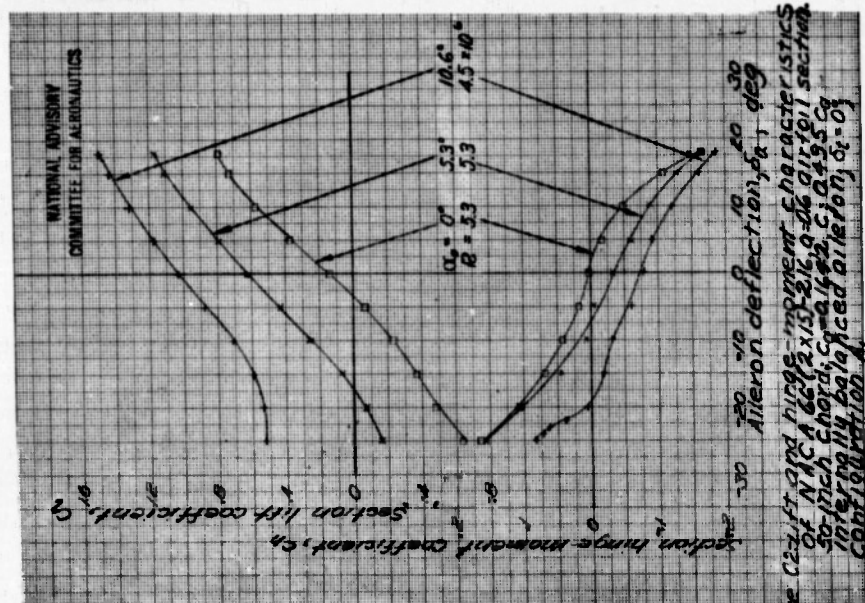
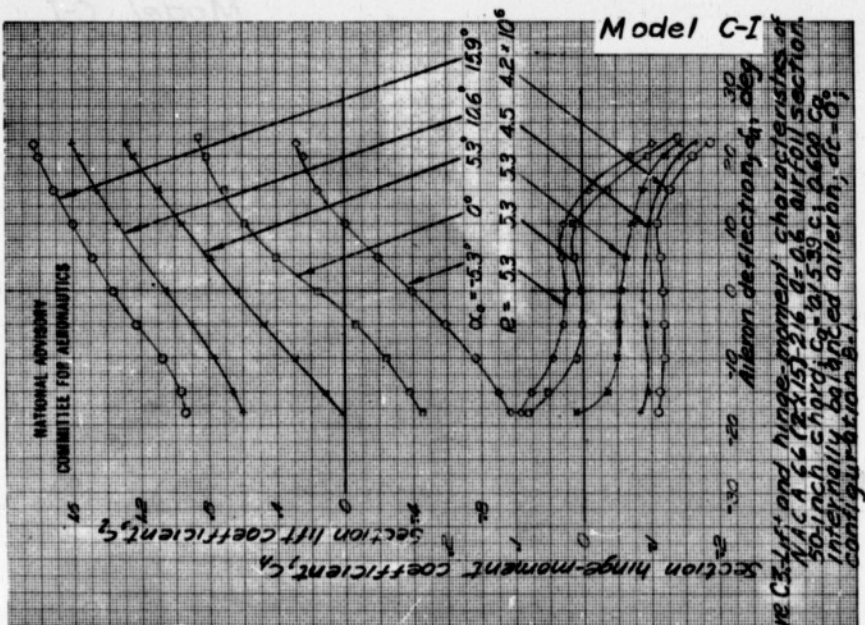


Figure C1. Balance configurations tested on the NACA 66(2X15)-216, $\alpha = 0.6$ airfoil section. Two-dimensional flow tests; 50-inch-chord model C-I; tests in NACA two-dimensional low-turbulence tunnel.



Model C-I

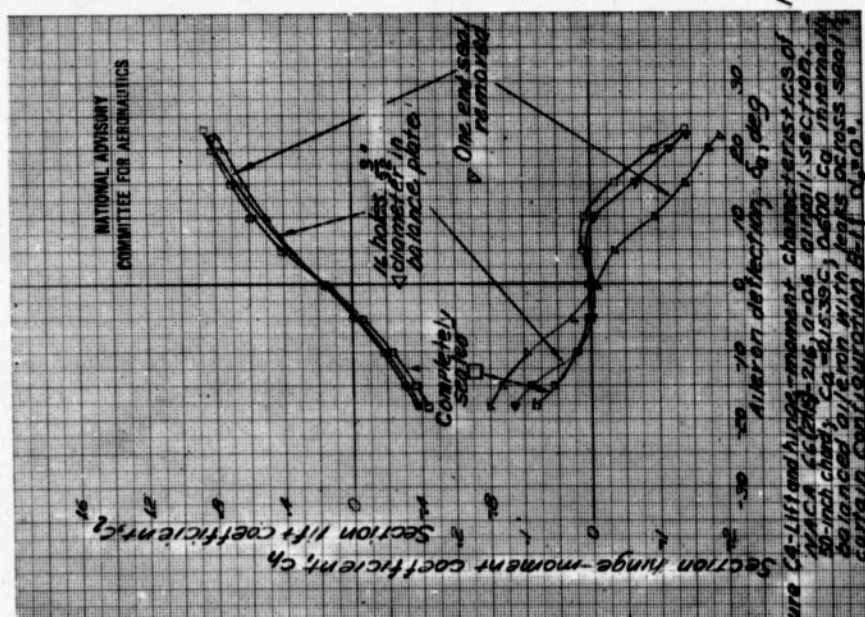
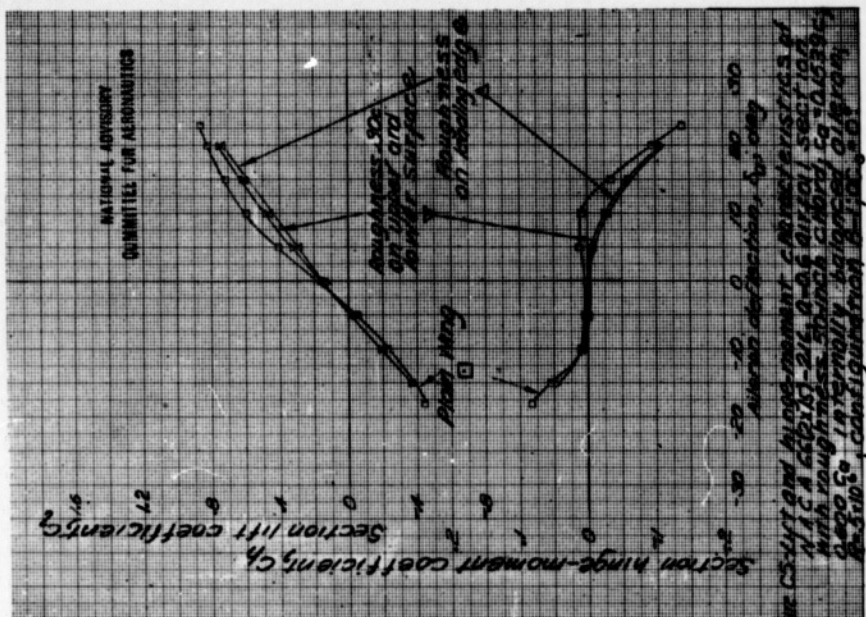
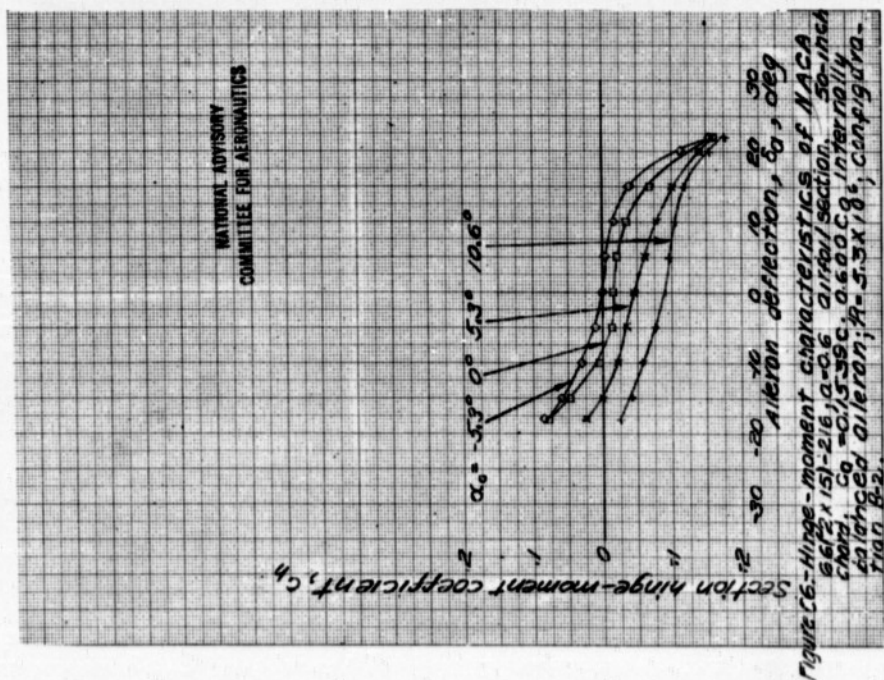
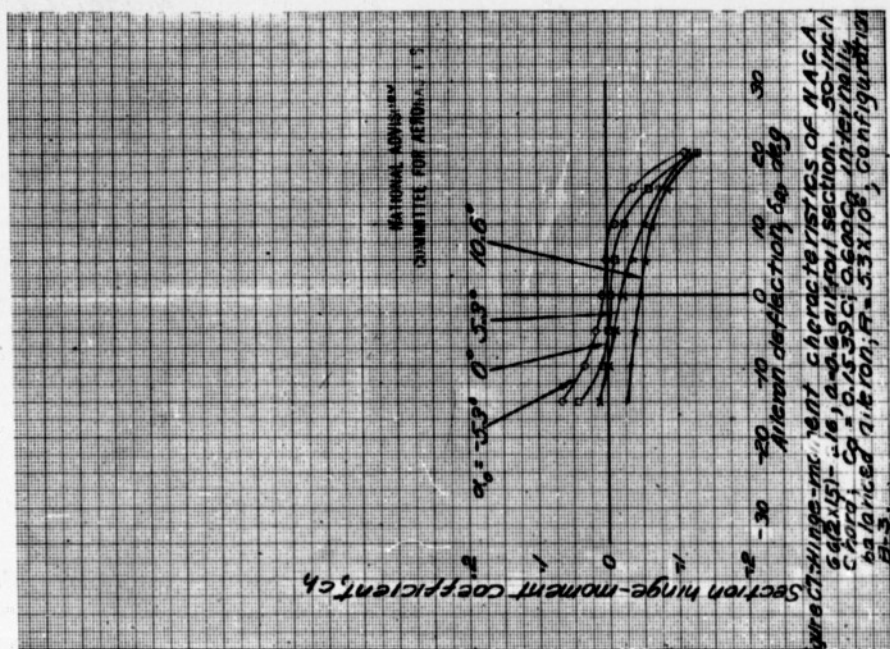


Figure C-11 and hinge-moment characteristics of NACA section 214, 0-06 aileron section. 30-inch chord, c_r , 0.0394; c_{r0} , 0.0205. Sealed aileron with lips of 0.0394. Configuration B-10, 0-01.

Model C-1



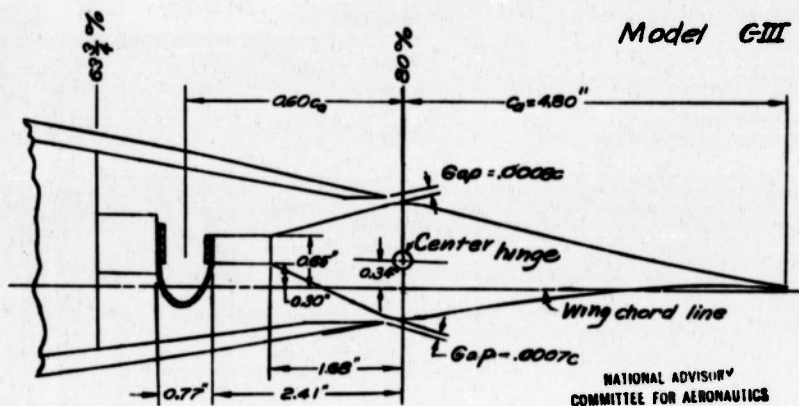


Figure C10.-Aileron and balance configurations on an intermediate section between root-NACA 63(420)-321, $\alpha=1.0$ and tip-NACA 65(318)-415, $\alpha=1.0$. Two-dimensional-flow tests. NACA two-dimensional low-turbulence tunnel.

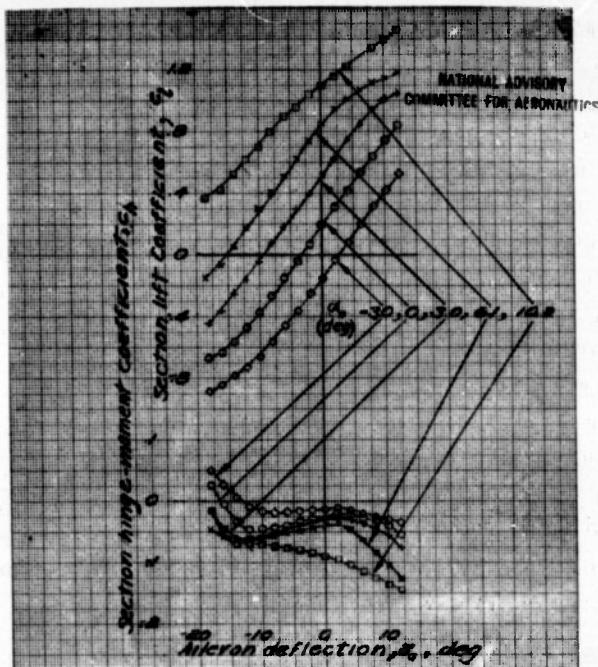


Figure C.11.— Characteristics of a completely sealed, 0.60c₀ internally balanced 0.20c aileron; $R = 2.5 \times 10^6$. Central hinge position.

Model C-III

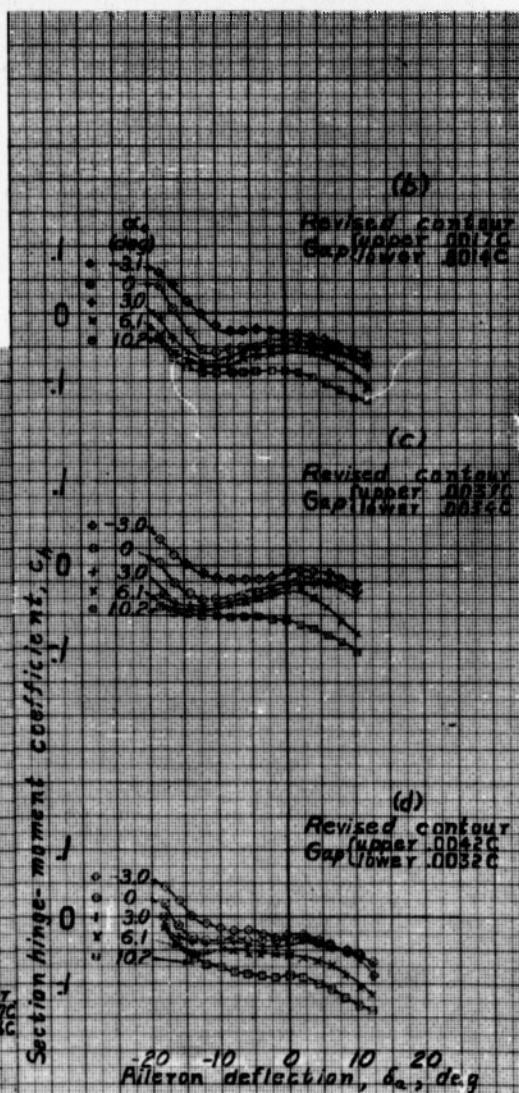
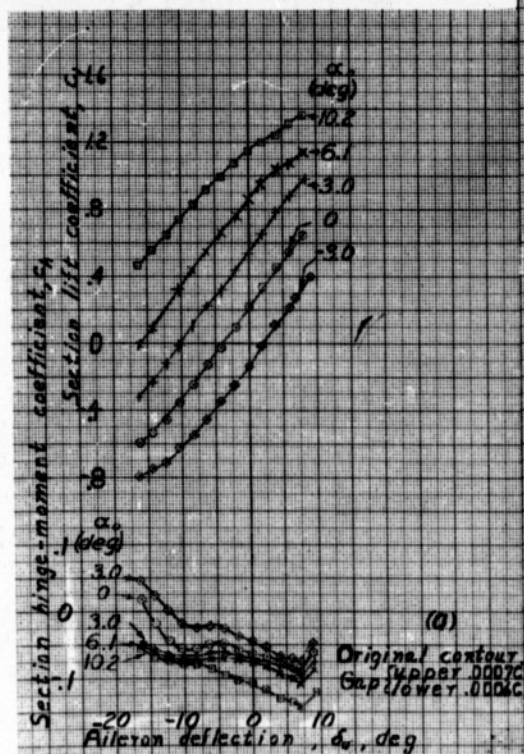
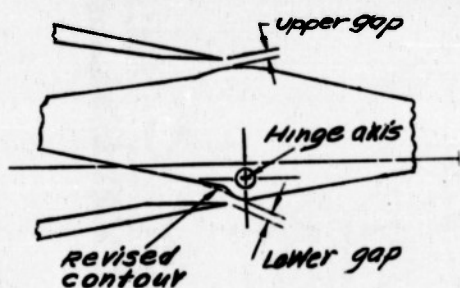


Figure C.12 - Characteristics of a completely sealed 0.60c internally balanced 0.20c aileron. Low hinge position; $R = 2.5 \cdot 10^6$.

Model C-IV

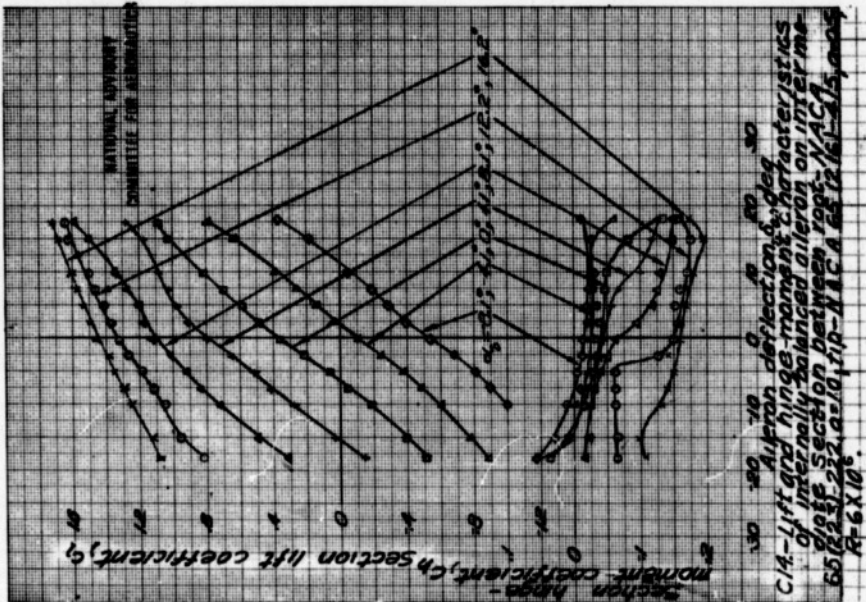


Figure C14.-Lift and hinge-moment characteristics of internally-balanced aileron on intermediate section between root-NACA 65(23)-222, $\alpha = 1.0$ and tip-NACA 65(23)-115, $\alpha = 0.5$. $R = 6 \times 10^6$.

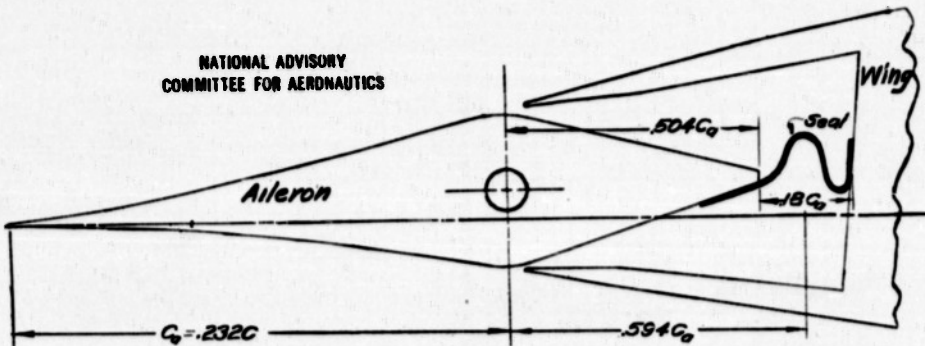


Figure C13.-Aileron and balance setup on intermediate section between root-NACA 65(23)-222, $\alpha = 1.0$ and tip-NACA 65(23)-115, $\alpha = 0.5$. Two-dimensional-flow tests; model C-IV; NACA two-dimensional low-turbulence pressure tunnel.

Model C-V

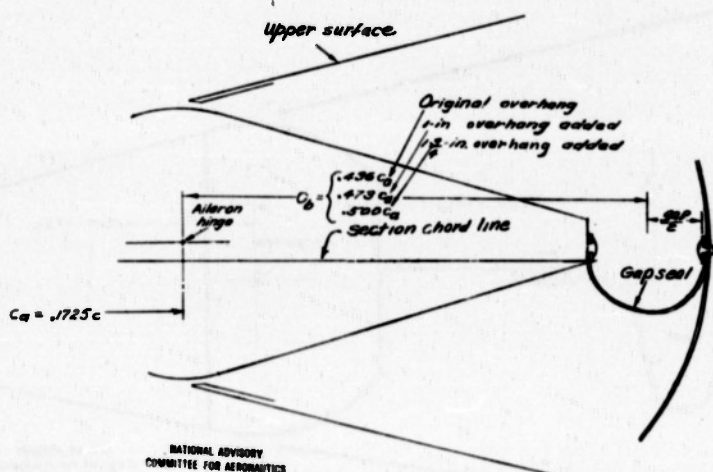


Figure C15.-Internal balance on NACA 66(215)-216, $\alpha = 0.6$ airfoil tested with various amounts of seal and balance. Two-dimensional-flow tests; model C-V; NACA two-dimensional low-turbulence tunnel.

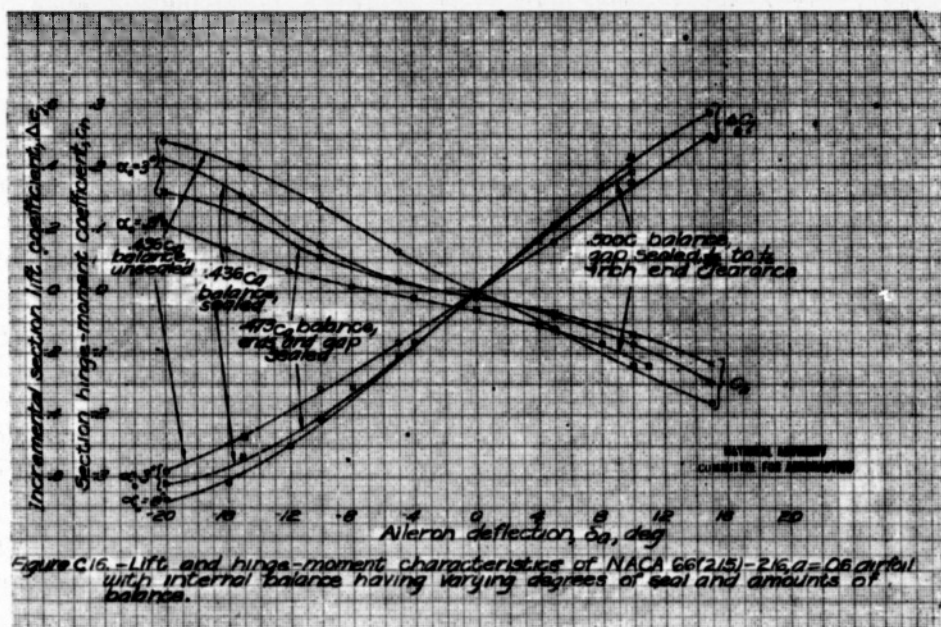


Figure C16.-Lift and hinge-moment characteristics of NACA 66(215)-216, $\alpha = 0.6$ airfoil with internal balance having varying degrees of seal and amounts of balance.

Model C-VI

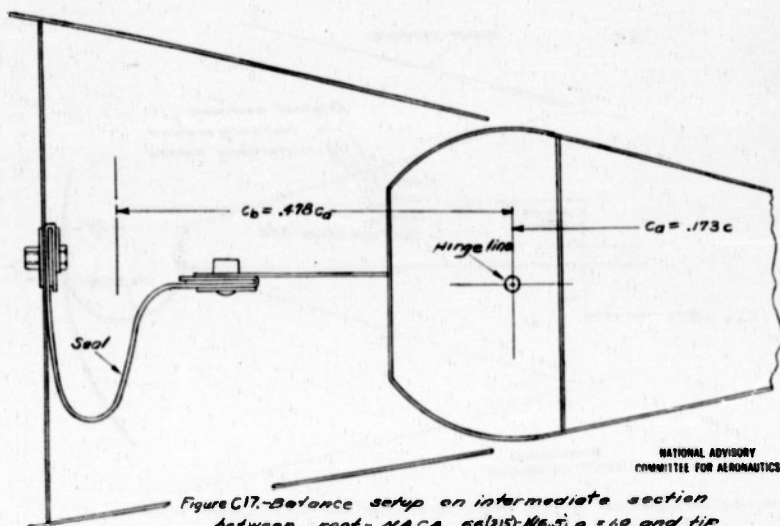
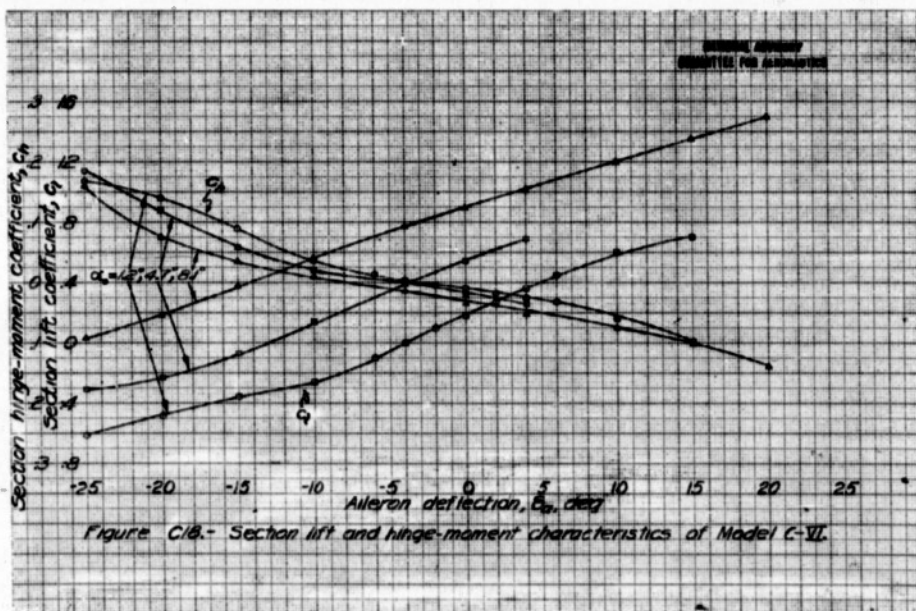
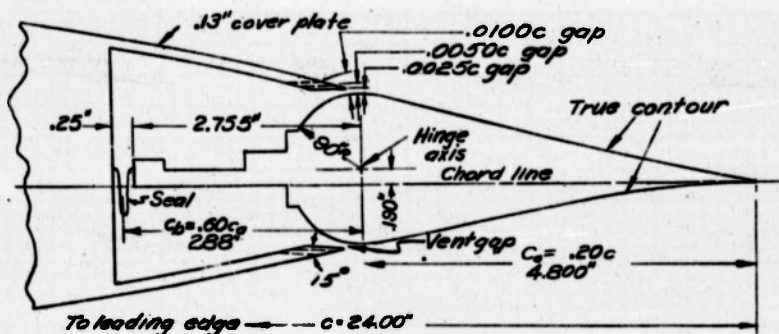


Figure C17.-Balance setup on intermediate section between root - NACA 66(215)-N6.5; $\alpha = 10$ and tip NACA 67(115)-213, $\alpha = 0.7$. Two-dimensional-flow tests; model C-VI; NACA Two-dimensional low-turbulence Tunnel

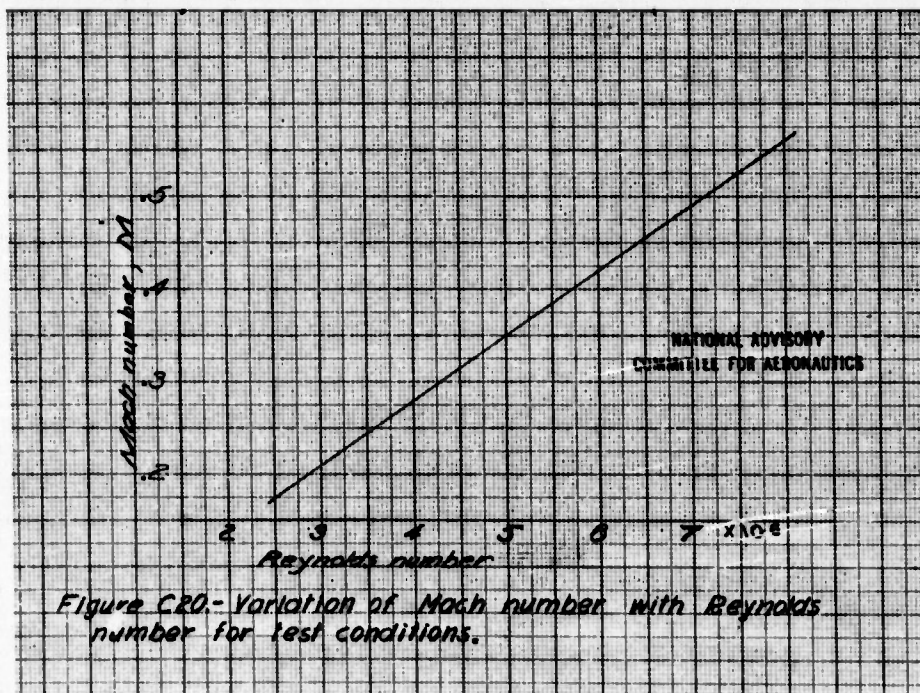


Model C-VII



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Figure C19.-Aileron section of the NACA 65(215)-210, $\alpha = 1.0$ airfoil tested with a 0.20c sealed internally balanced aileron of true contour. Model C-VII, $C_b = 0.60C_0$; NACA stability tunnel.



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Figure C20.-Variation of Mach number with Reynolds number for test conditions.

Model C-VII

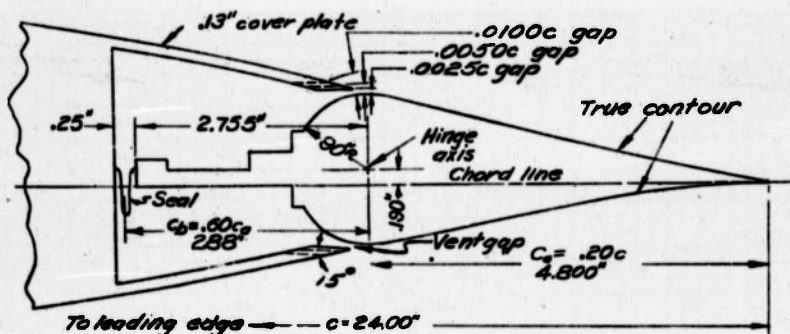
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Figure C19.-Aileron section of the NACA 66(215)-216, 0.10 airfoil tested with a 0.20c sealed internally balanced aileron of true contour. Model C-VII. $C_b = 0.60C_a$; NACA stability tunnel.

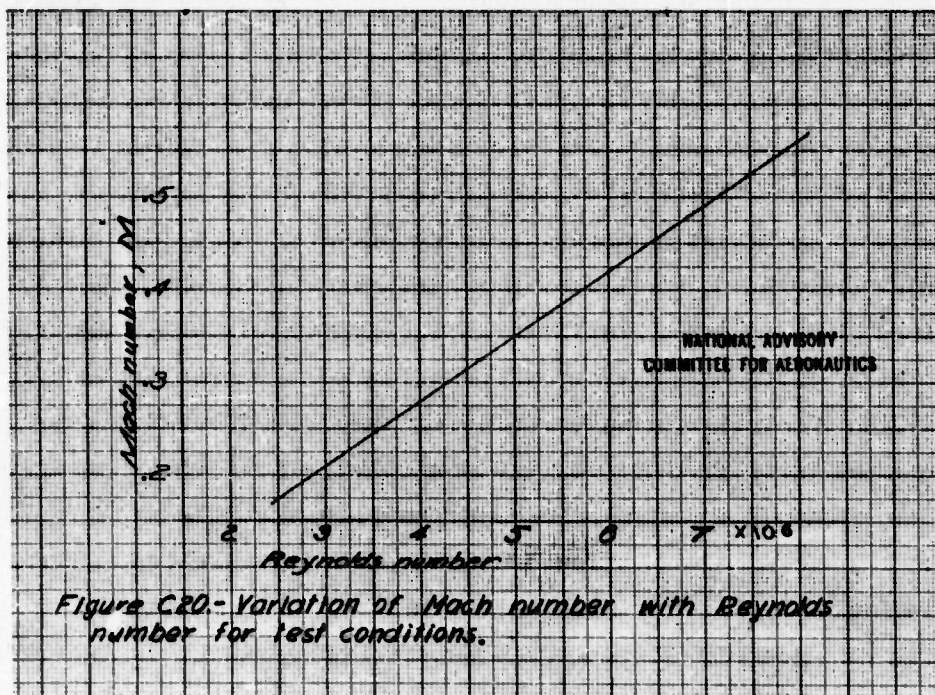
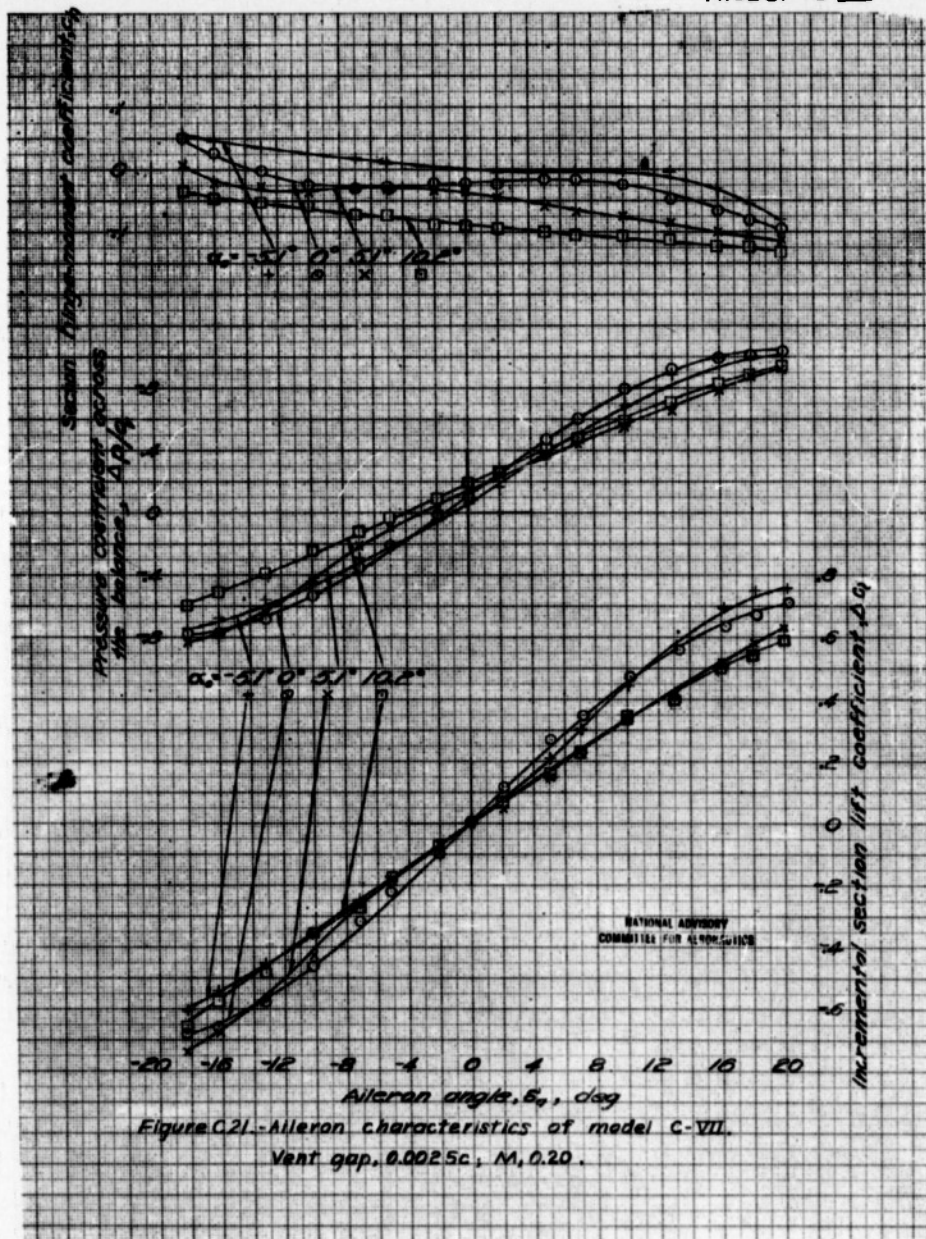
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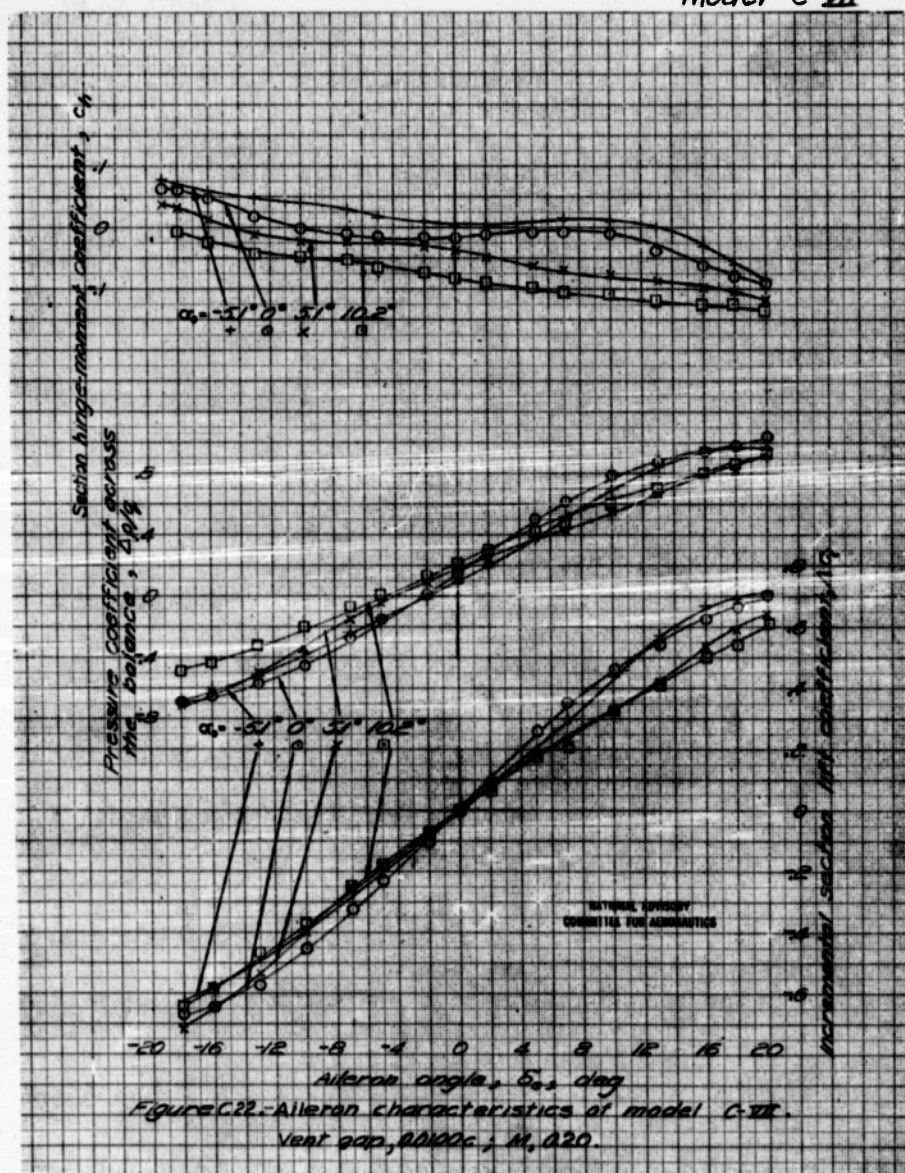
Figure C20.- Variation of Mach number with Reynolds number for test conditions.

Model C-VII

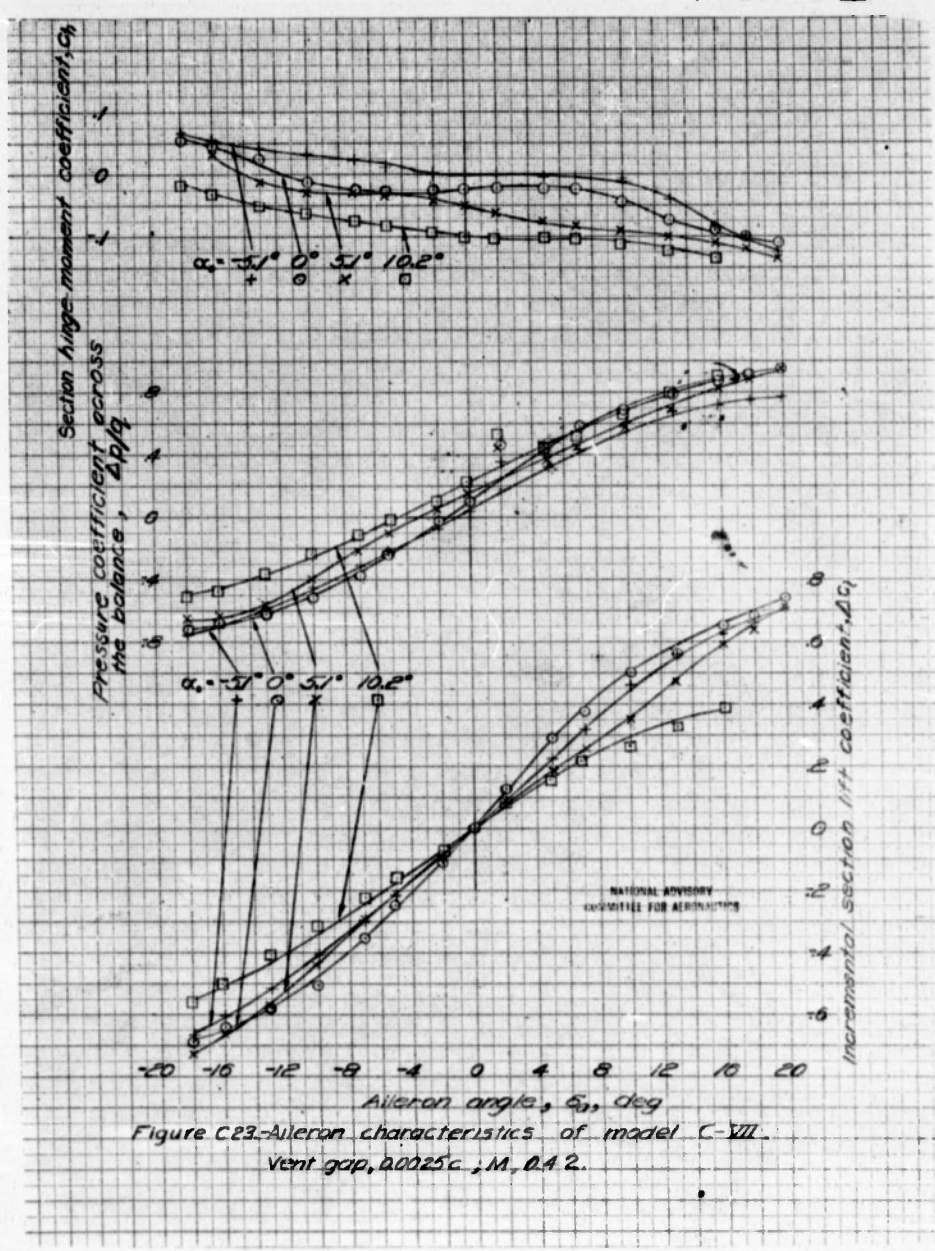


L-419

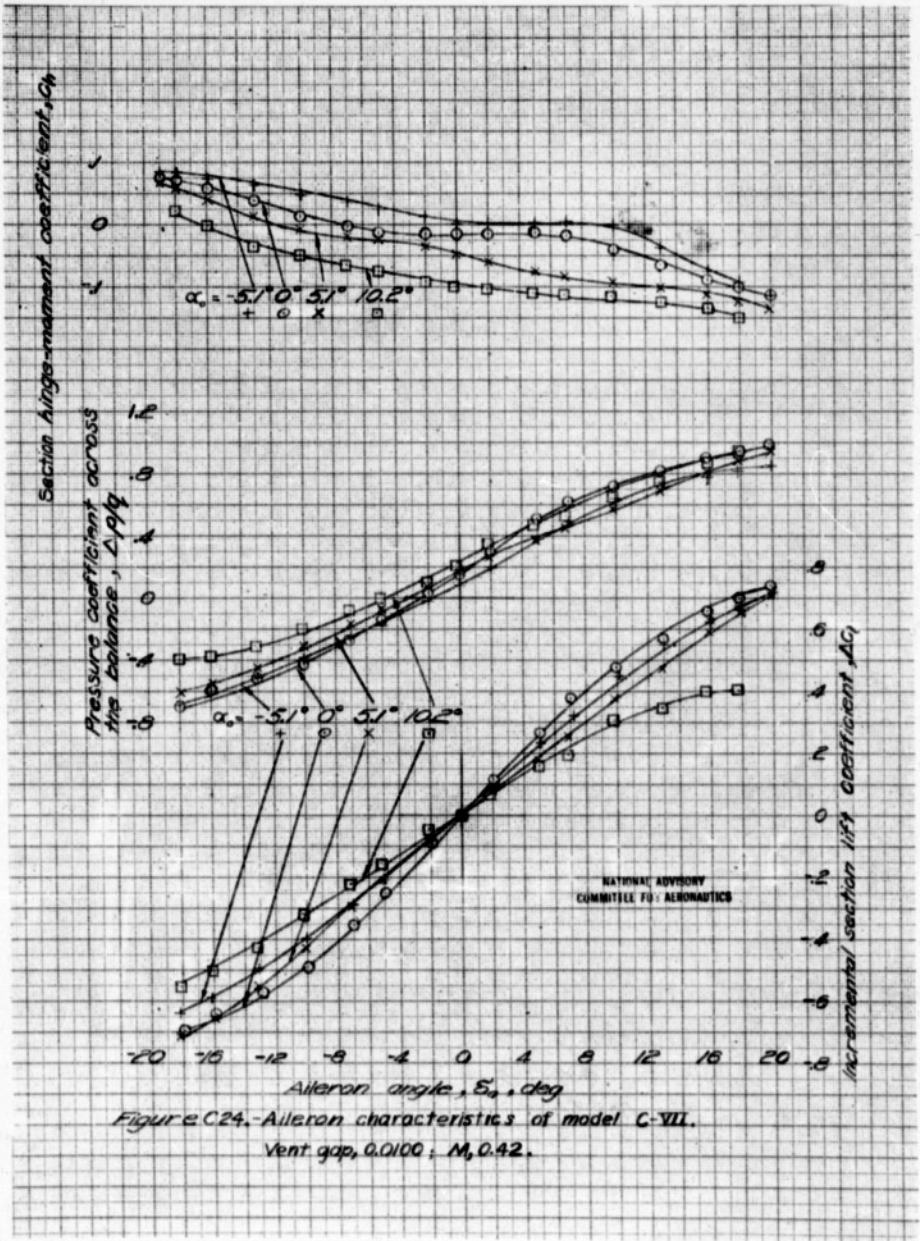
Model C-VII



Model C-VII



Model C-VII



Model C-VIII

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L-419

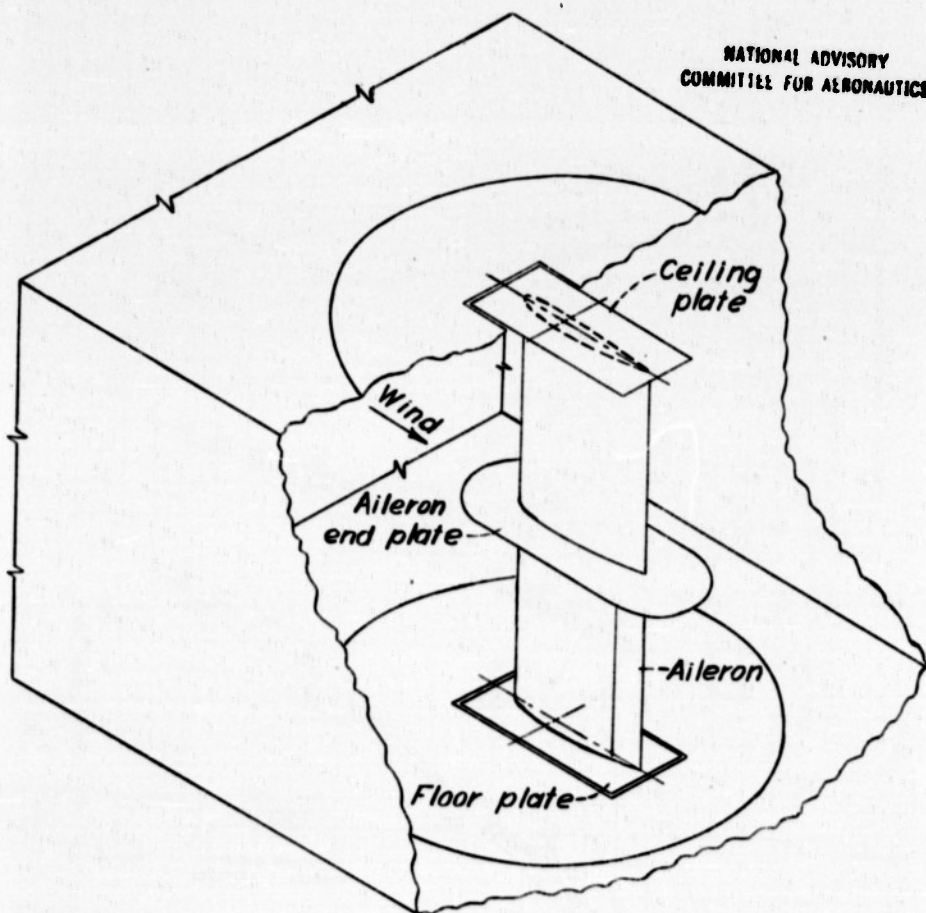


Figure C25.-Test setup for intermediate section of a wing between root NACA 23017 and tip NACA 4409R. Model C-VIII; AAL 7-by 10-foot tunnel.

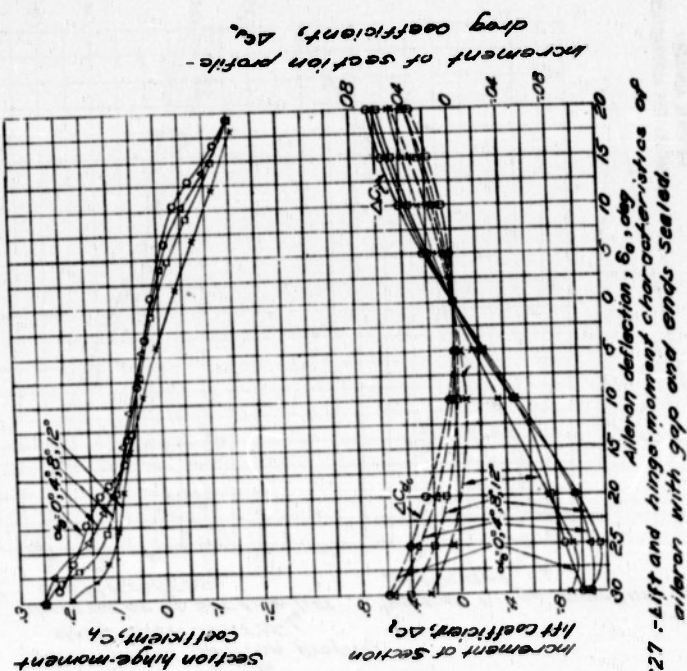


Figure C26-7: The aileron and balance with end and gap seals.

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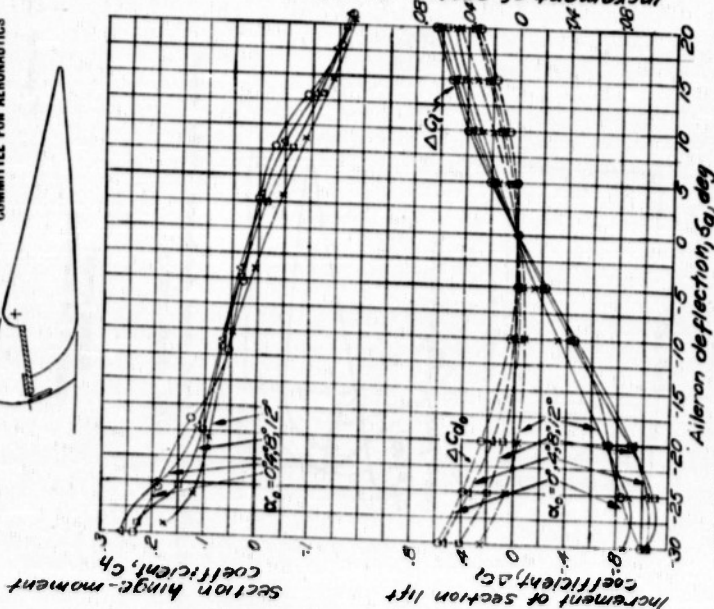


Figure 28—Lift and hinge-moment characteristics of aileron with ends unsealed.

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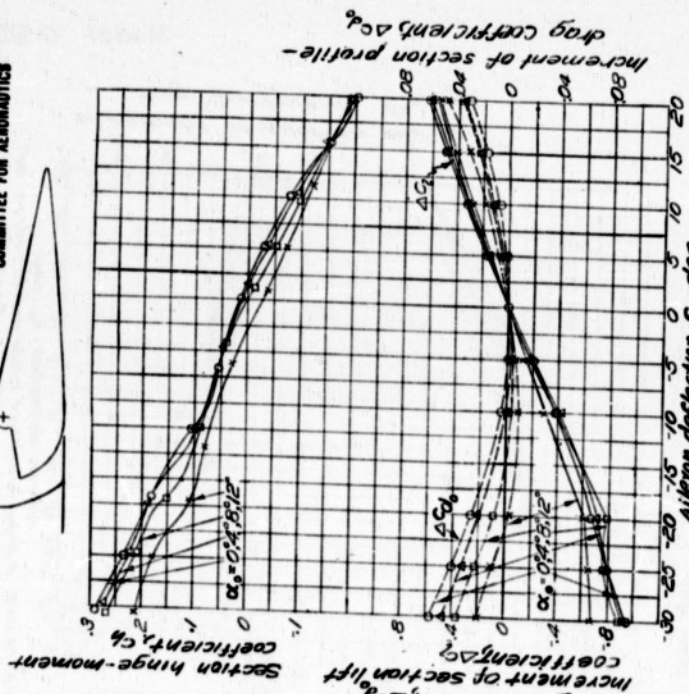
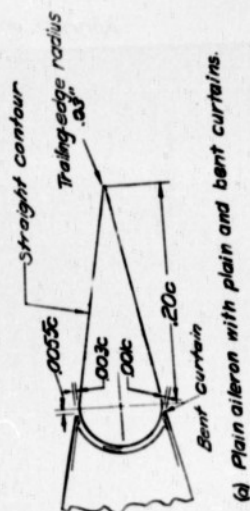


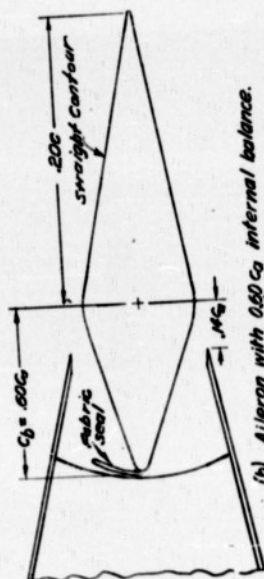
Figure 29—Lift and hinge-moment characteristics of aileron with seals and overhang plate removed.

Model C-VIII



(a) Plain aileron with plain and bent curtains.

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(b) Aileron with $0.60 c_u$ internal balance.

Figure C31-Typical sections of ailerons tested on model C-IX.

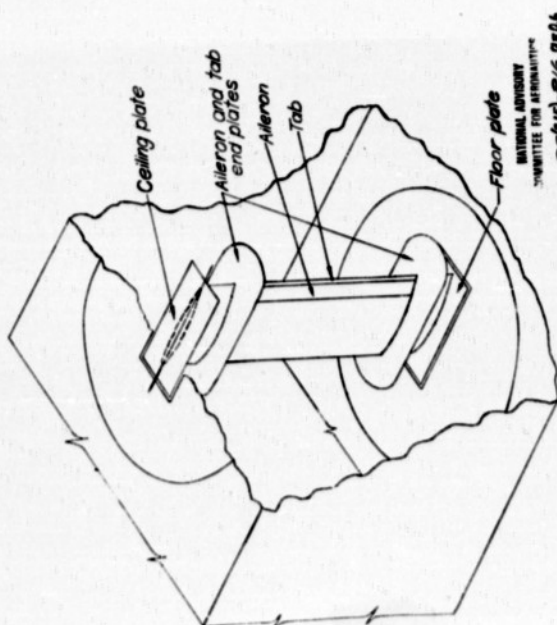
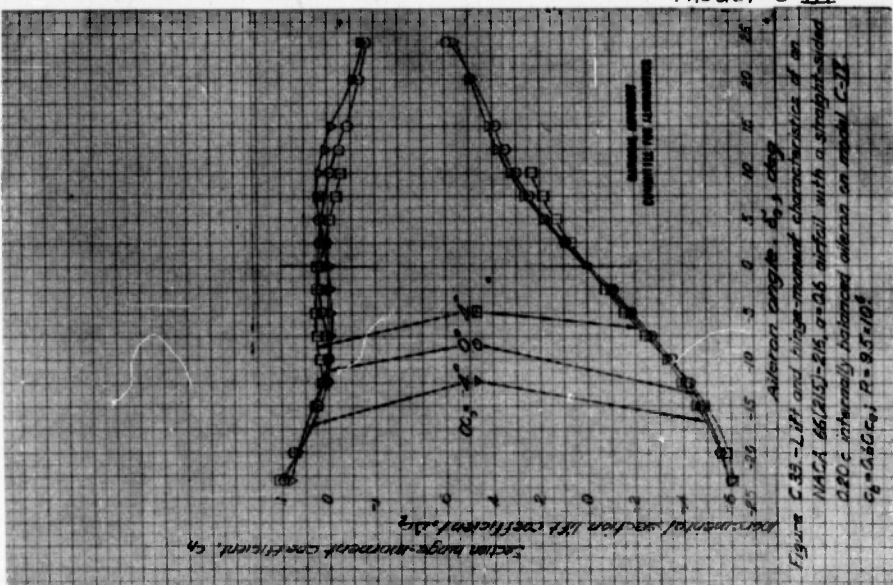
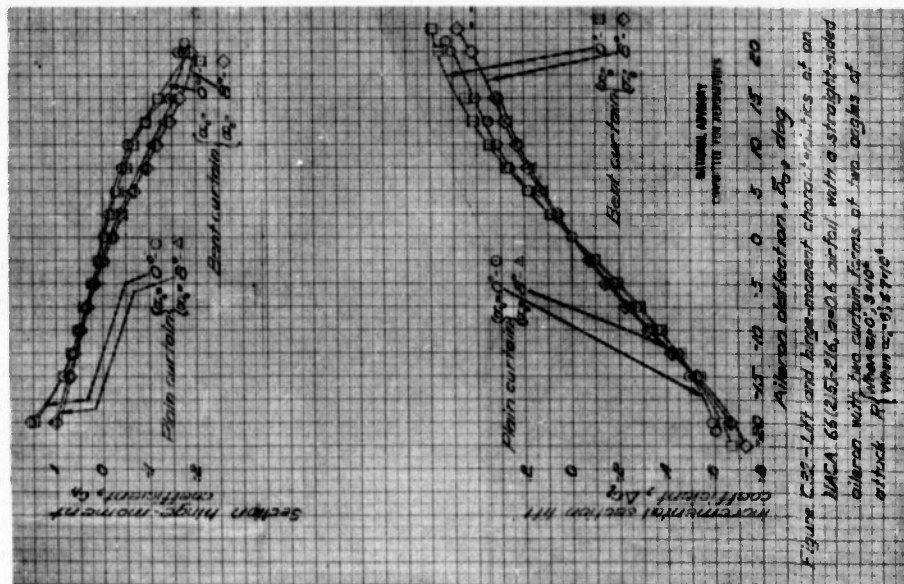


Figure C30-Test installation for NACA 66215-E1/6, 66216-E1/6 airfoil with aileron. Model C-IX; AAL T-by 10-foot tunnel.



Model C-IX

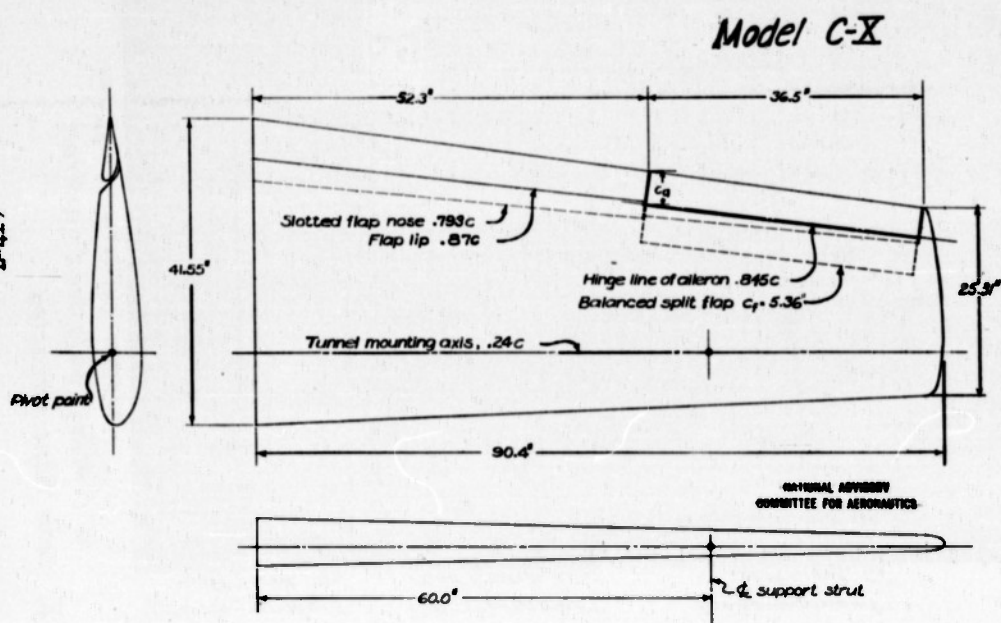


Figure C34.-Semispan wing model C-X. Tested in LMAL 7 by 10-foot tunnel.

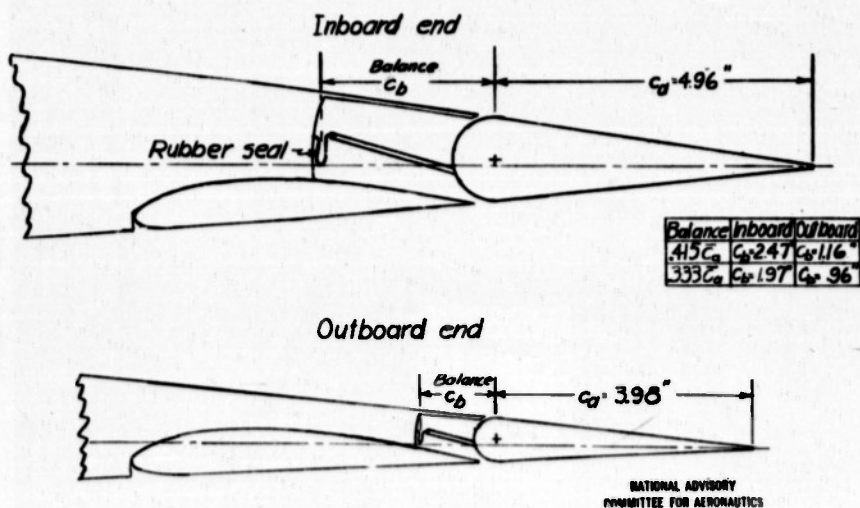
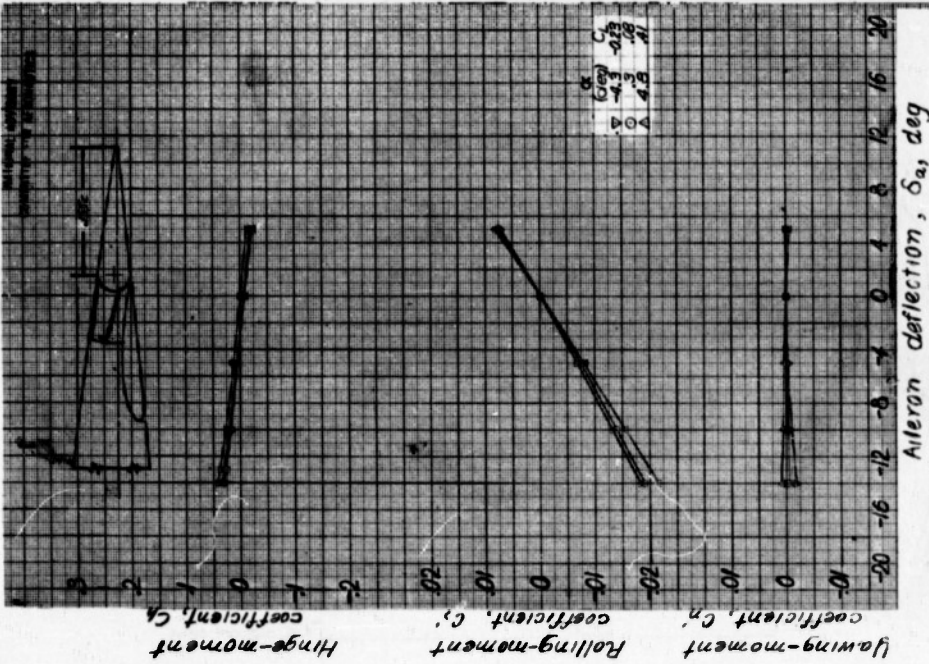
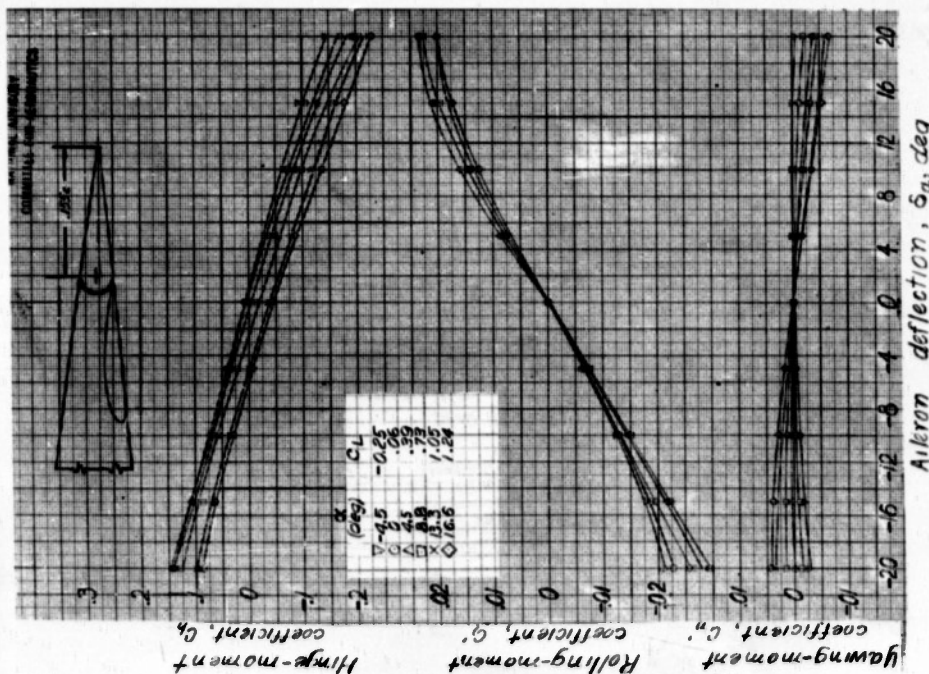


Figure C35.-Profile of the balance arrangement of model C-X.

Model C-X



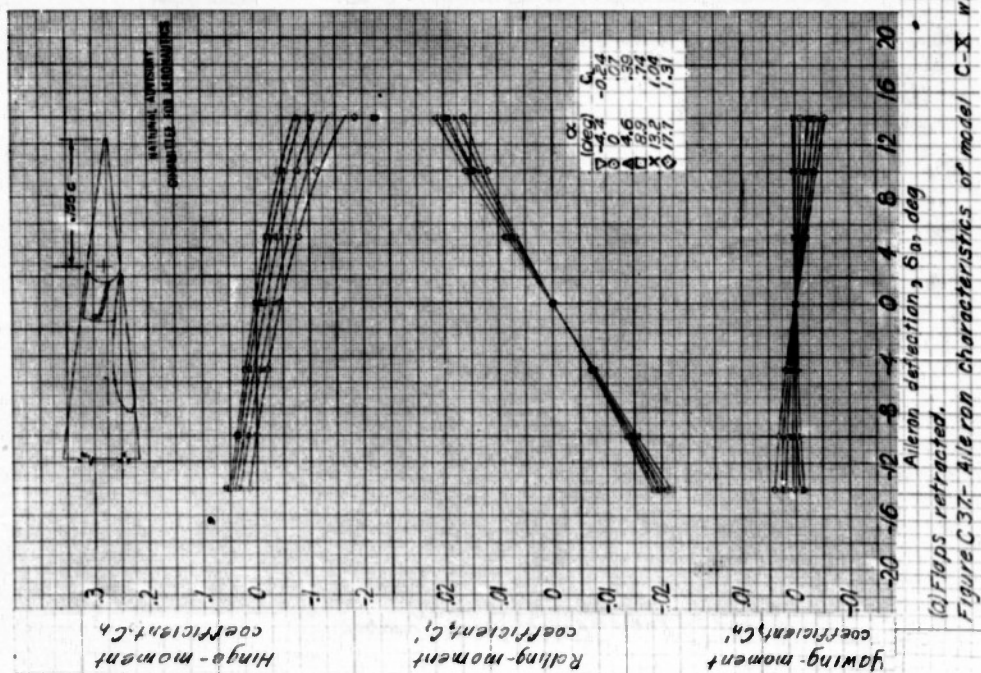
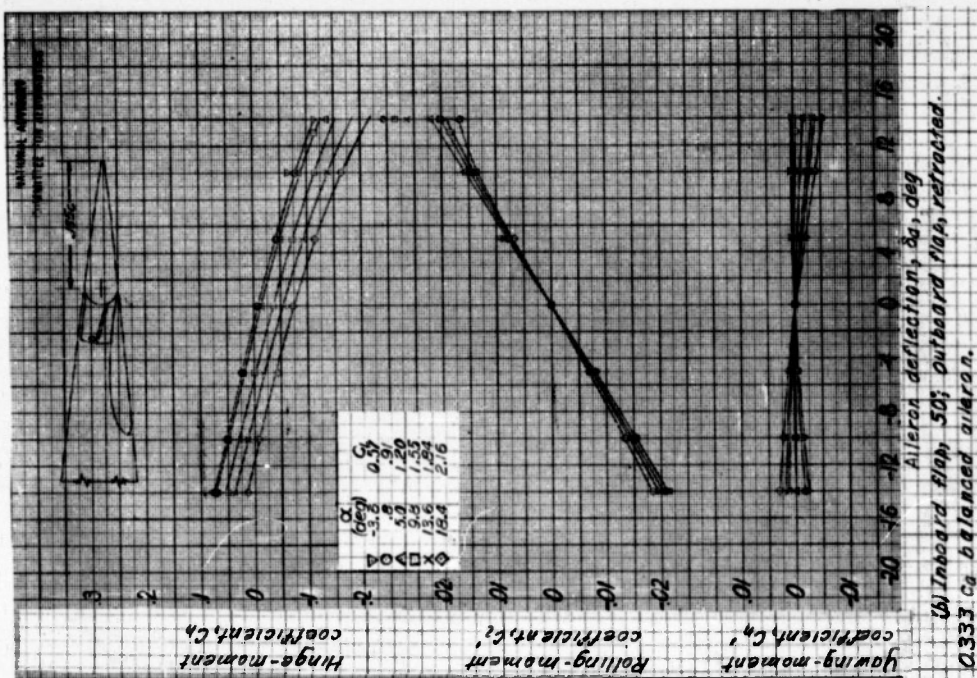
(b) 0.415 C_{a0} balanced aileron with flaps retracted



(a) Plain sealed aileron.

Figure C36-Aileron characteristics of model C-X

Model C-X



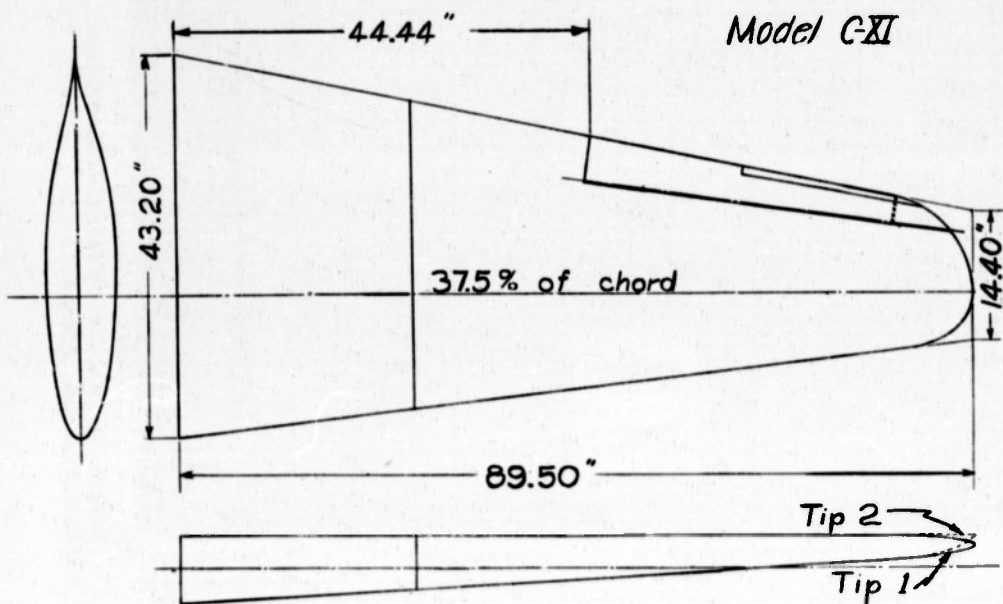


Figure C38. - Semispan wing model C-XI.

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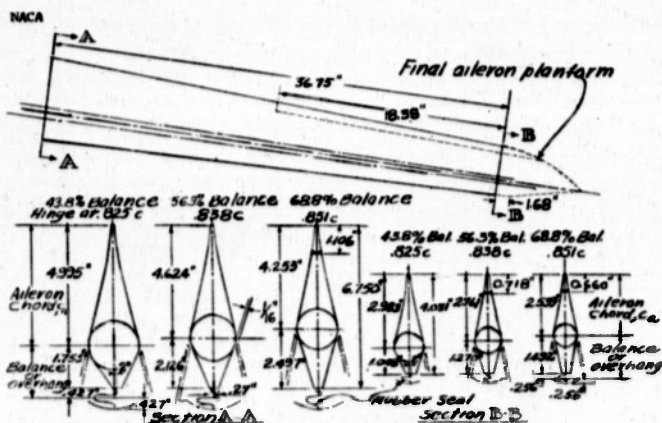
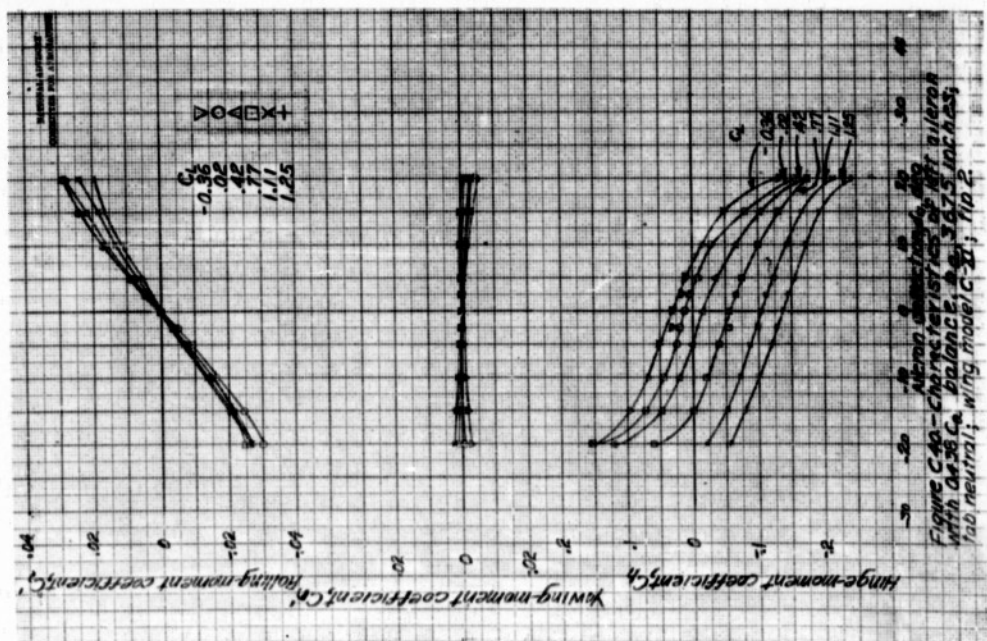
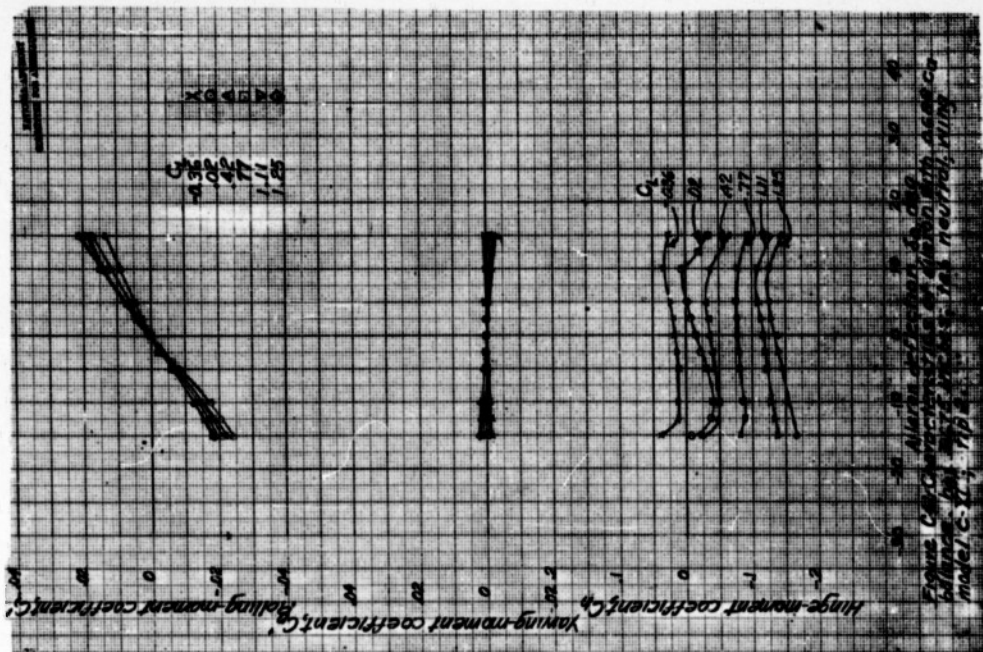
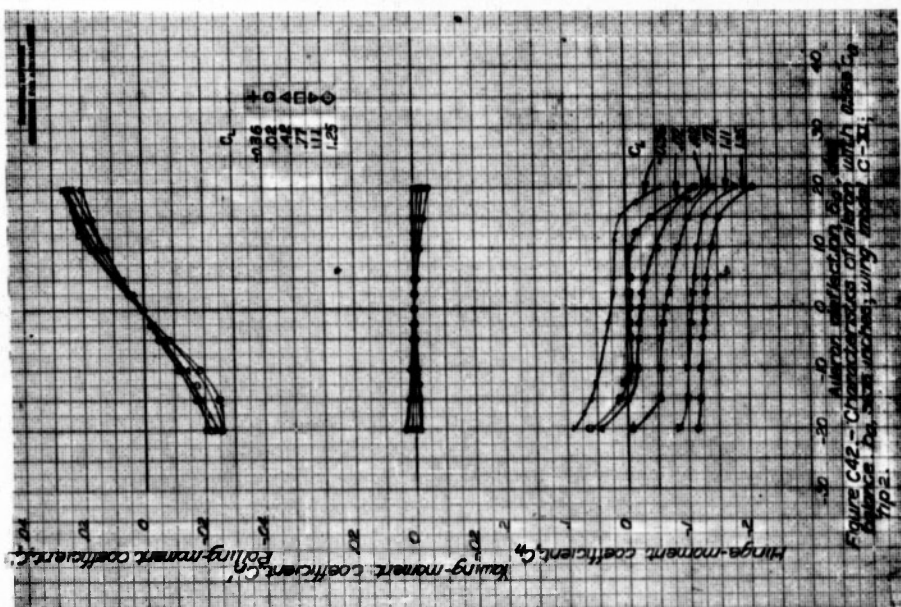
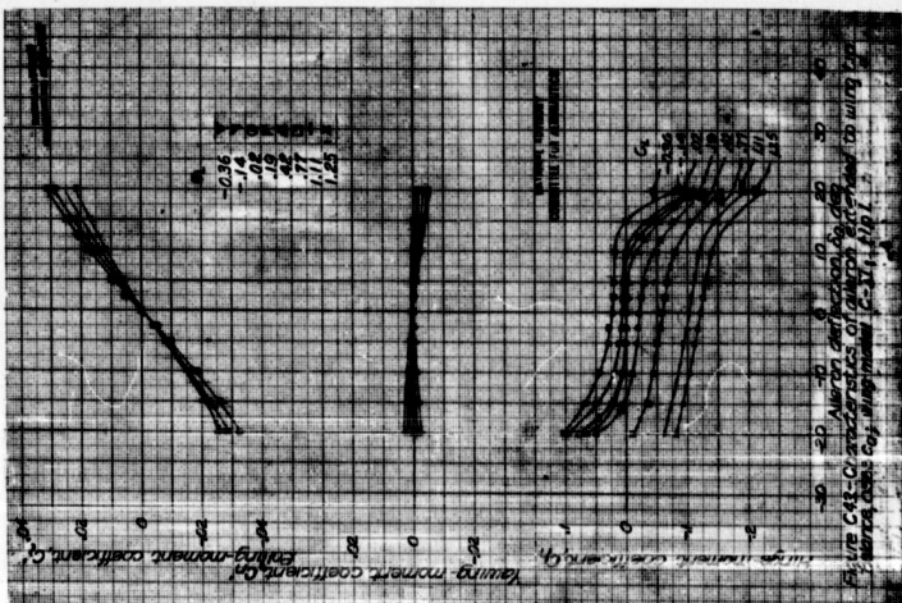


Figure C39. - Ailerons of semispan wing model C-XI as tested in the LNAL 7-6Y 10-foot tunnel.



Model C-XI



Model C-XII

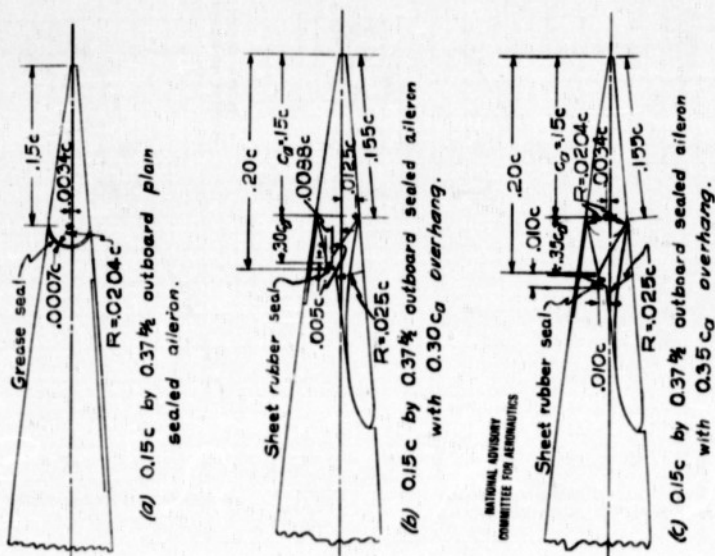


Figure C-45. Profile of ailerons of semispan wing model C-XII.

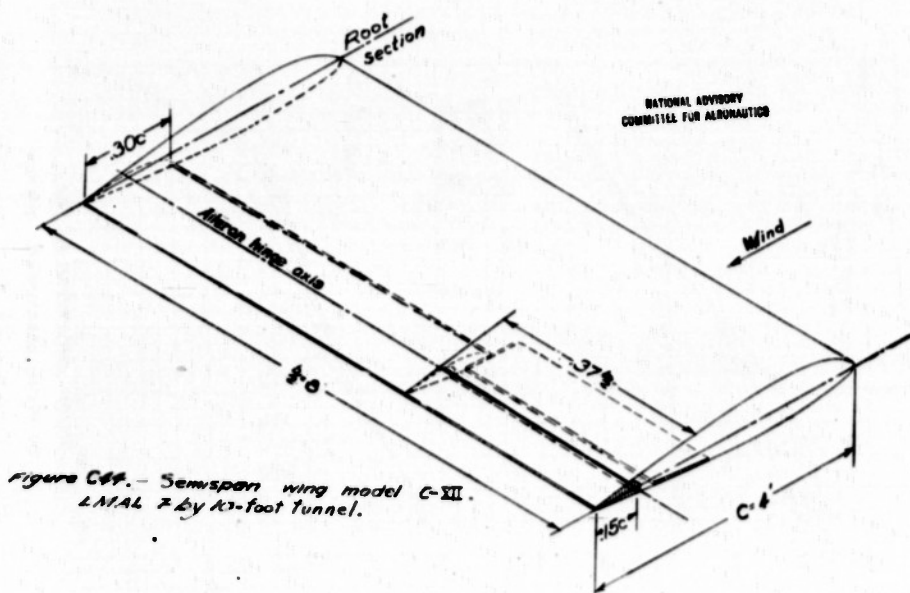
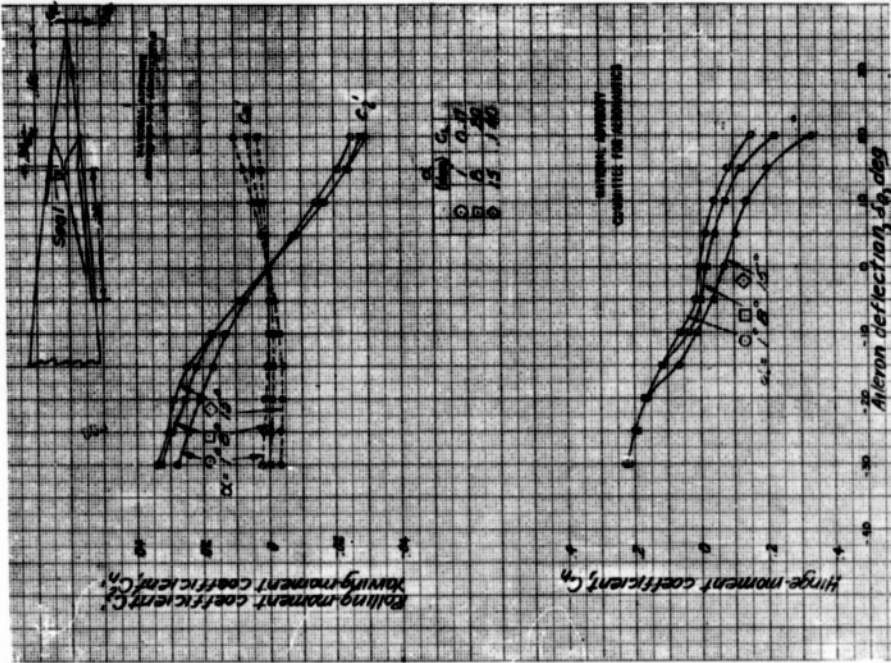
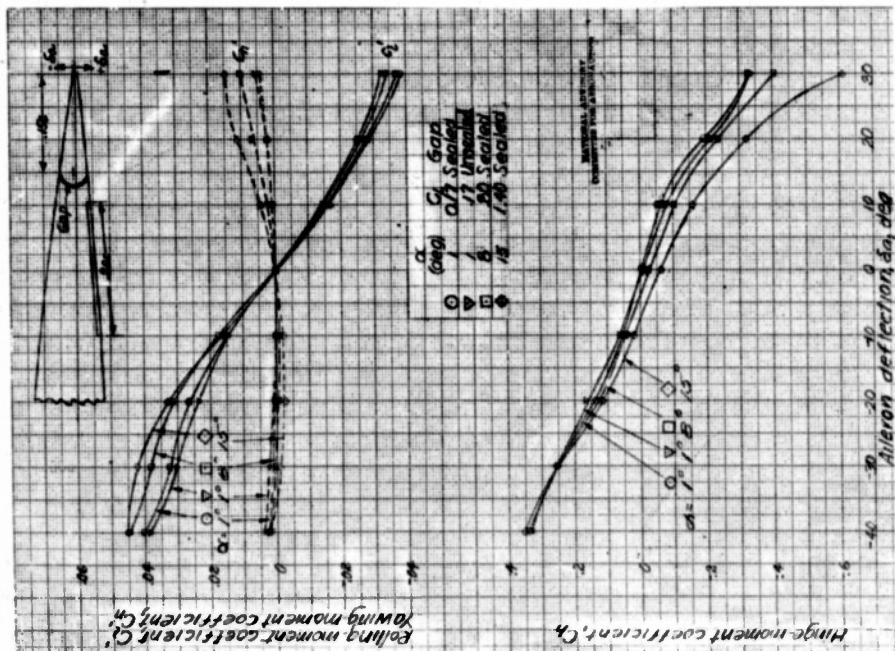


Figure C-44. Semispan wing model C-XII. NACA 7 by 10-foot tunnel.

Model C-XII

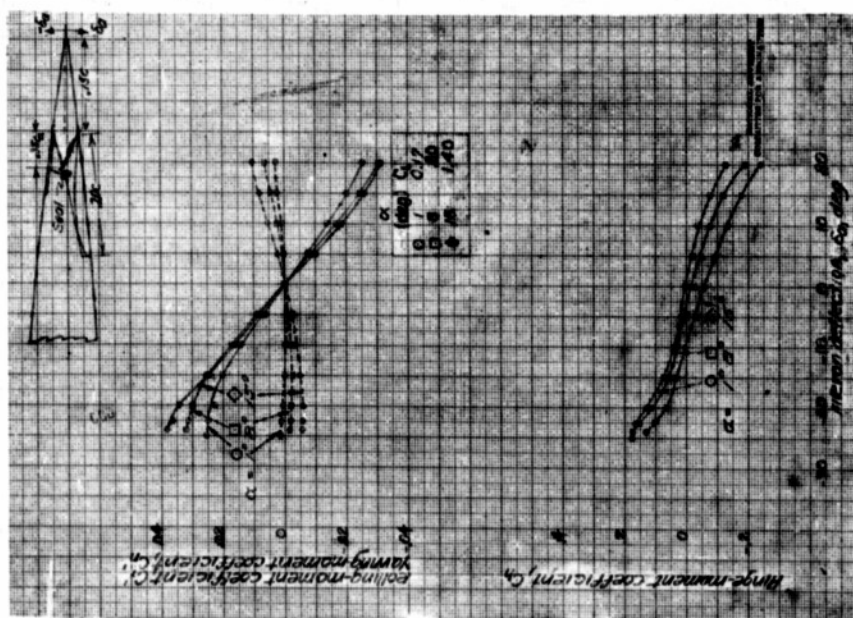
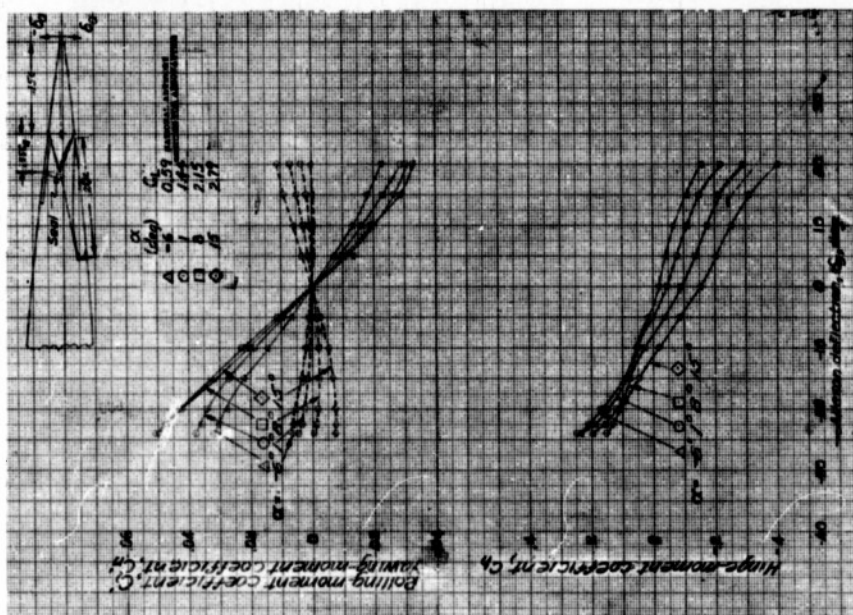


(b) Aileron with 0.30 c_a overhang sealed.



(a) Plain, unbalanced aileron.

Figure C46.- Aileron characteristics of model C-XII with flaps retracted.



Model C-XII

(b) Inboard flap, 40° ; outboard flap retracted.

(a) Flaps retracted.

Figure C 47.- Aileron characteristics of model C-XII with $0.35c_o$ overhang.

Model C-XIII

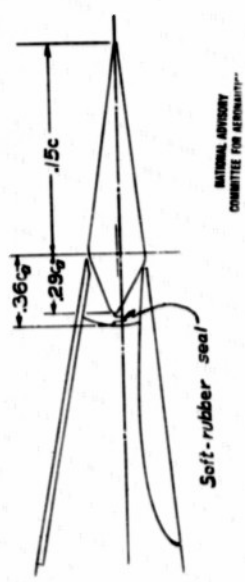
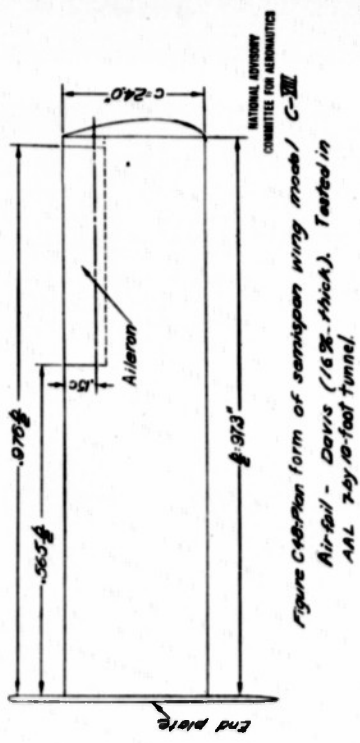
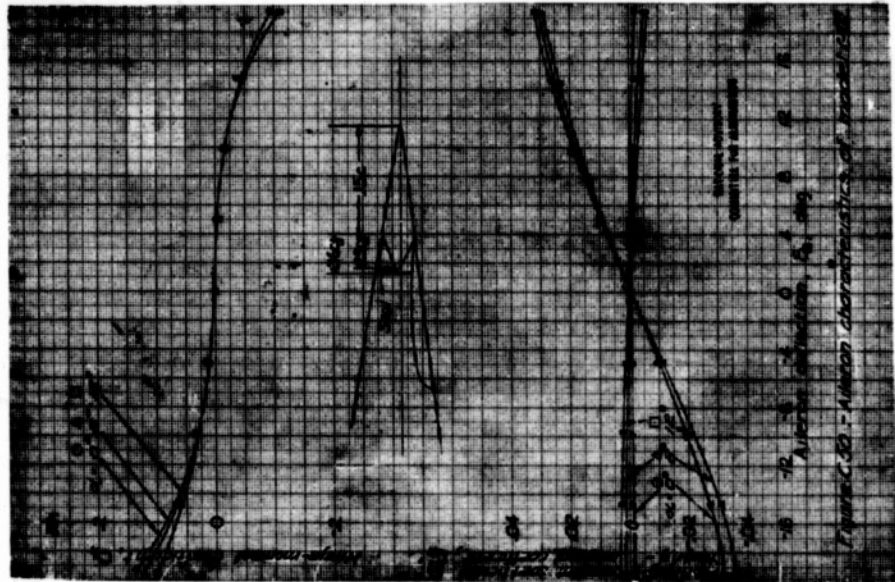


Figure C-49 - Balance arrangement of model C-XIII

Model C-XIV

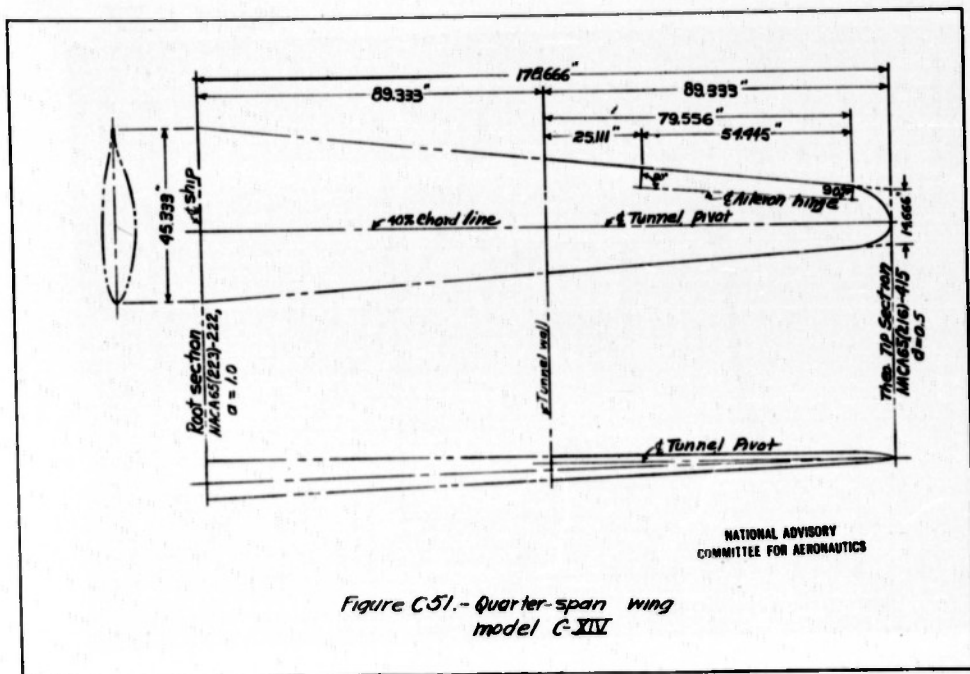


Figure C51.- Quarter-span wing
model C-XIV

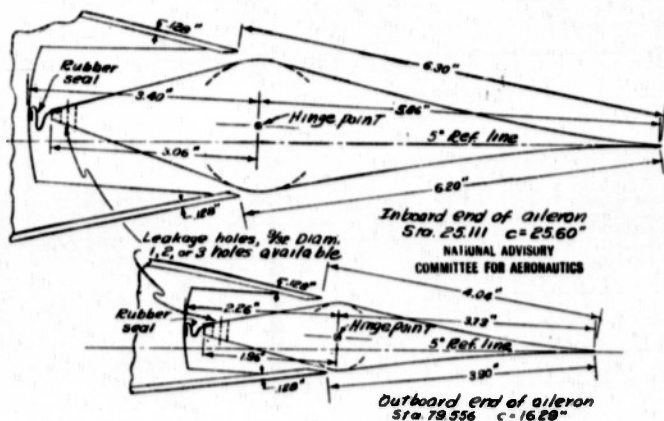
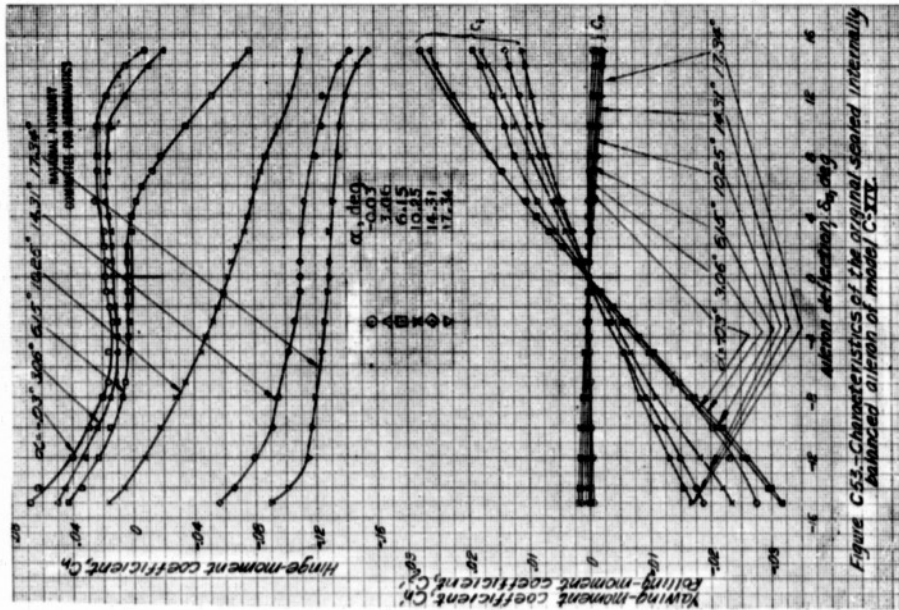
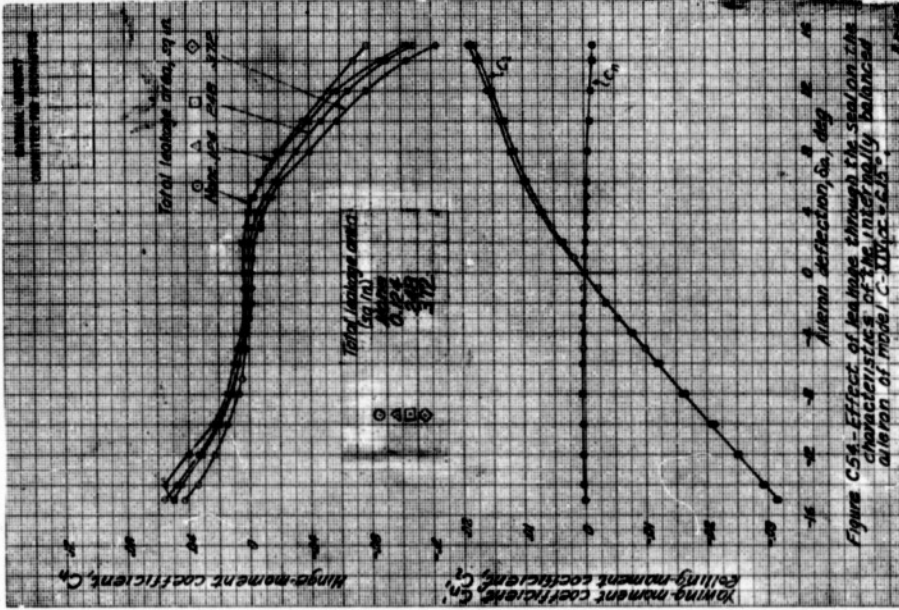


Figure C52.- End sections of aileron on quarter-span
wing model C-XIV. LMAL 7 by 10-foot
tunnel.

Model C-XIV



Model C-XV

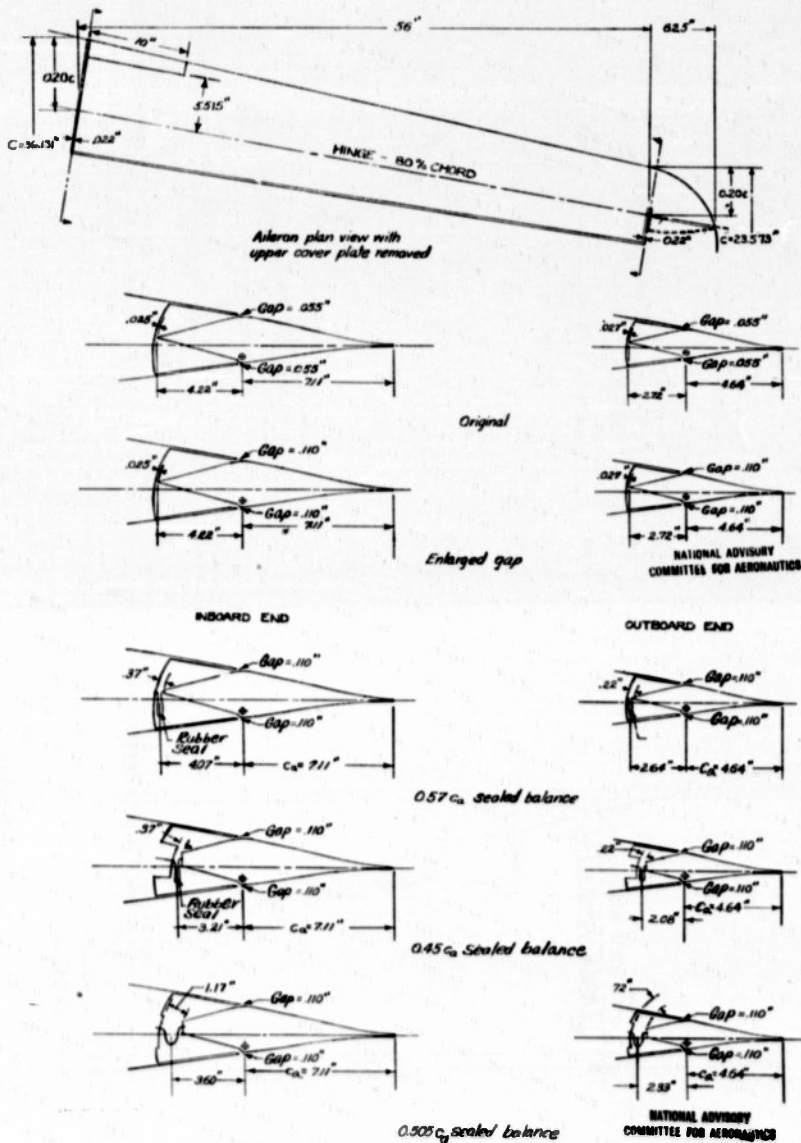
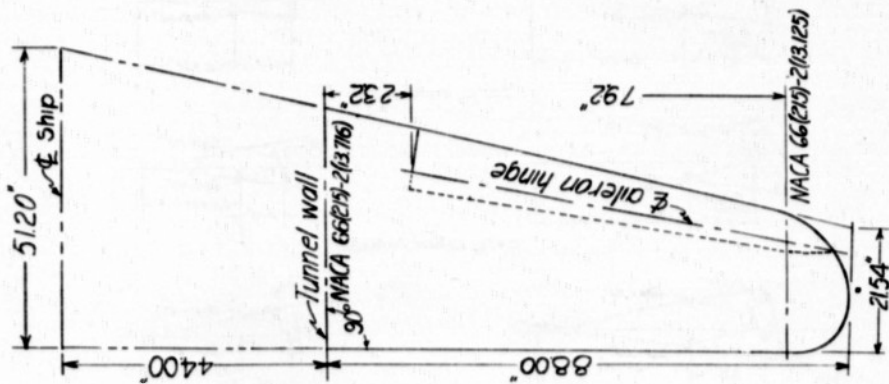
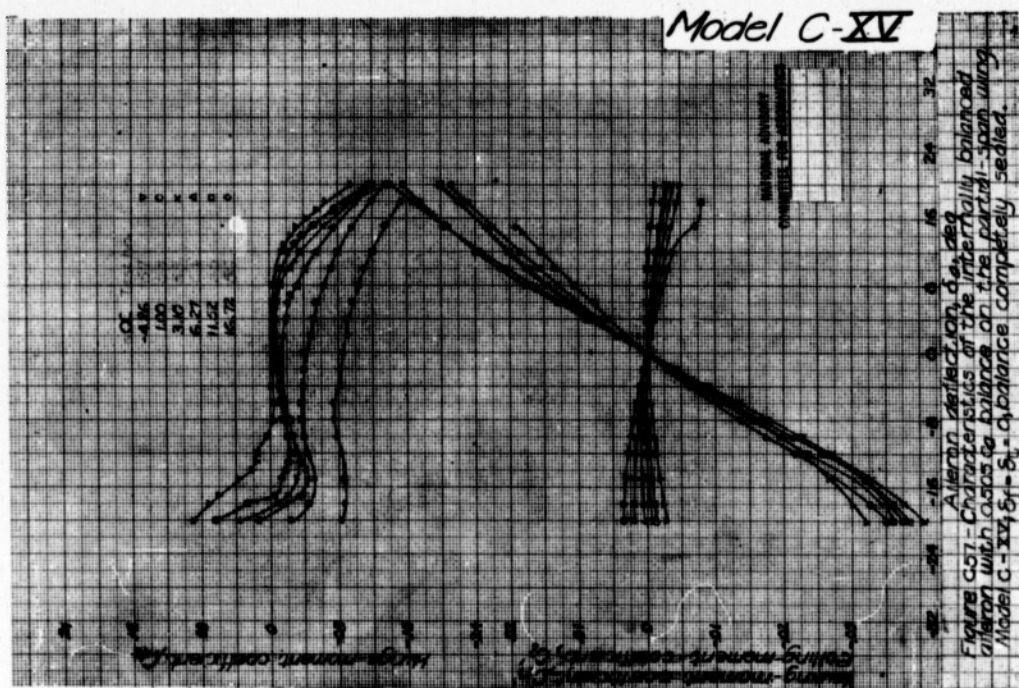


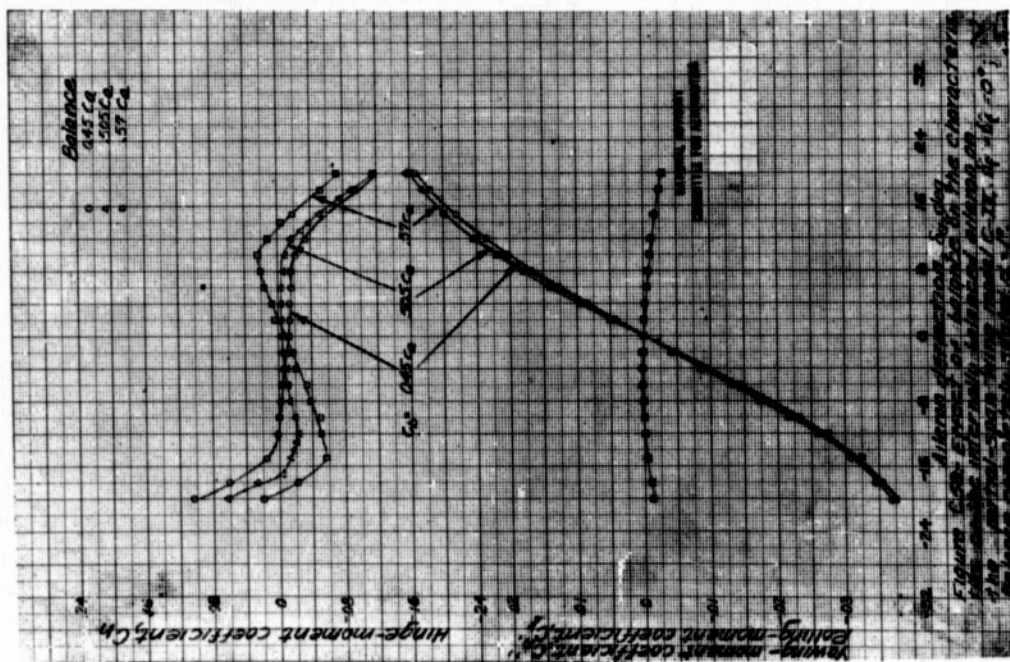
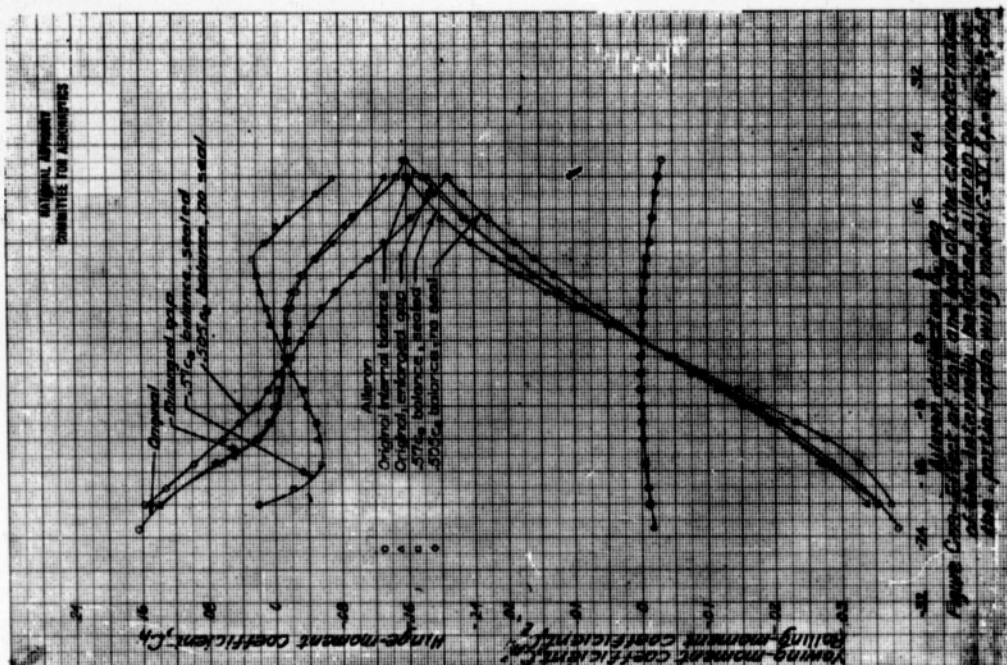
Figure c55.-Internally balanced ailerons on partial-span wing model C-XV. LMAL 7-by 10-foot tunnel.



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Figure C56.- Partial-span wing model C-XV.





Model C-XVI

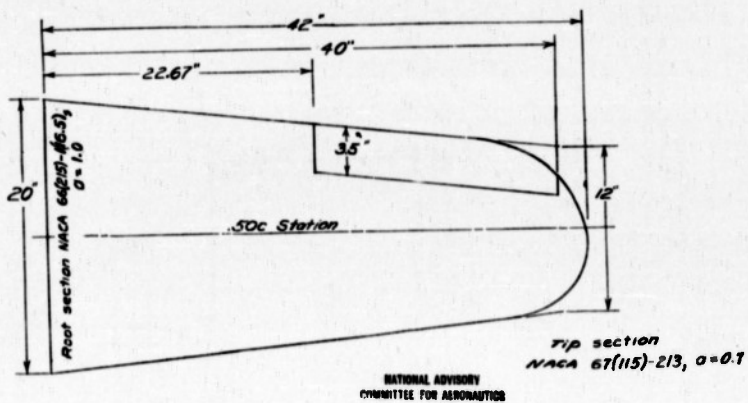


Figure C60.- Semispan plan form of complete model C-~~XVI~~.

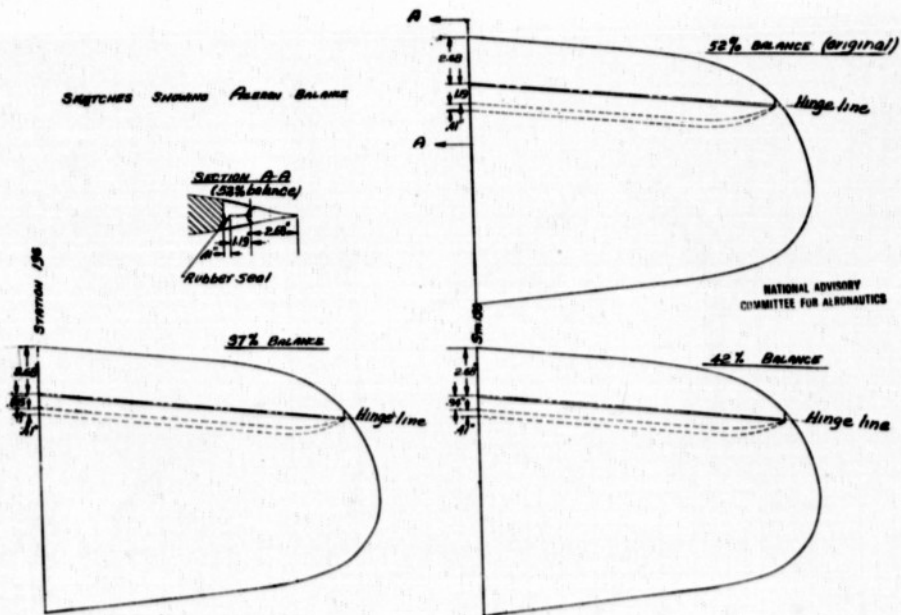


Figure C61.- Ailerons tested on model C-XVI in LMAL 7-by-10-foot tunnel.

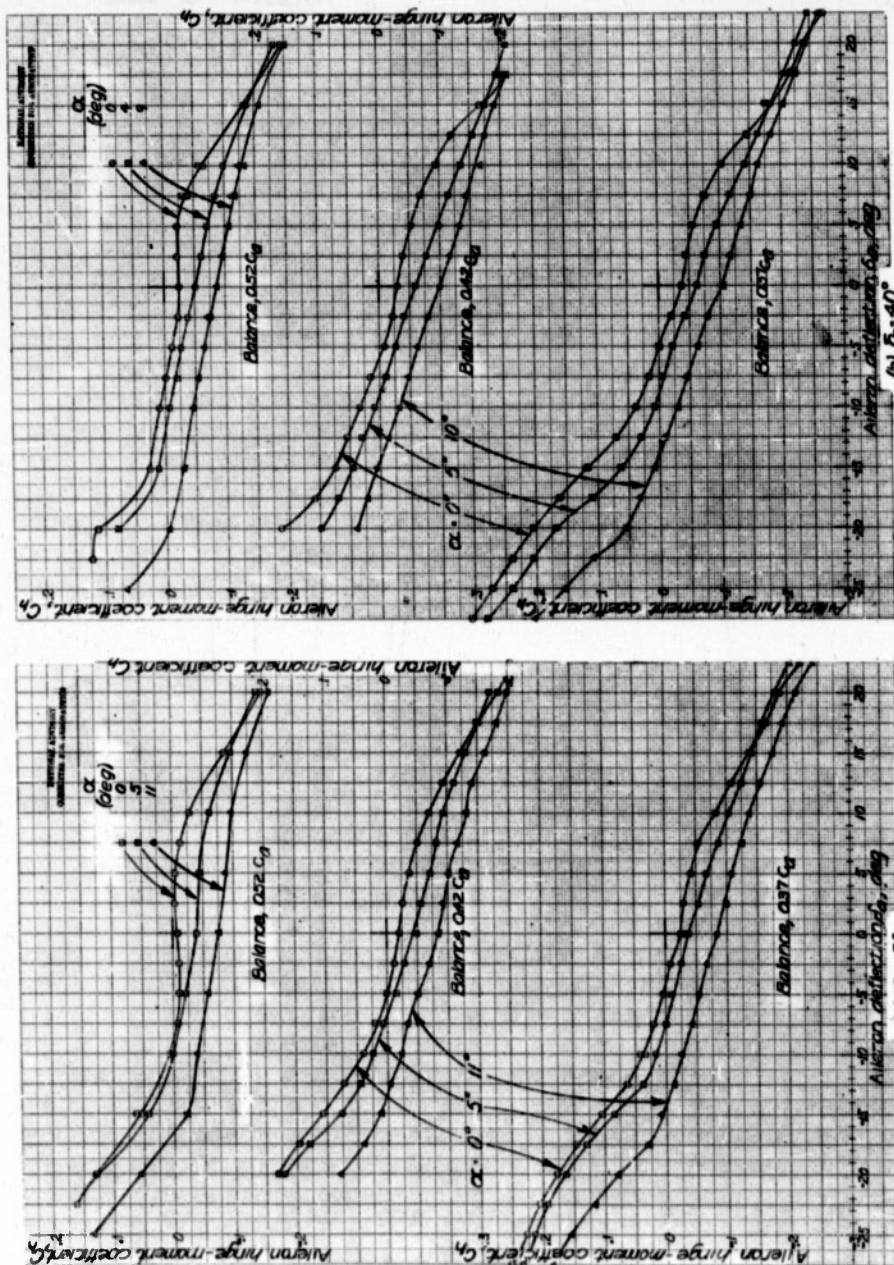


Figure C62. Hinge-moment characteristics of aileron of complete model C-XVI.

Model C-~~XVI~~^{XVII}

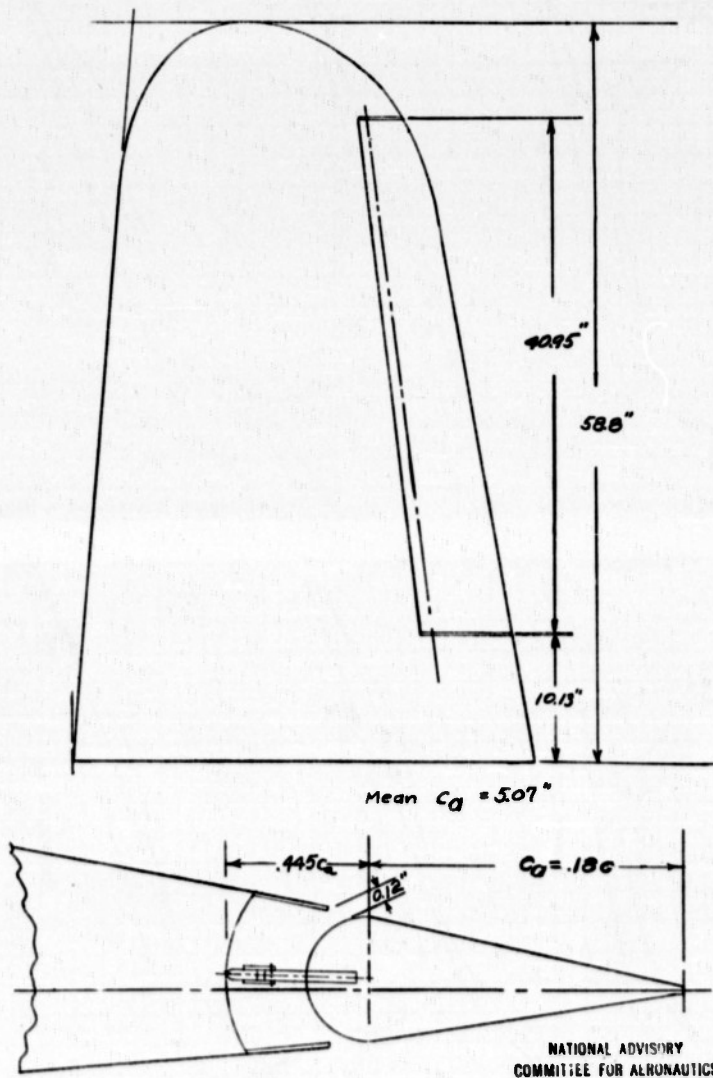


Figure C63.- Partial-span wing model CXVII tested in the N.P.L. NO. 2 wind tunnel.

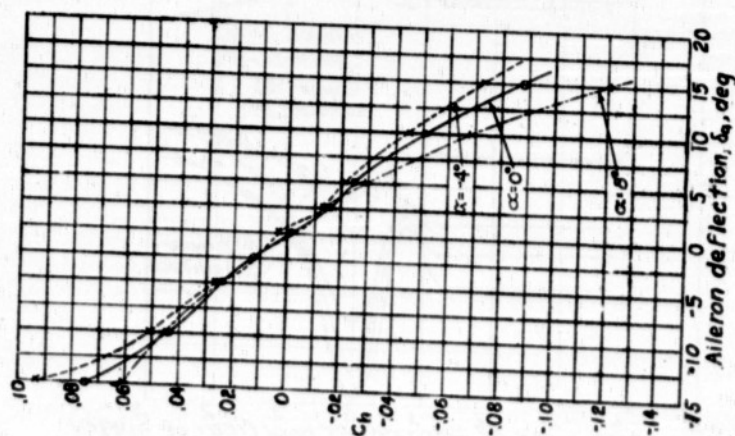


Figure C-64. Hinge-moment characteristics of unbalanced aileron. Model C-XIII; nose gap sealed.

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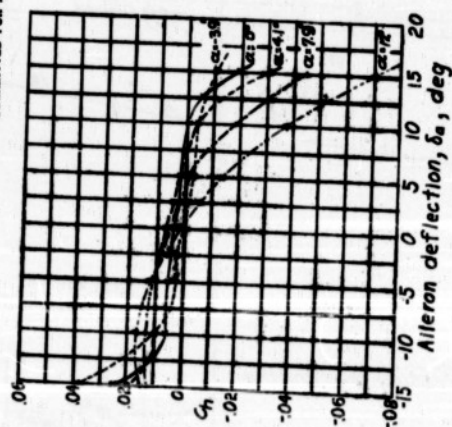
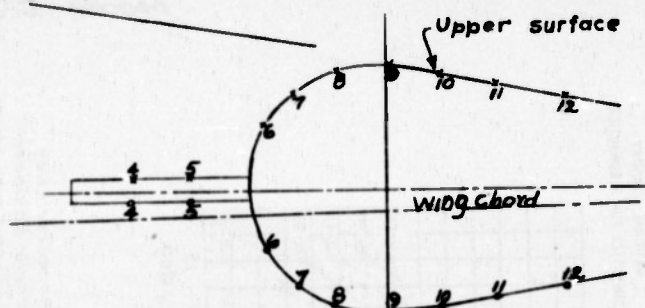


Figure C-65. Hinge-moment characteristics of internally balanced aileron. Model C-XIII; nose gap sealed.

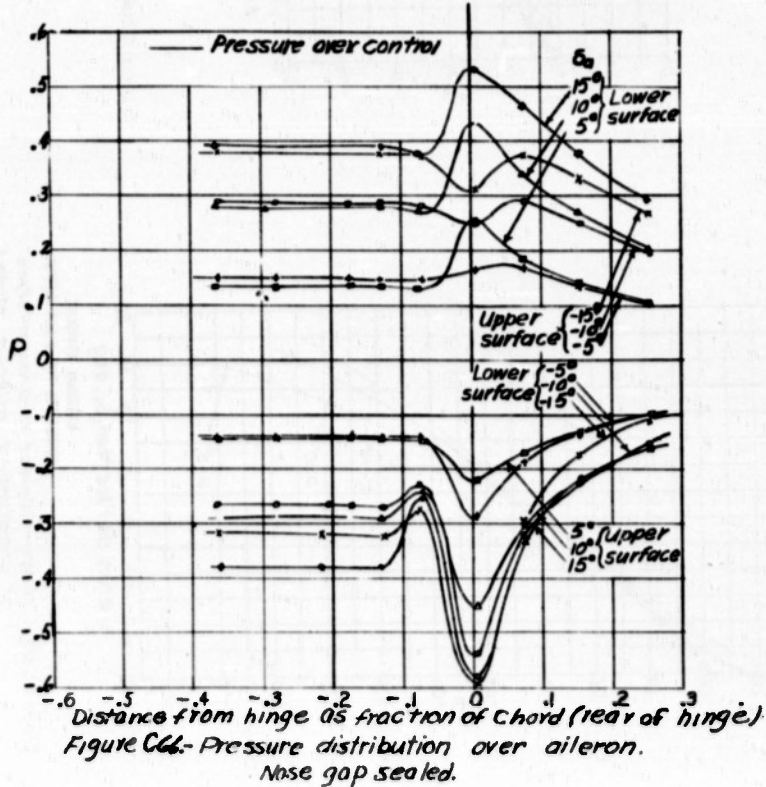
Model C-XIII

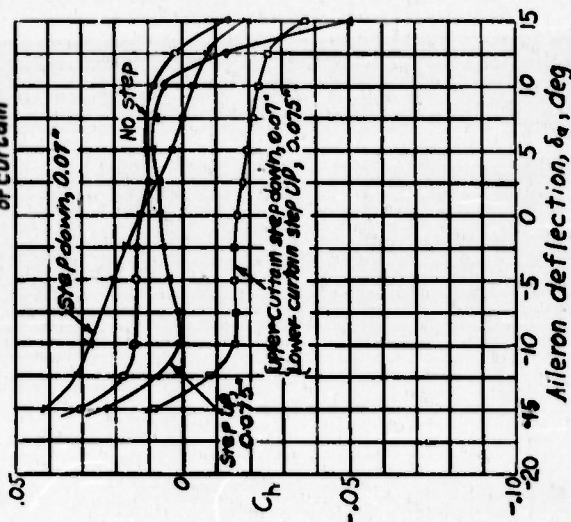
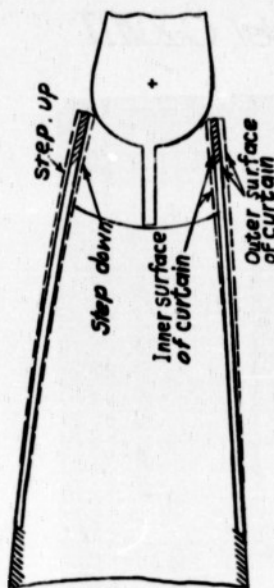
outside surface of
curtain ($\delta_0 = 0^\circ$)

Model C-XVII



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Figure C68-Variation of hinge-moment coefficient with vertical position of curtain trailing edge. $\alpha = 0^\circ$; nose gap sealed.

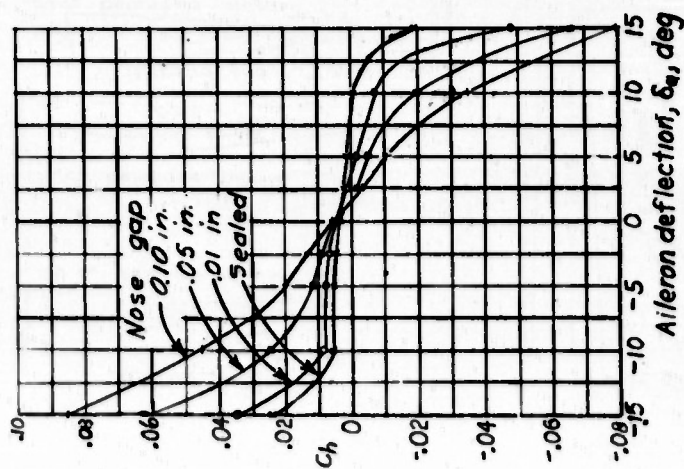
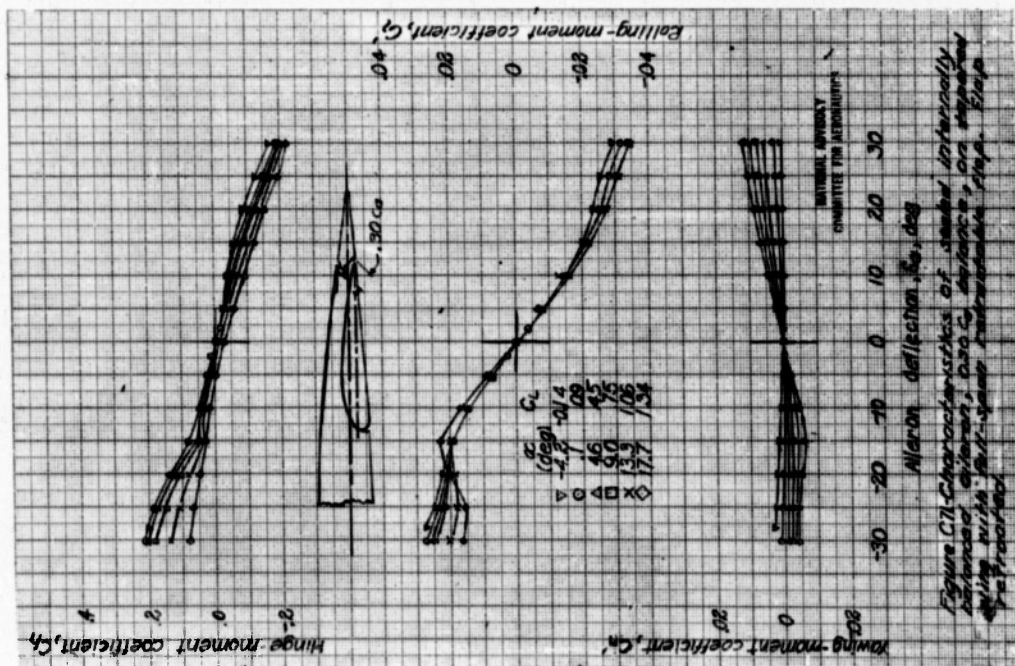
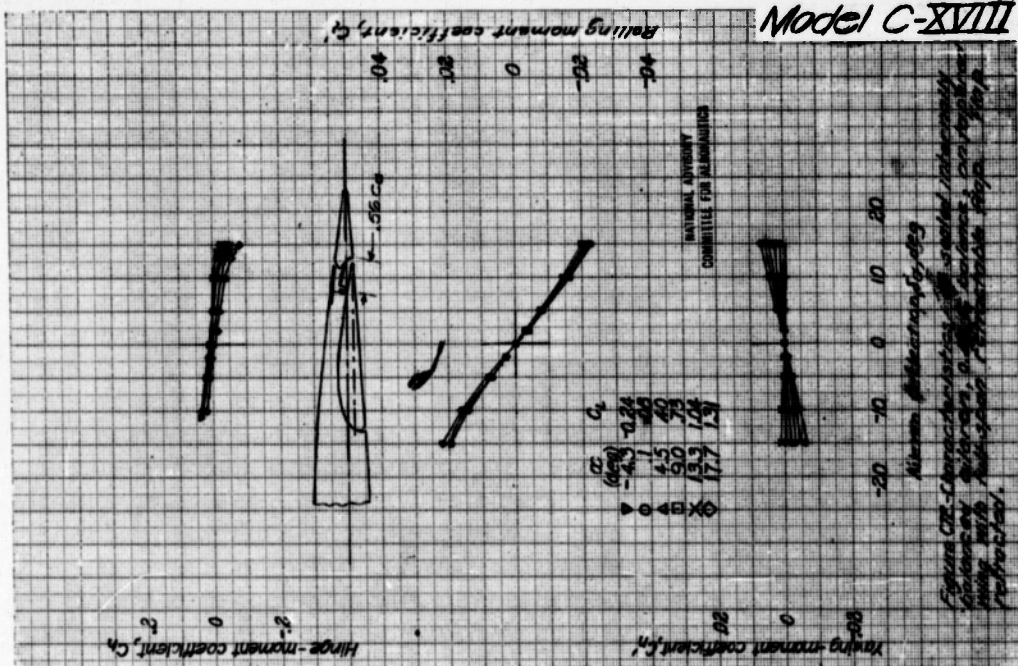
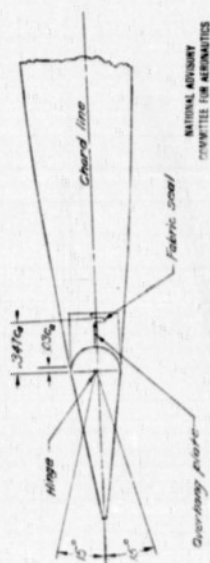
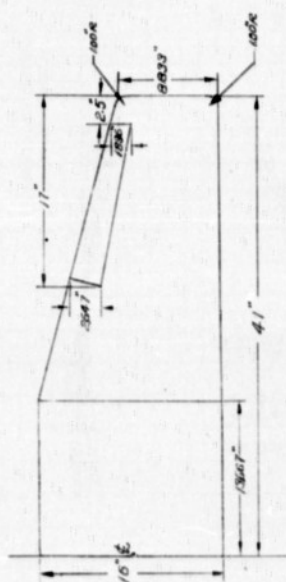
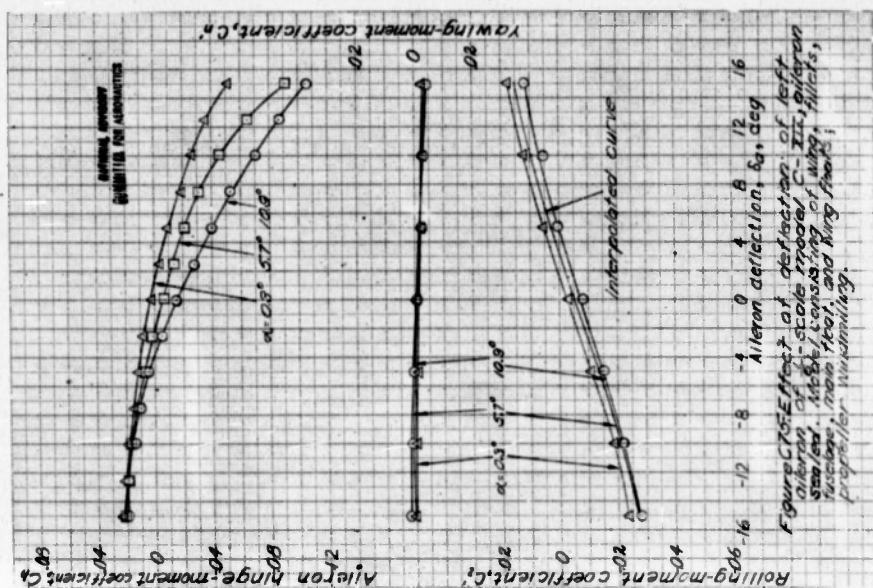
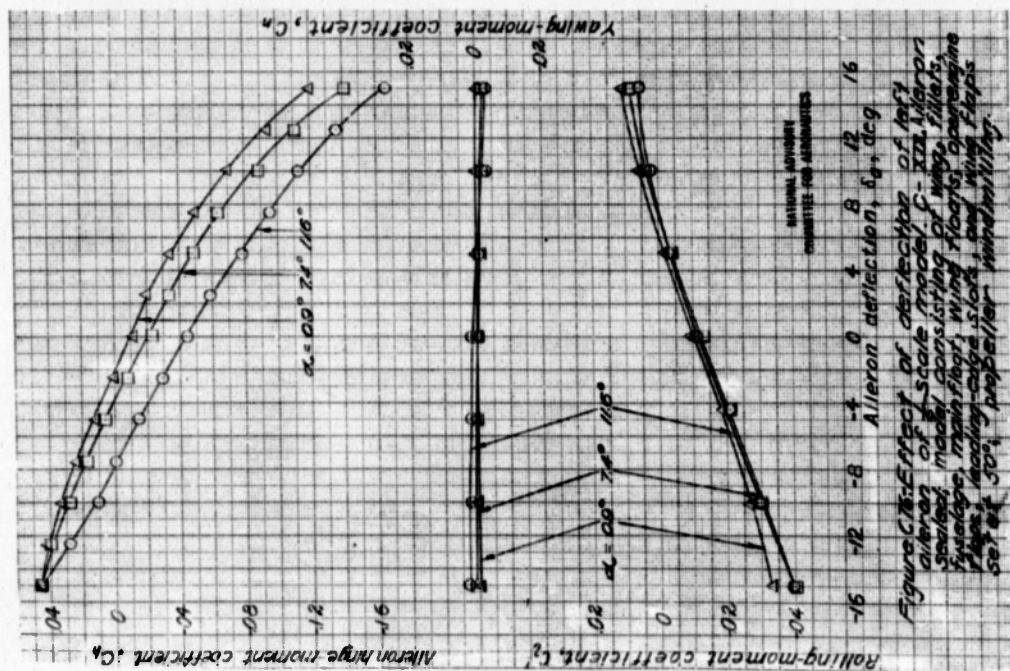
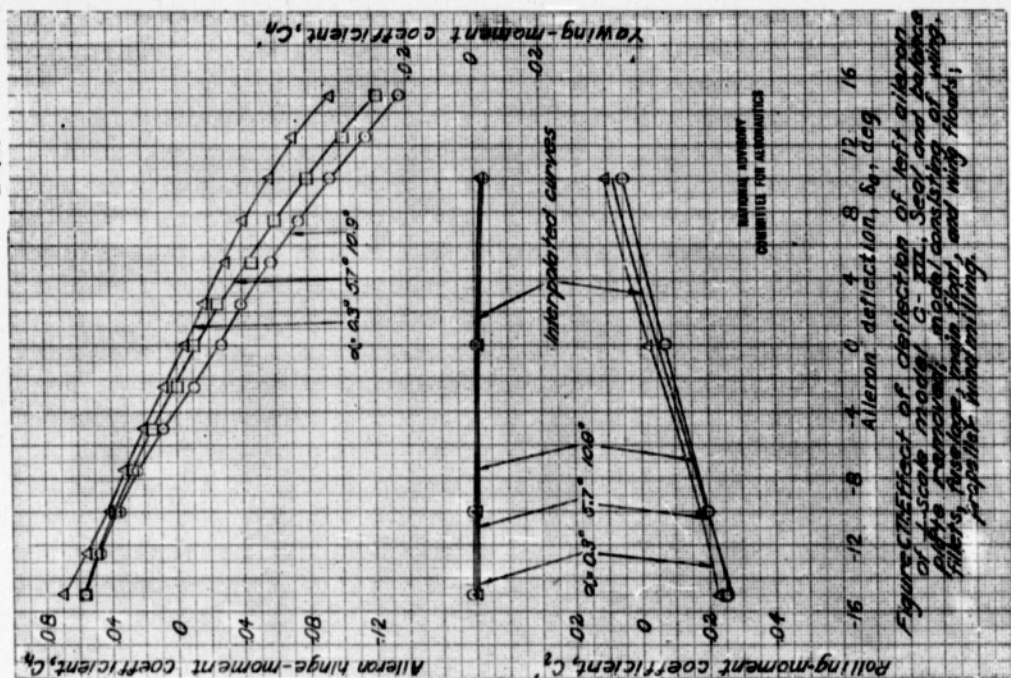


Figure C67-Effect of nose gap on aileron hinge-moment coefficient. $\alpha = 0^\circ$

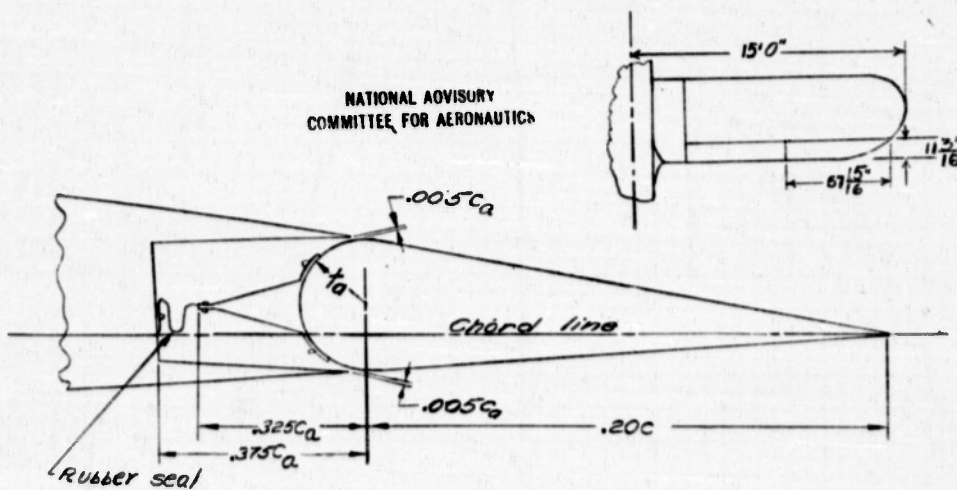
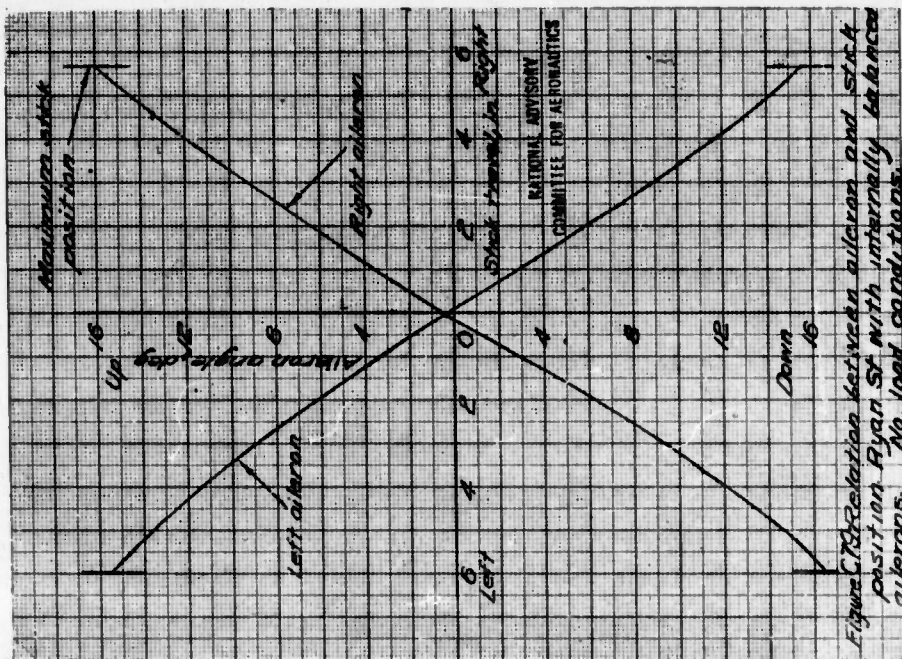
Model C-XVII







Airplane C-XX



Airplane C-XX

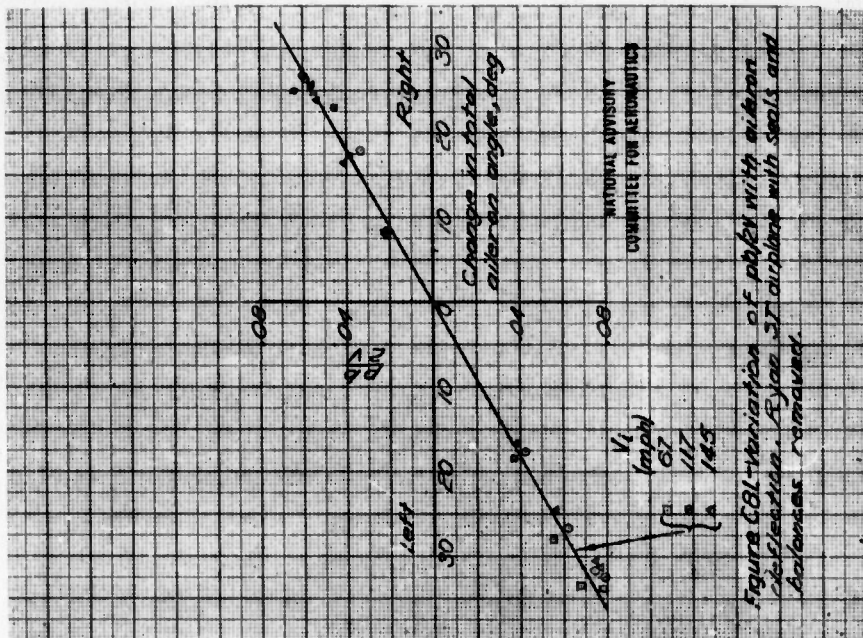


Figure C81-Variation of pitch with aileron deflection. Airplane C-XX with sealed and balanced ailerons removed.

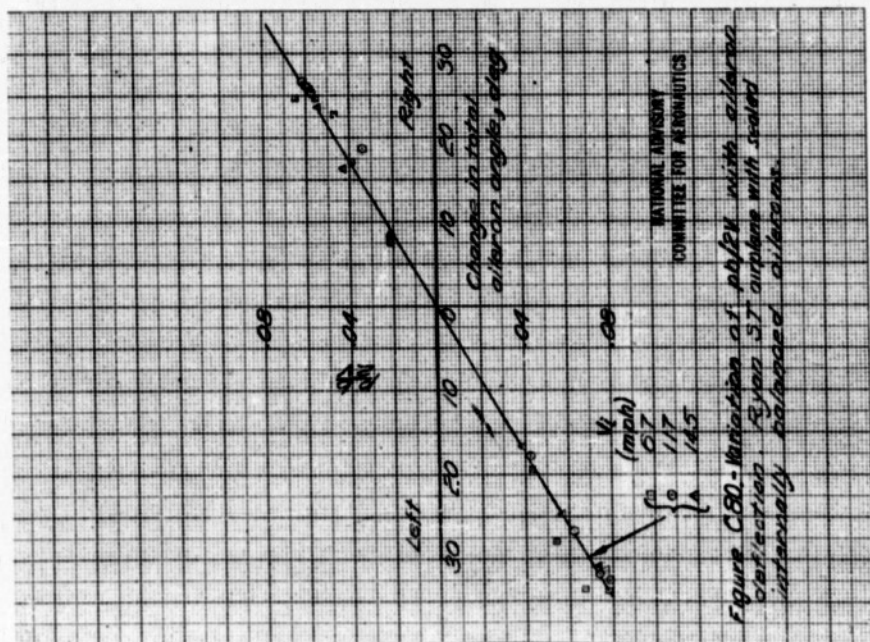
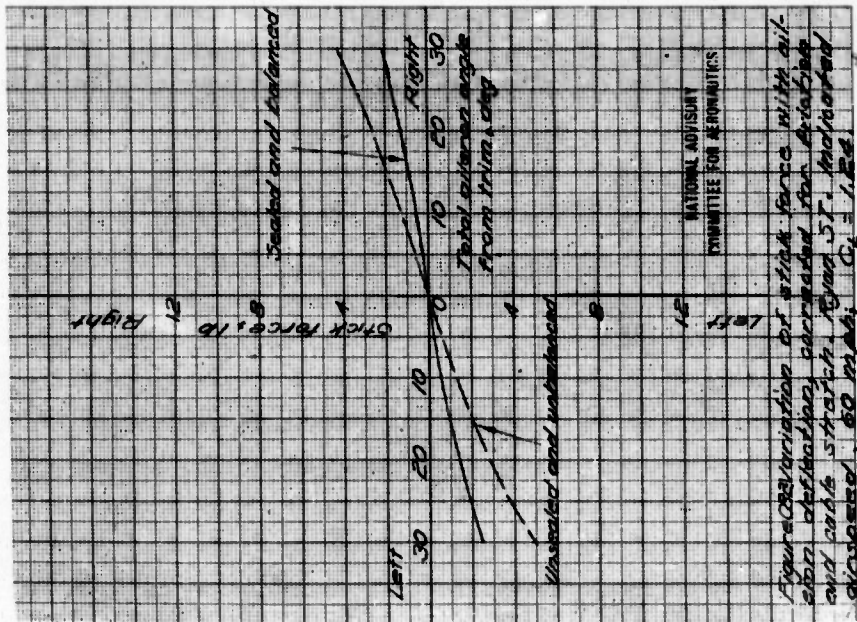
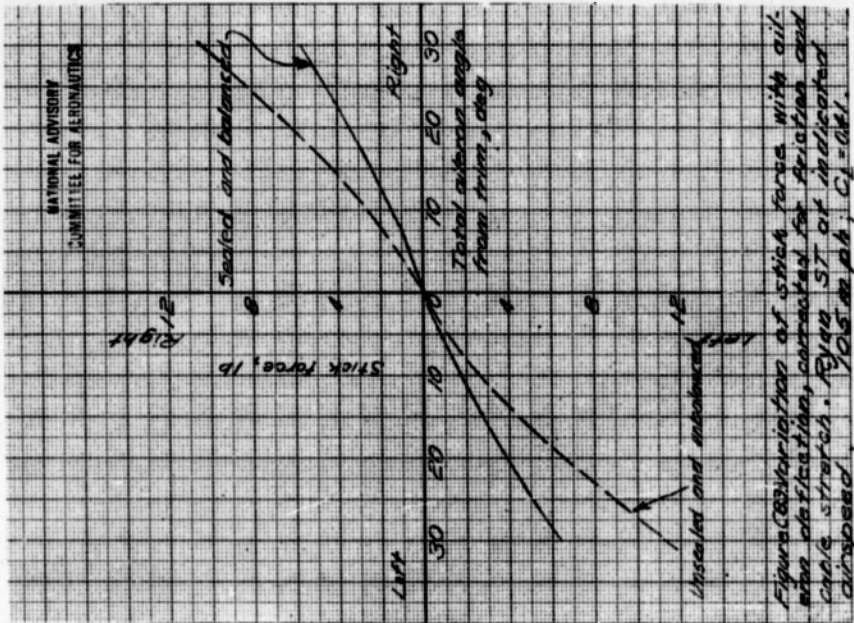


Figure C80-Variation of pitch with aileron deflection. Airplane C-XX with sealed internally balanced ailerons.

Airplane C-XX



Airplane C-XX

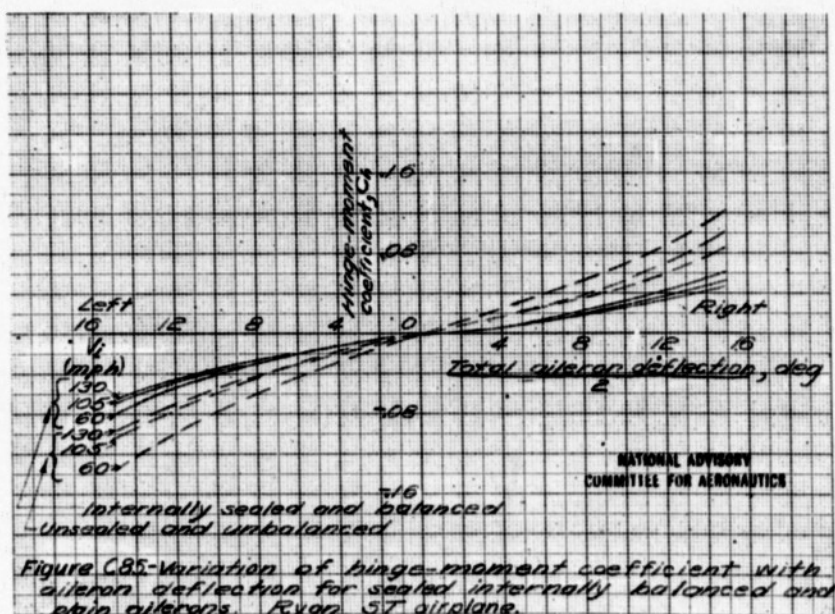
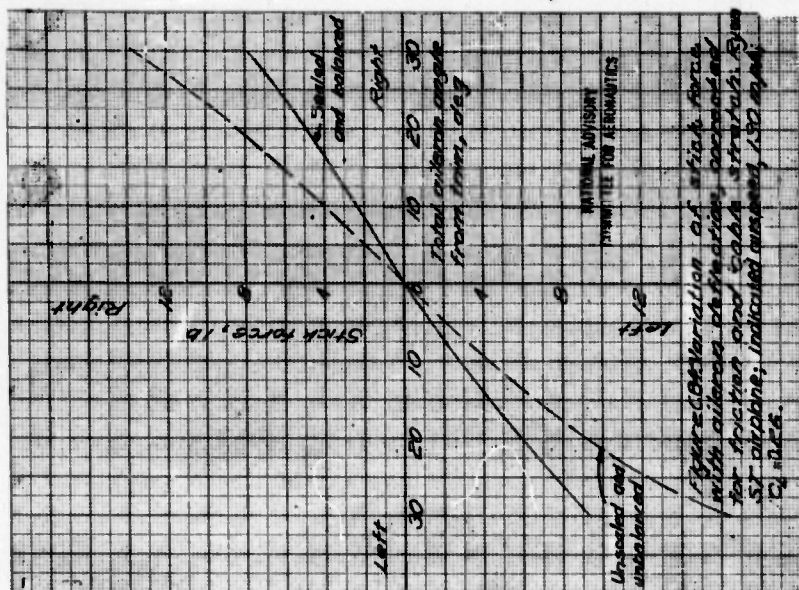


Figure C.85-Variation of hinge-moment coefficient with aileron deflection for sealed internally balanced and plain ailerons. Ryan 57 airplane.

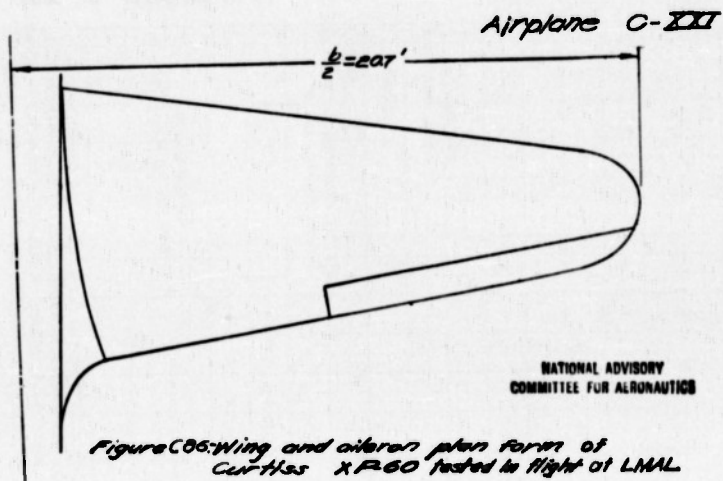
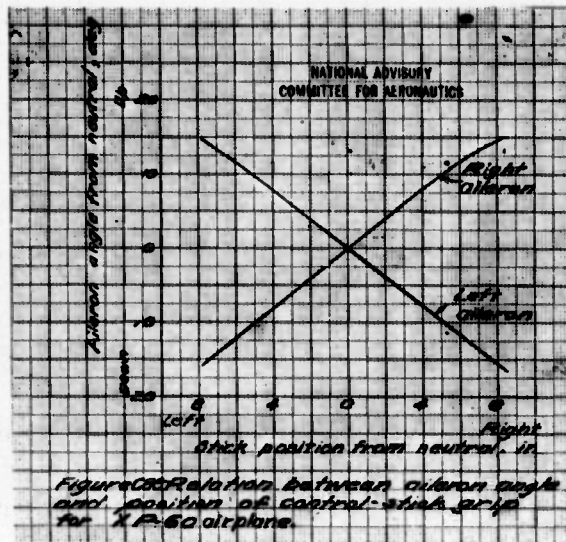


Figure C87: Schematic view of the internally balanced
and sealed aileron on low-drag wing of Curtiss XP-60.



Airplane C-XXI

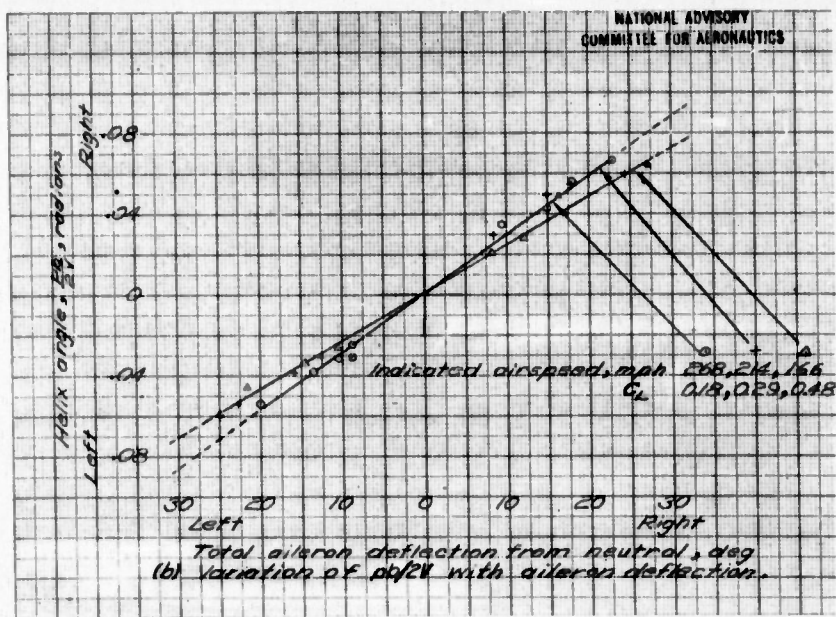
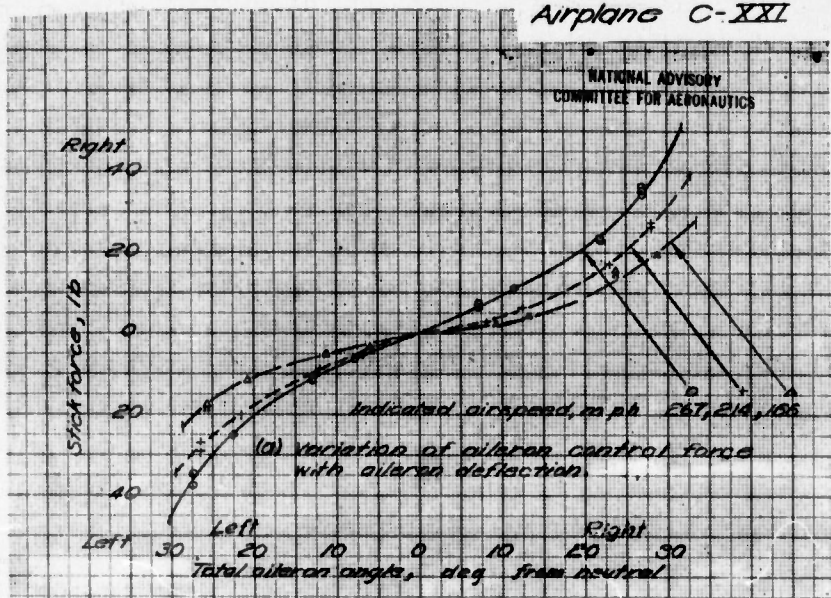
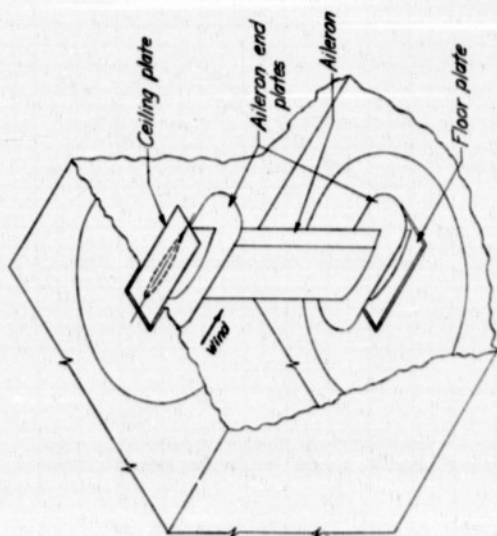


Figure (C89).—Aileron control characteristics of Curtiss XP-60 airplane.



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Figure D1. - Two-dimensional model installation of an NACA 66(215)-216, $\alpha=0.6$ airfoil with a 0.15c and a 0.20c aileron. AAL 7 by 10-foot tunnel.

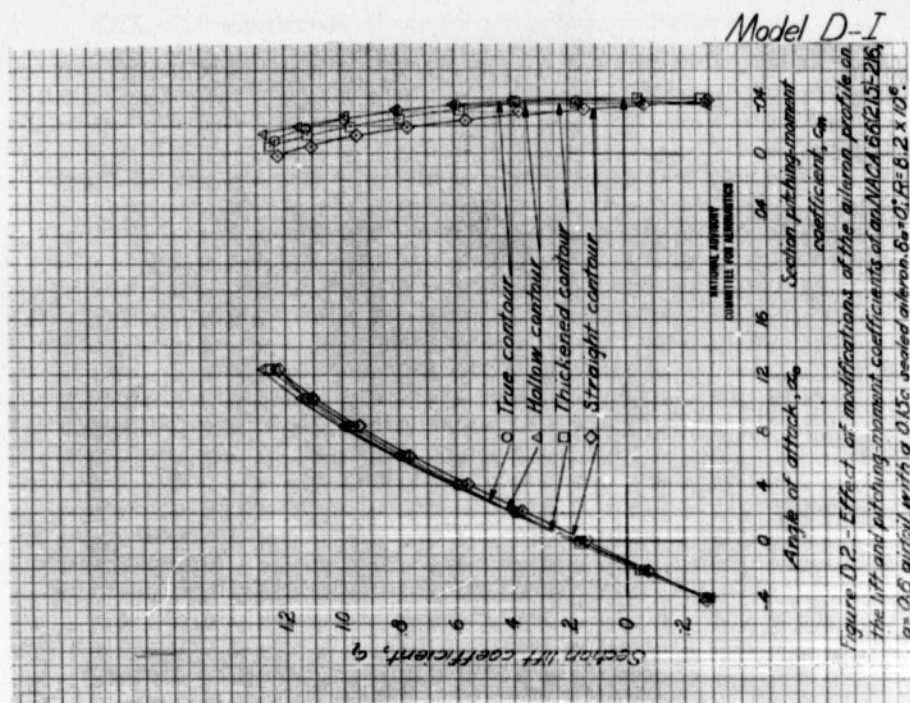


Figure D2. - Effect of modifications of the aileron profile on the lift and pitching moment coefficients of an NACA 66(215)-216, $\alpha=0.6$ airfoil with a 0.15c sealed aileron. $S_a=0.7$; $R=8.2 \times 10^6$.

Model D-I

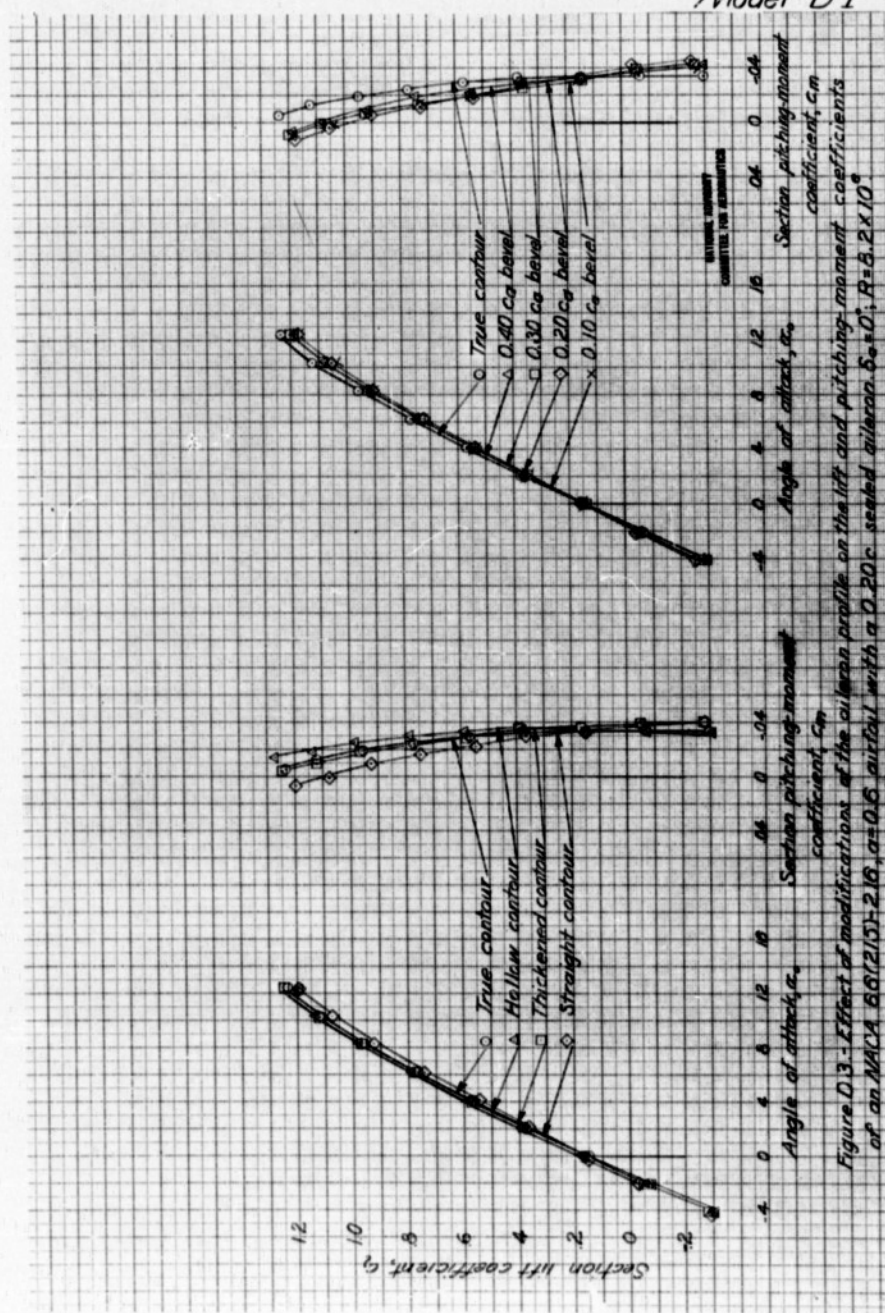


Figure D.3 - Effect of modifications of the airfoil profile on the lift and pitching-moment coefficients of an NACA 66(215)-218, $\alpha = 0.6$ airfoil with a 0.20c sealed aileron $\delta = 0$; $R = 3.2 \times 10^6$

Model D-I

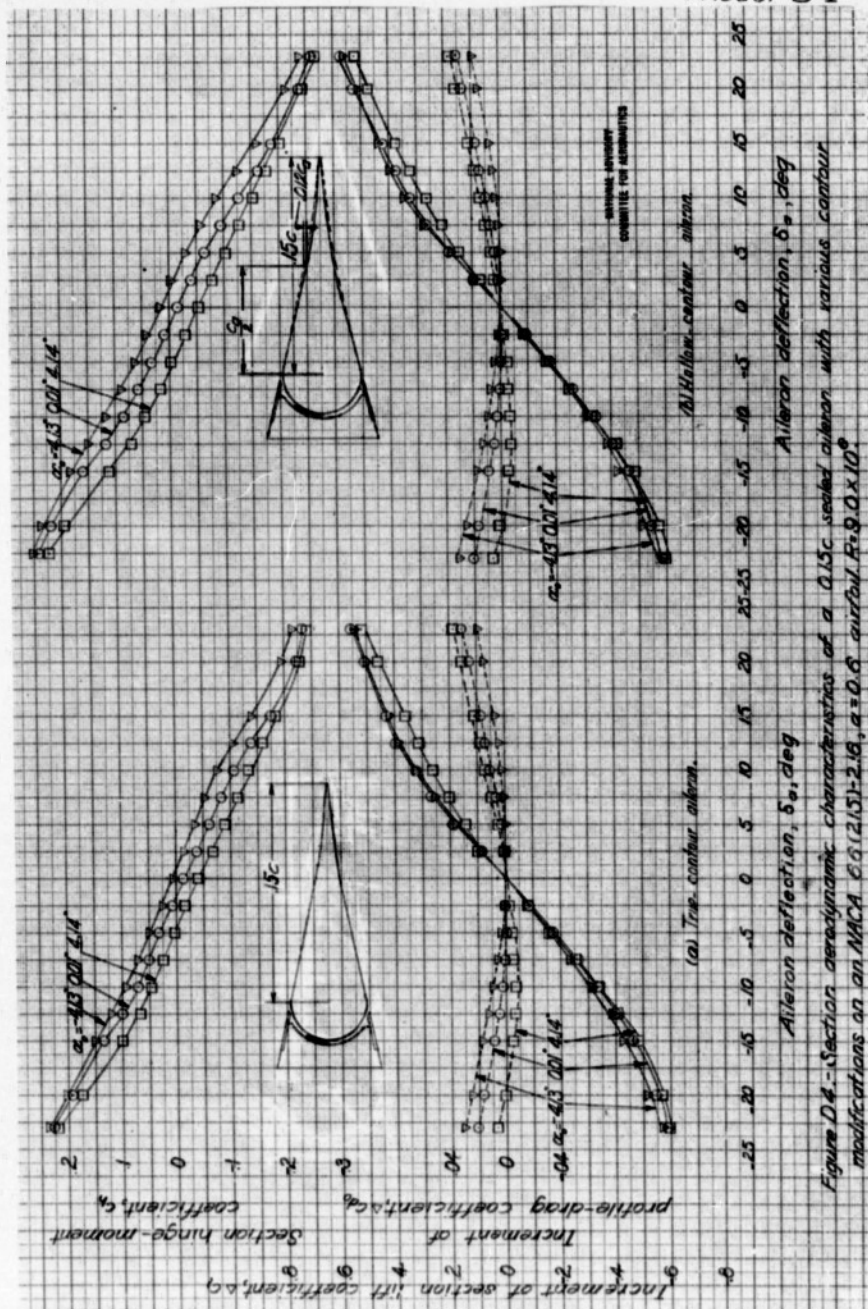


Figure D-4 - Section aerodynamic characteristics of a 0.15c sectioned aileron with various camber modifications on an NACA 0012.15-2.18, $\alpha = 0.8$ radian $F = 9.0 \times 10^6$

Model D-I

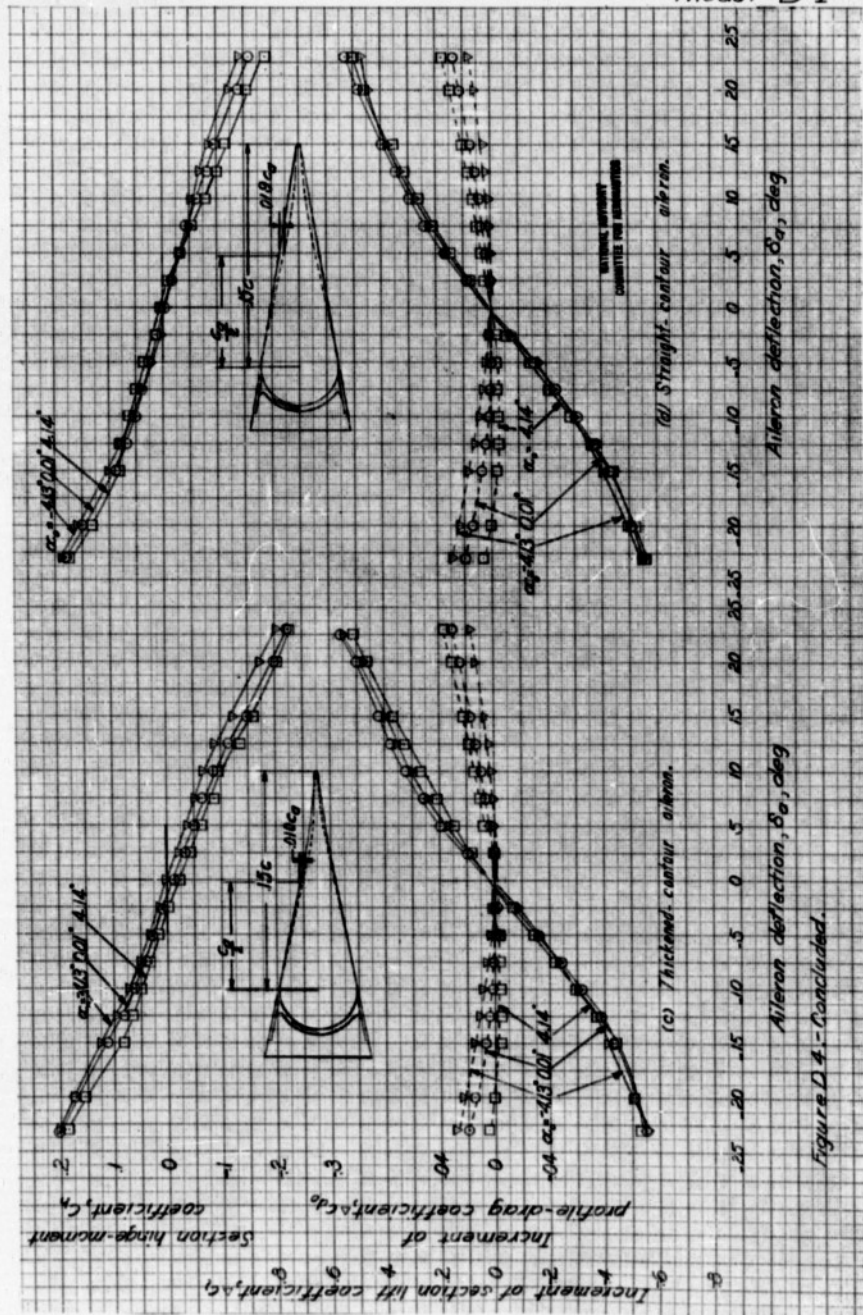
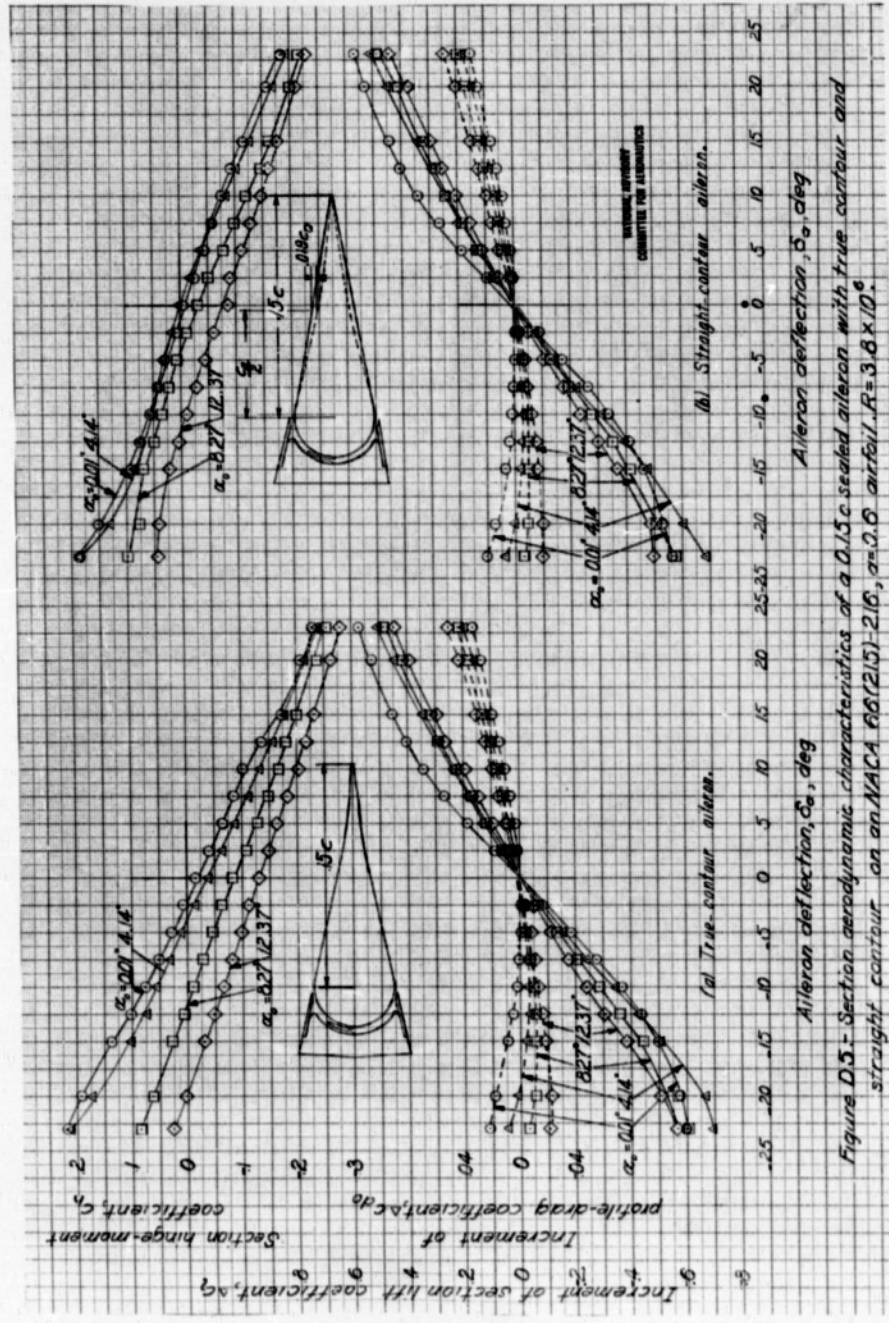
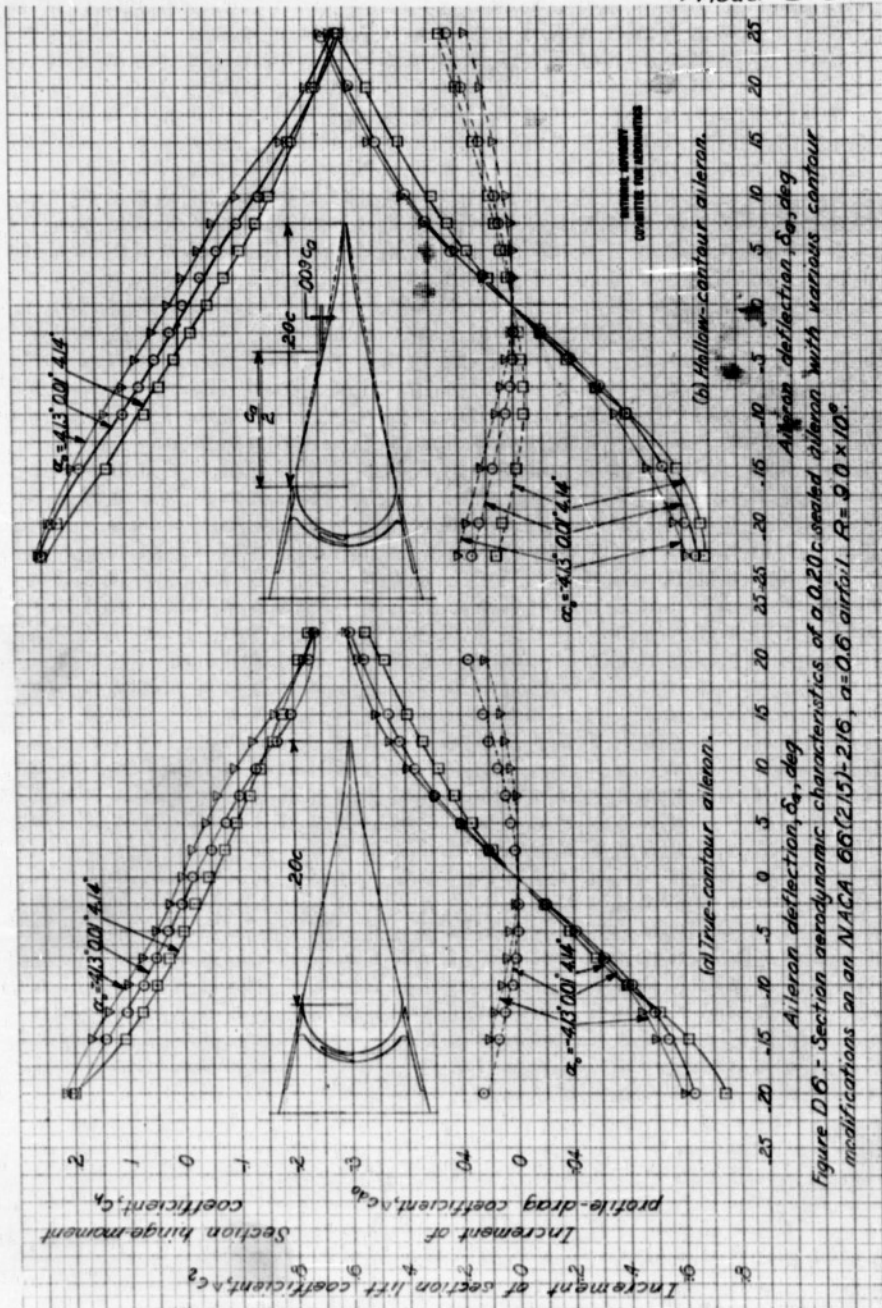


Figure D 4.-Concluded.





Model D-I

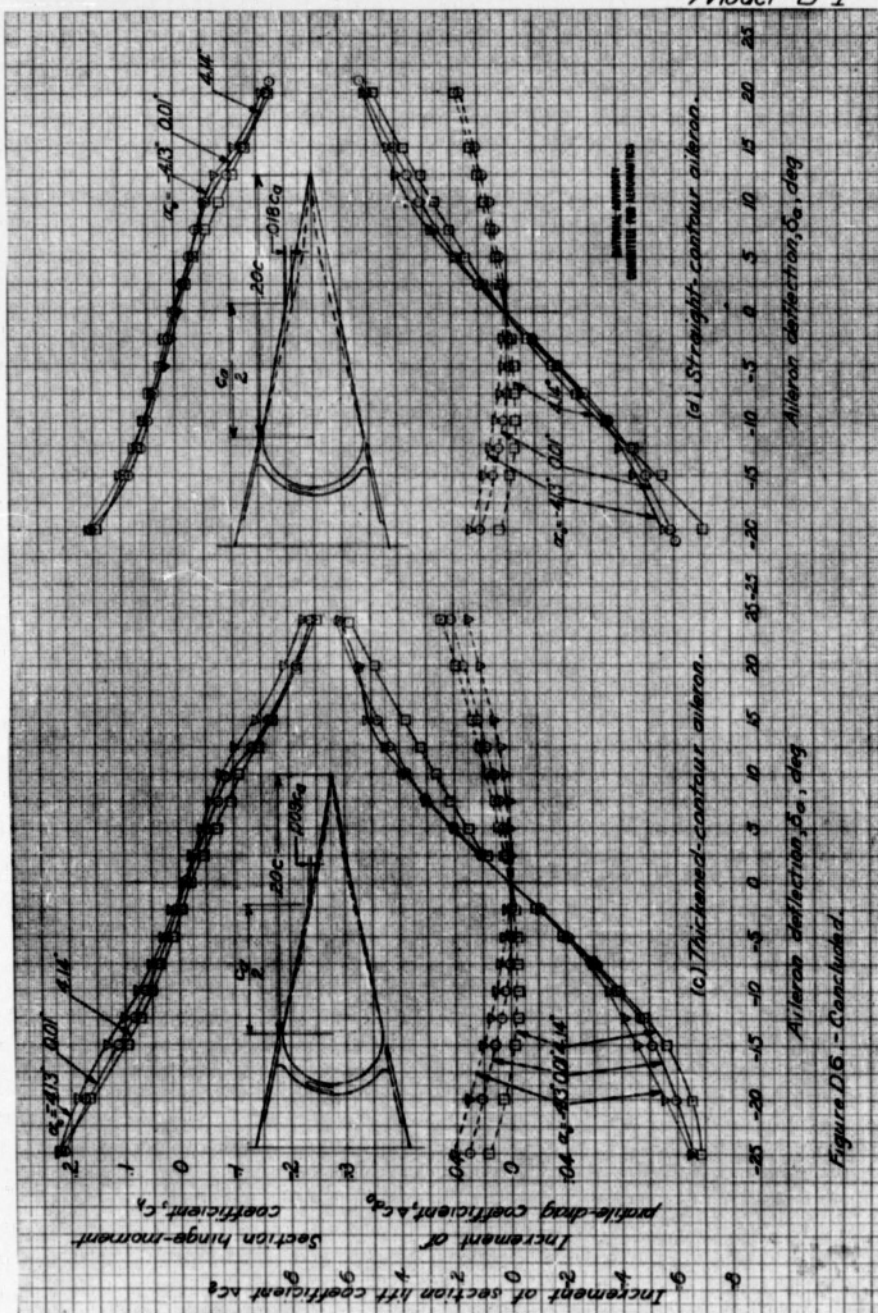


Figure D.15. - Concluded.

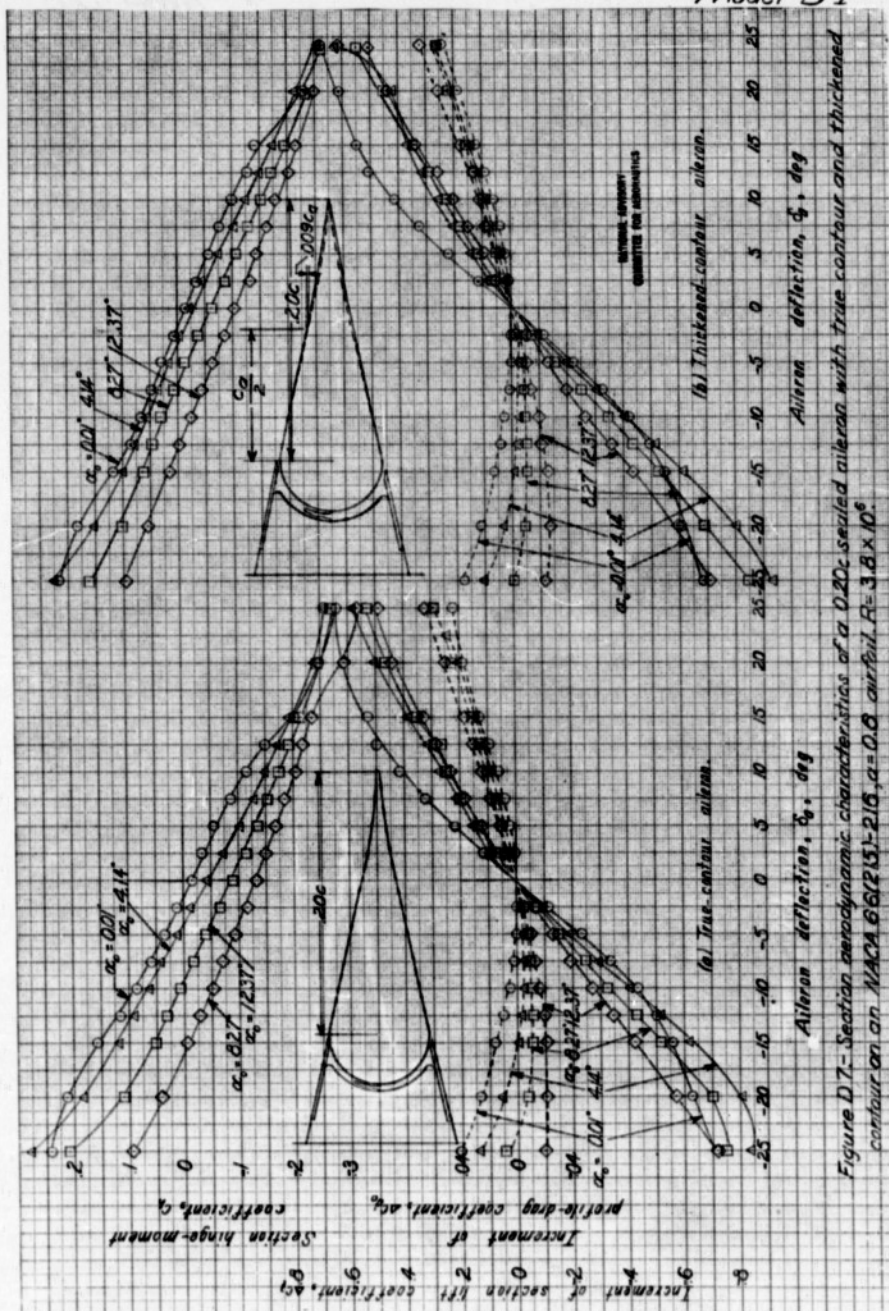


Figure D7- Section aerodynamic characteristics of a 0.20c sealed aileron with true contour and thickened contour on an NACA 66(215)-216, $\alpha = 0.0$ airfoil $R = 3.8 \times 10^6$.

Model D-I

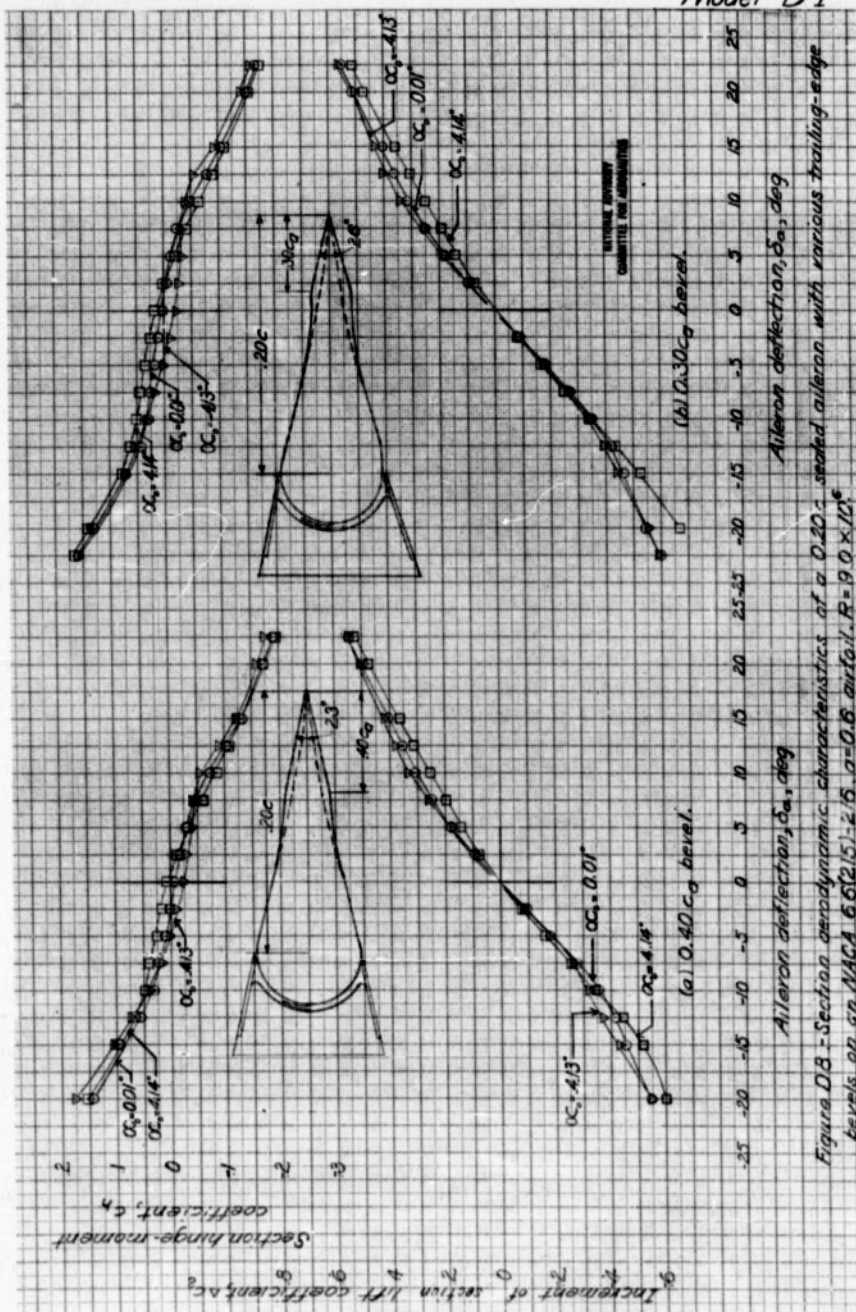
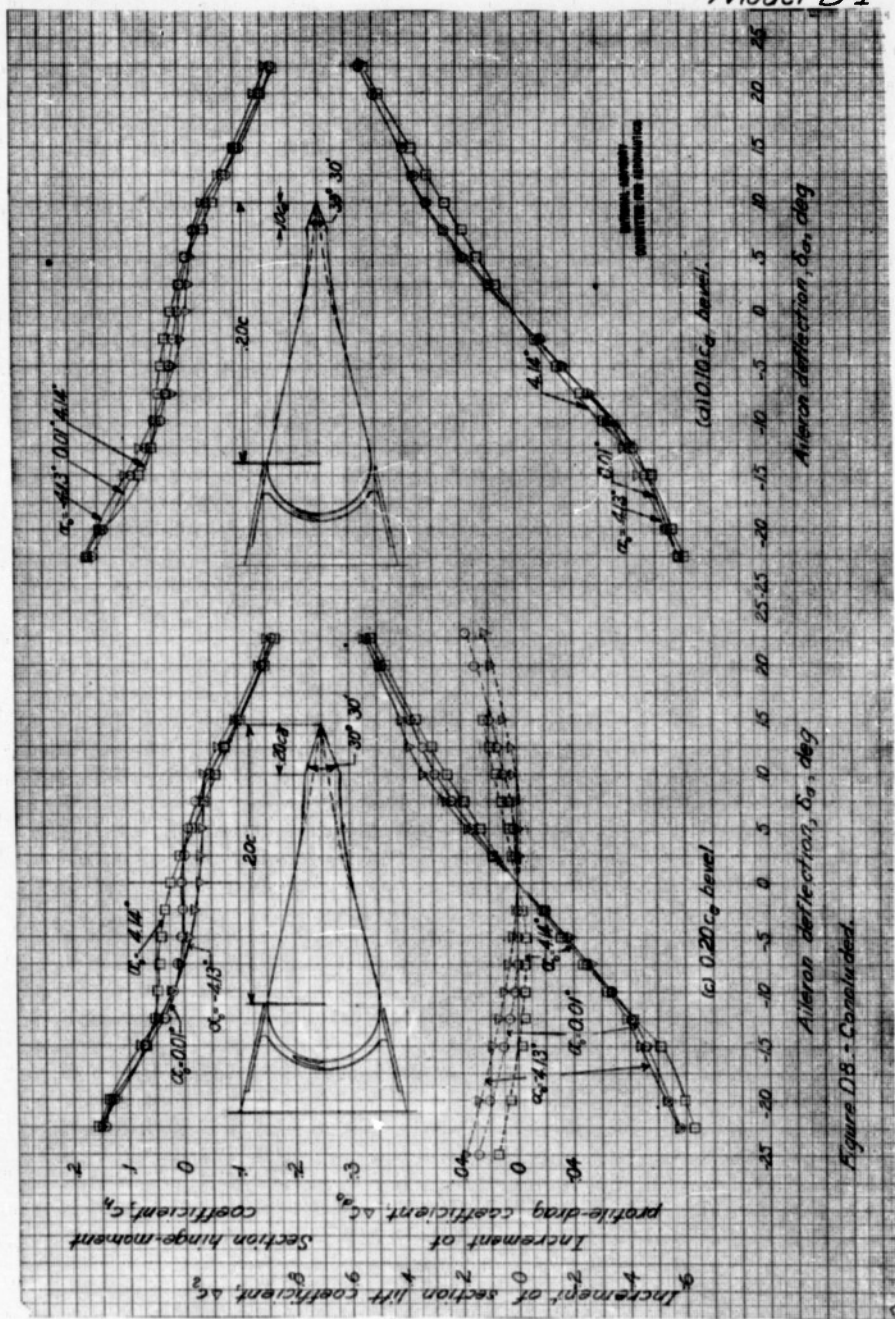
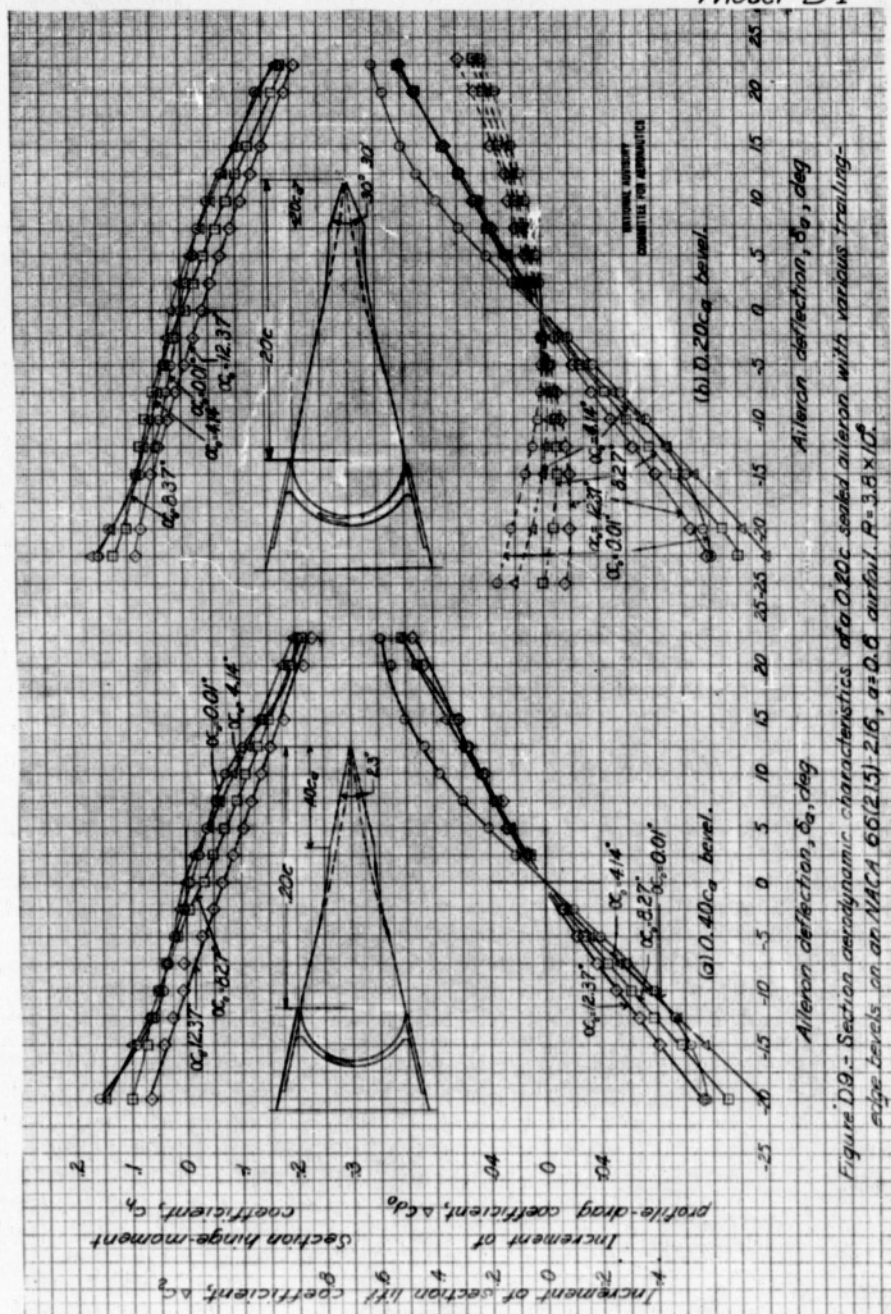


Figure DB - Section aerodynamic characteristics of a 0.20-c sealed aileron with various trailing-edge bevels on an NACA 66(215)-215, $p=0.8$ airfoil. $R=9.0 \times 10^6$

Model D-I



Model D-I



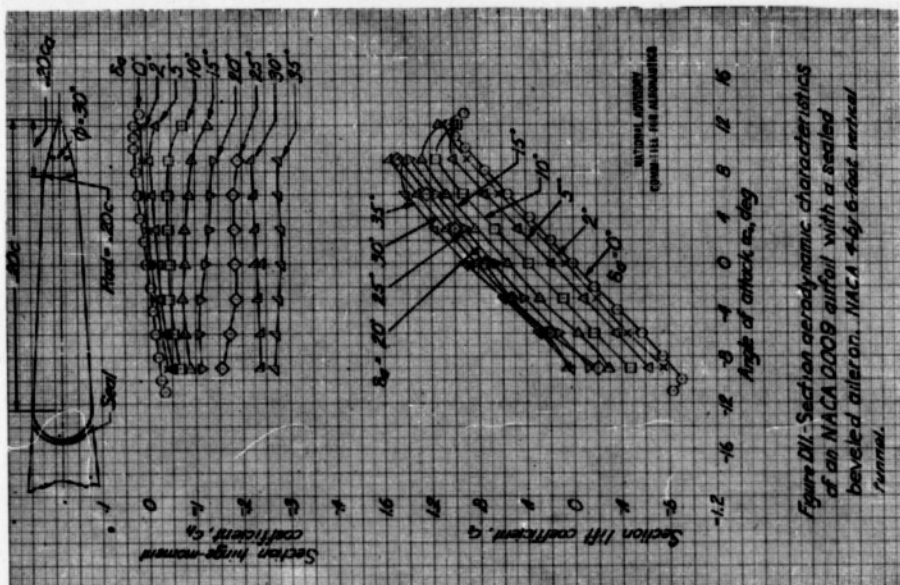


Figure DII-Section aerodynamic characteristics of an NACA 0009 airfoil with a sealed beveled aileron. NACA 4-by 6-foot vertical tunnel.

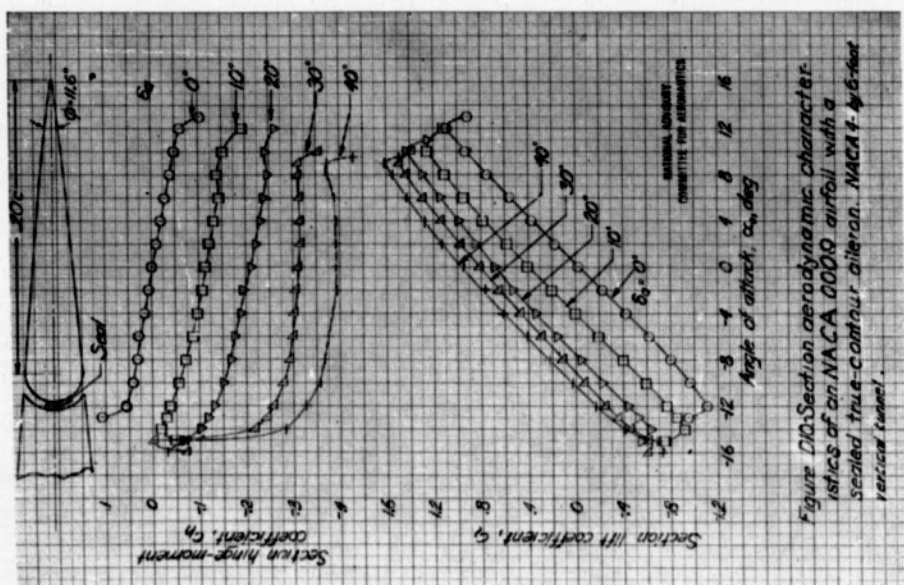


Figure DIO-Section aerodynamic characteristics of an NACA 0009 airfoil with a sealed true-contour aileron. NACA 4-by 6-foot vertical tunnel.

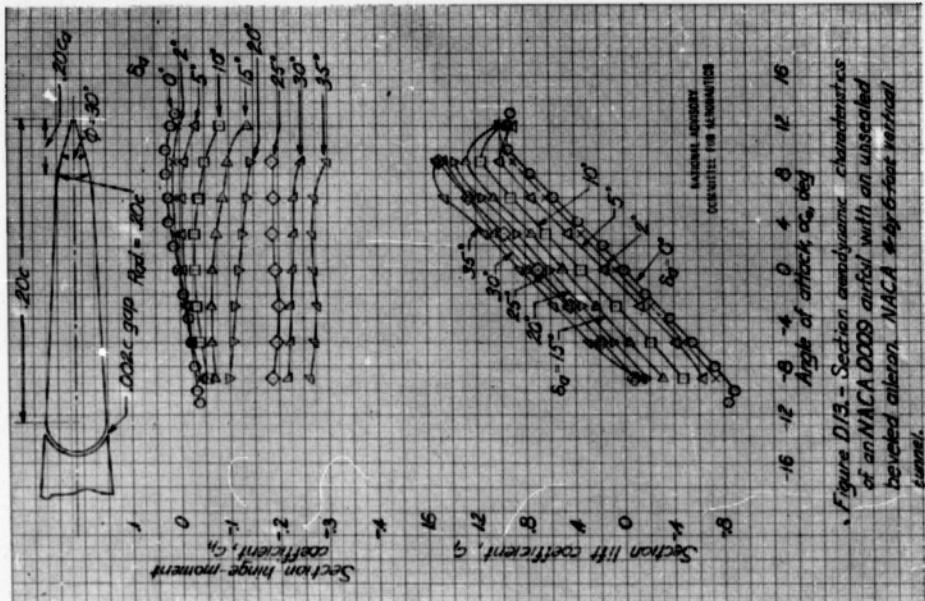


Figure D12 - Section aerodynamic characteristics of an NACA 0009 airfoil with an unsealed true-contour slot on NACA 4416-6-foot method tunnel.

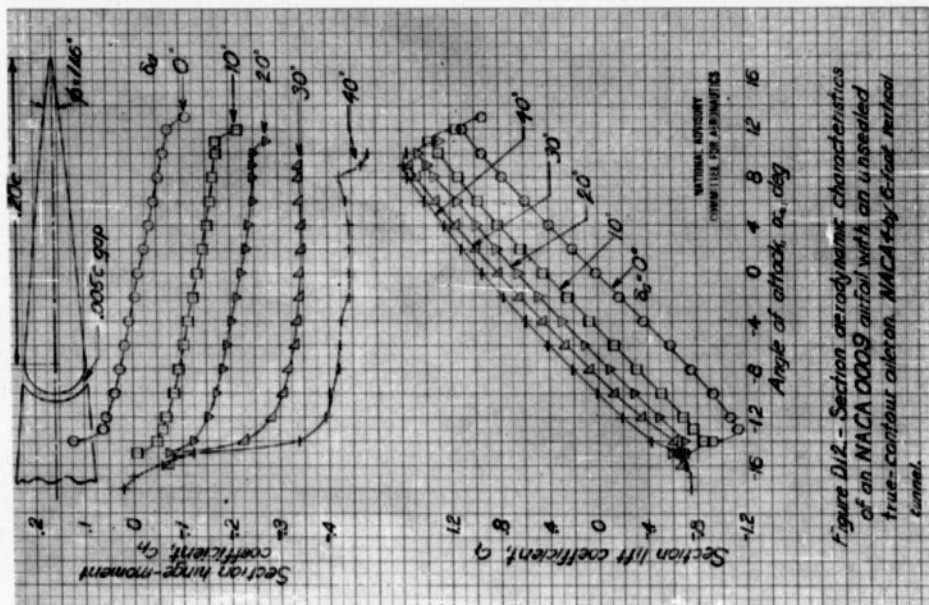
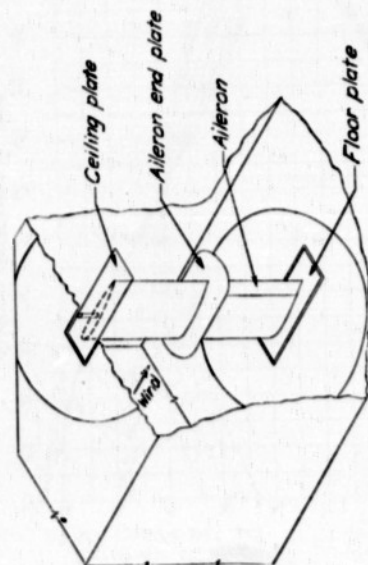


Figure D13 - Section aerodynamic characteristics of an NACA 0008 airfoil with an unsealed beveled alteration NACA 4416-6-foot method tunnel.

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Figure D.M. - Two-dimensional model installation
and airfoil section with 0.20c aileron.
AAL 7-by 10-foot tunnel.

Model

D-III

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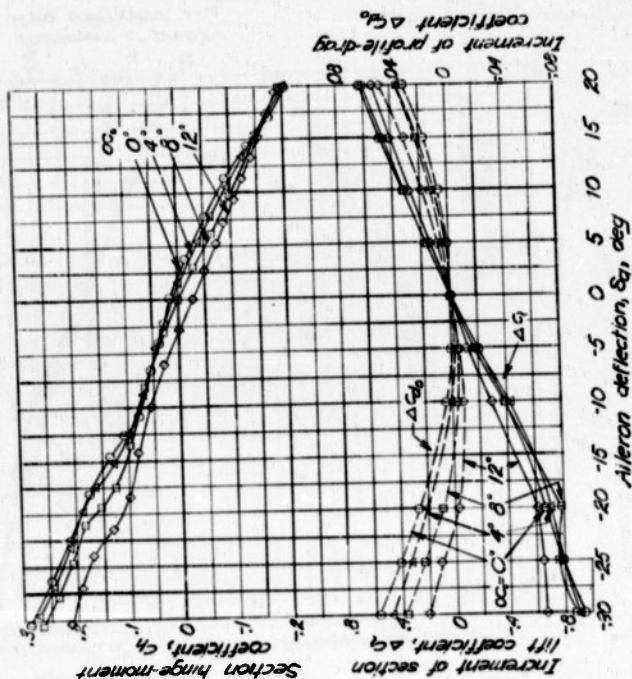


Figure D.15.-Section aerodynamic characteristics of
an unsealed true-contour aileron.

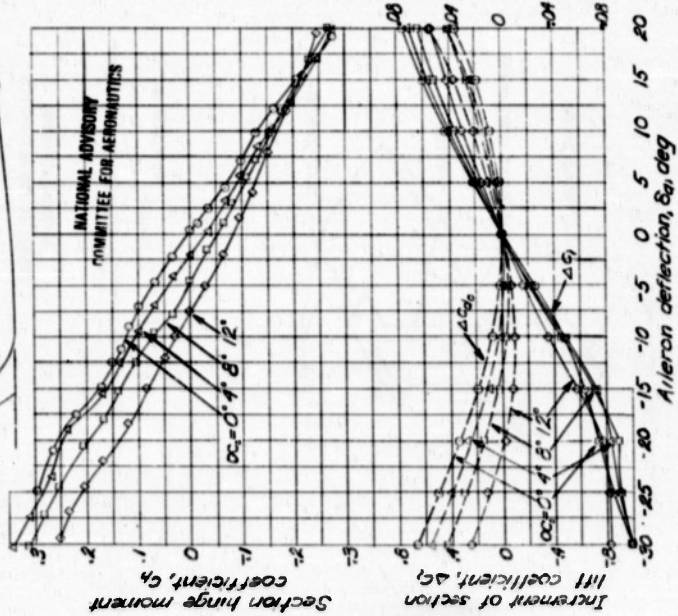


Figure D 16-Section aerodynamic characteristics of an unsealed true-contour aileron with beaded trailing edge

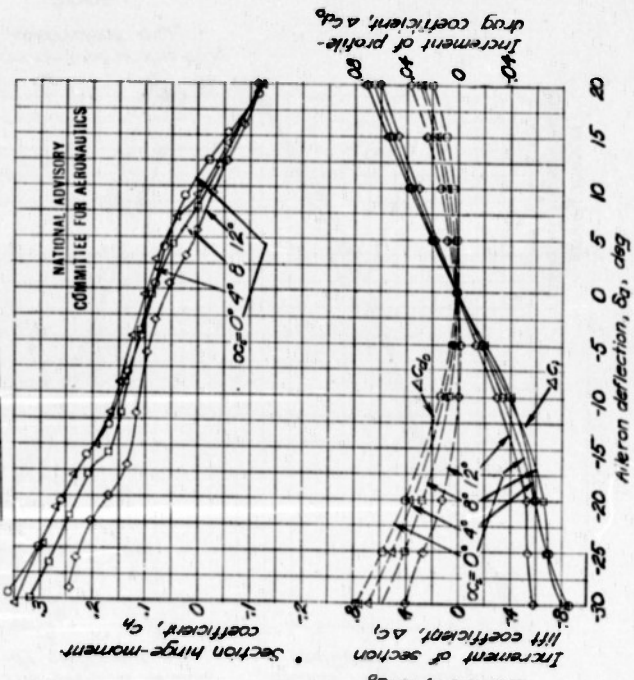
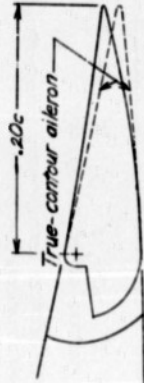


Figure D 17-Section aerodynamic characteristics of an unsealed aileron with reflexed trailing edge.

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Model D-IV

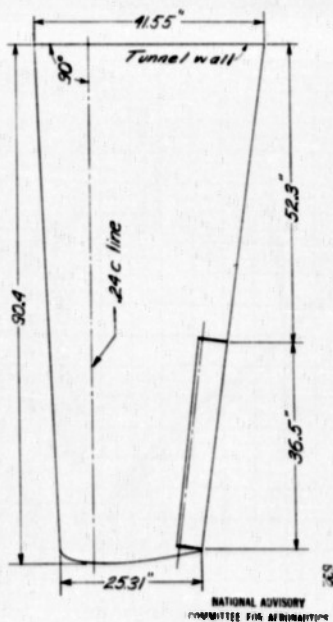
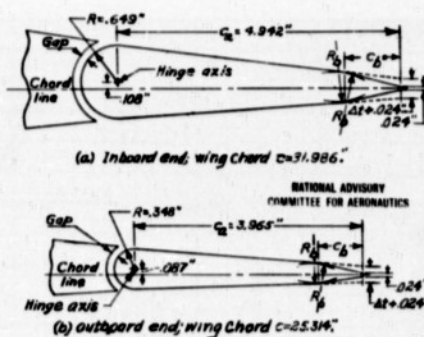


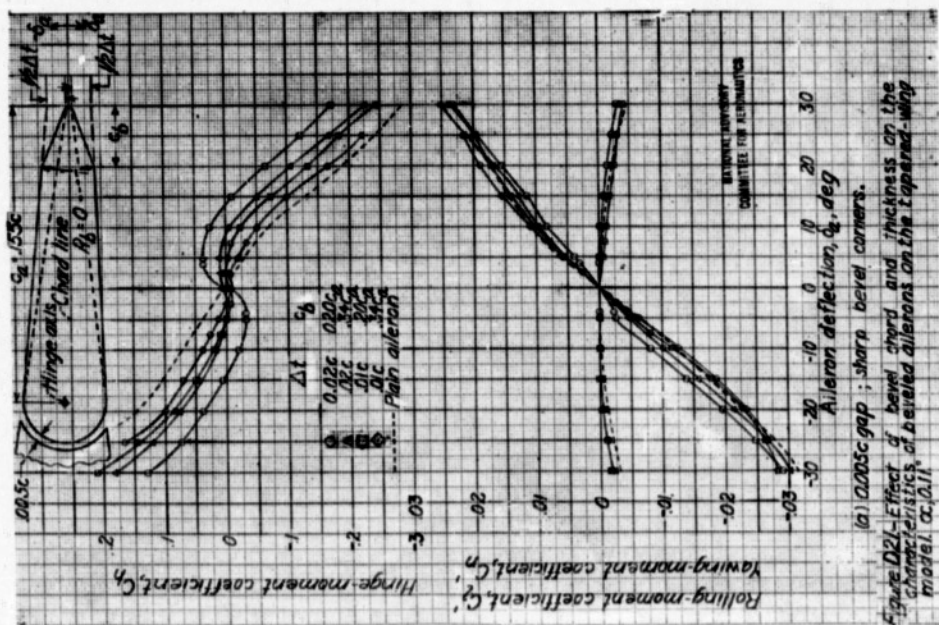
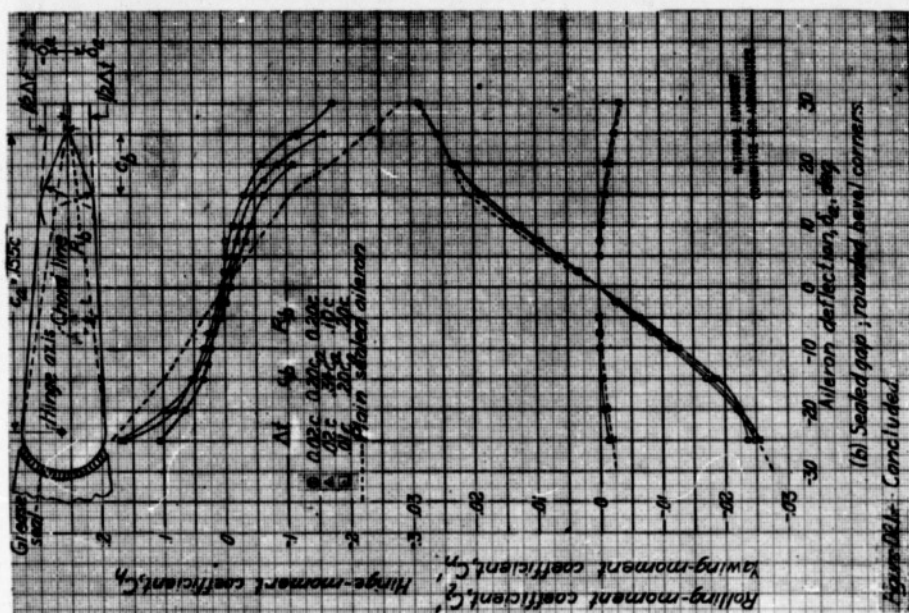
Figure D18.- Semispan model of tapered wing. LMAL 7-by-10-foot tunnel.



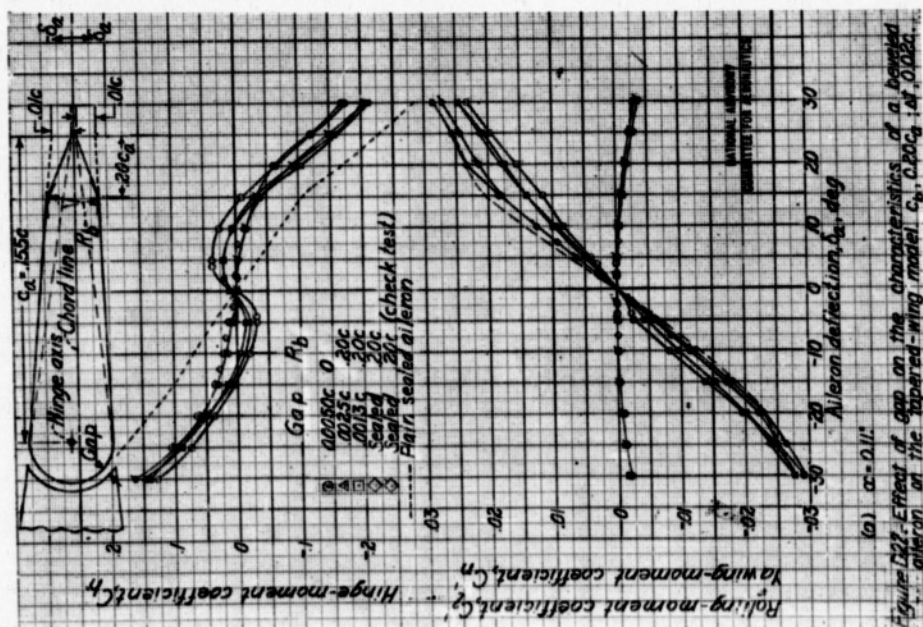
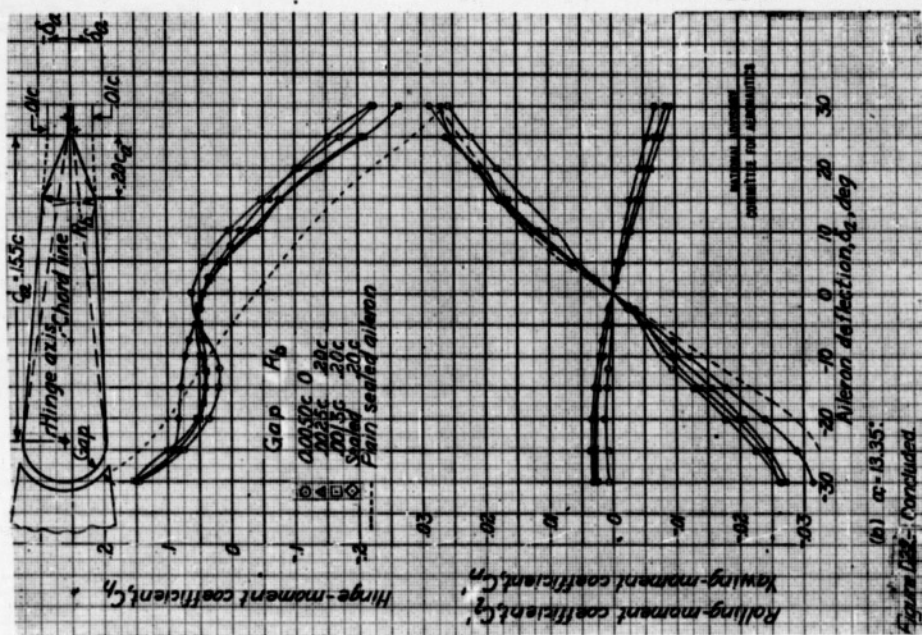
Trailing edge angle, deg	C_d percent	C_l percent	Δl percent
4.0	20	20	2.0
2.7	32.6	33.5	2.0
2.7	20	20	1.0
1.0	32.6	33.5	1.0

Gap and H_2 were varied during tests and are noted on figures that show test results.

Figure D19.- The 0.155 by 0.405% beveled ailerons tested on the tapered-wing model.



Model D-IV



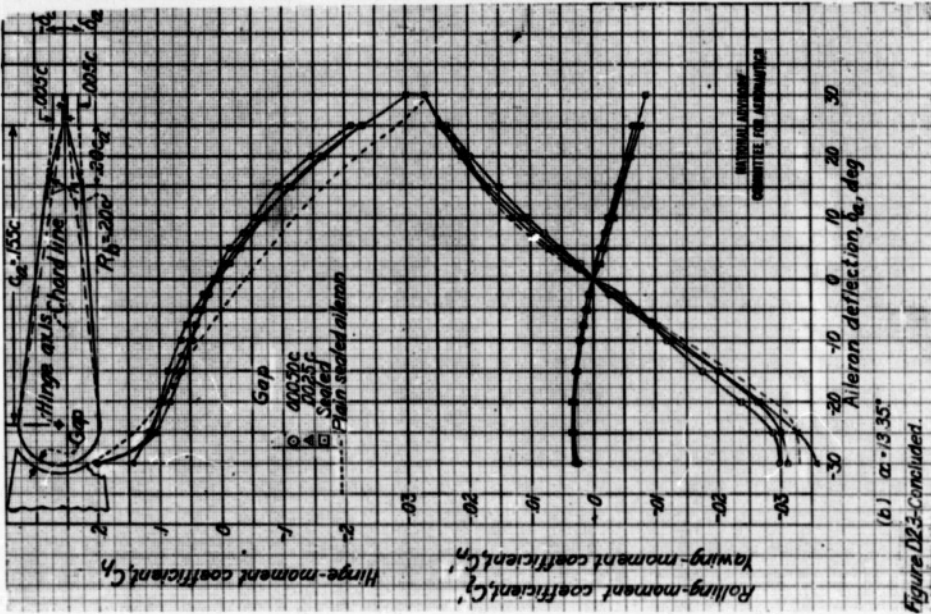


Figure D23-Concluded.

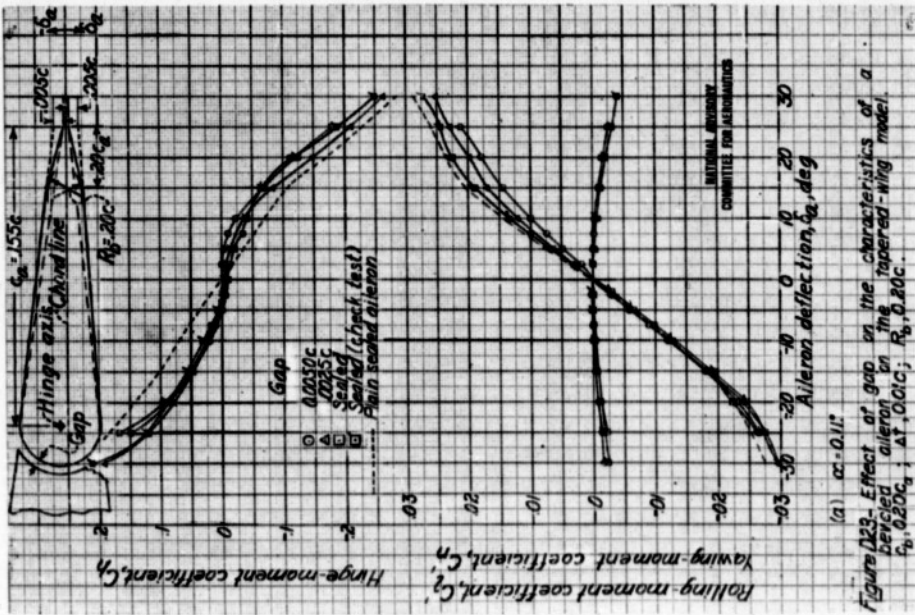
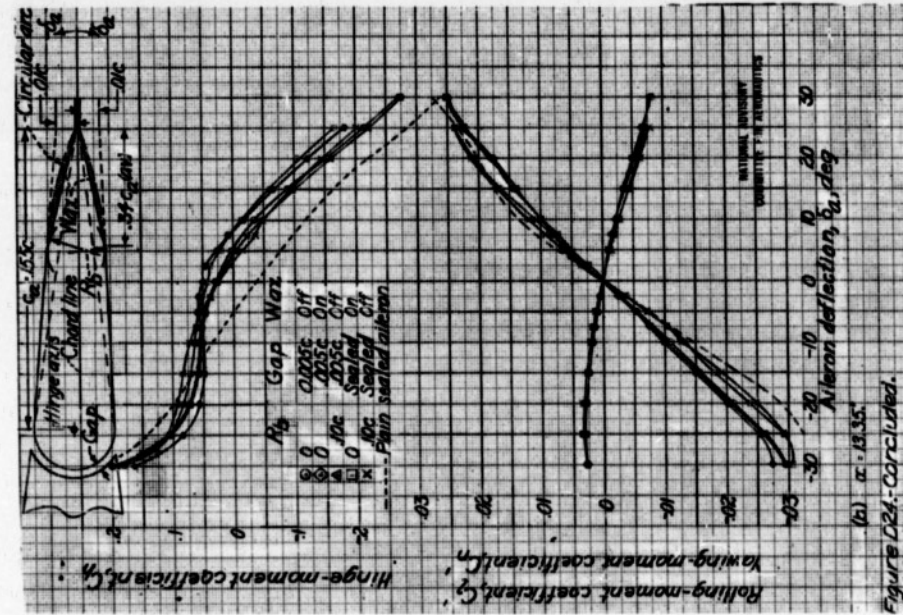


Figure D23-Effect of gap in the characteristics of a tapered-wing model. C_h, C_l, C_n at $0.01c$; R_b, R_c, R_d at $0.01c$.

Model D-IV



Model D-IV

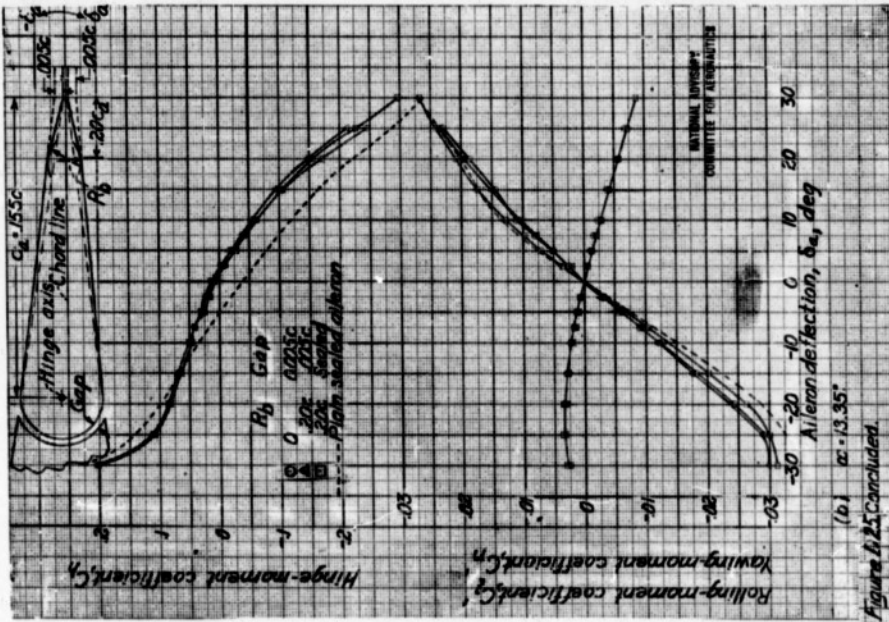


Figure 6.25. Concluded.

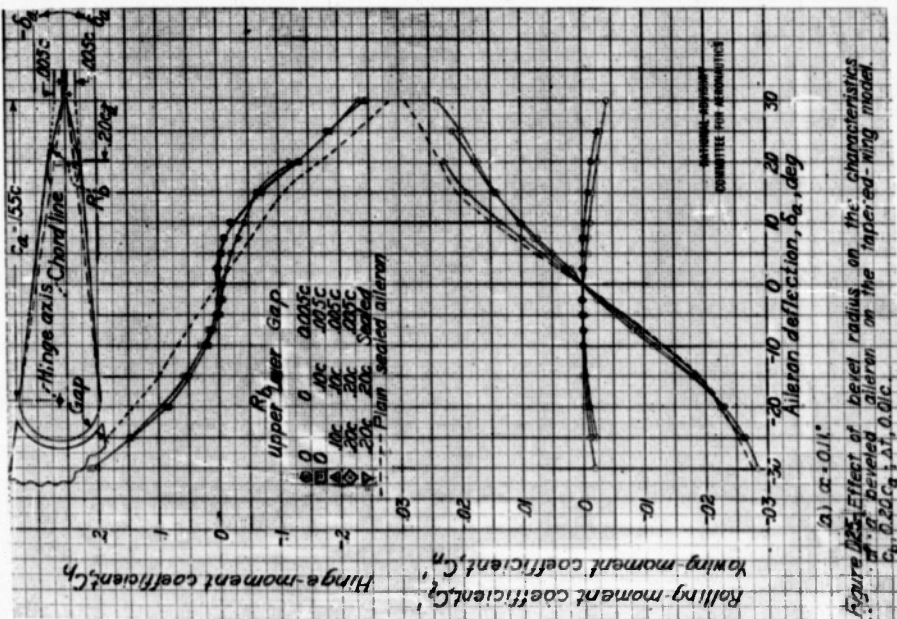


Figure 6.25. Effect of bevel radius on the characteristics of a beveled aileron on the tapered-wing model. $R_b = 0.20c$; $\Delta T = 0.01c$.

Model D-IV

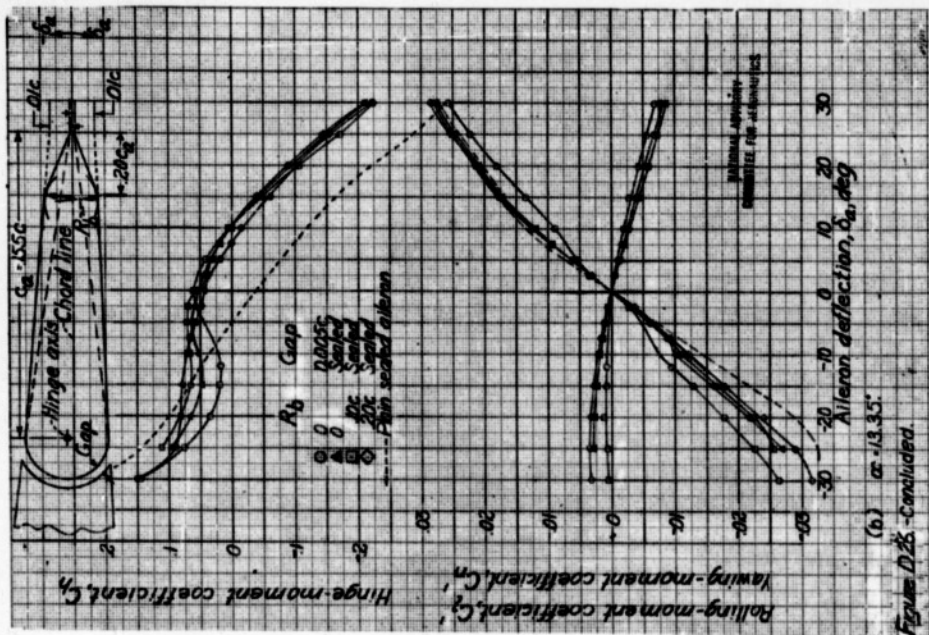


Figure D25-Continued.

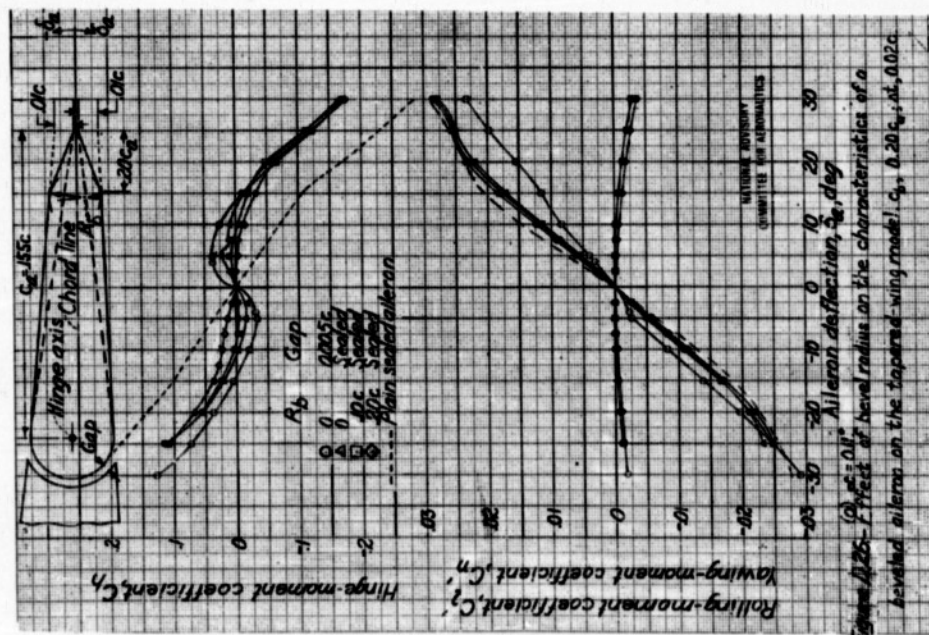


Figure D25- Effect of bevel radius on the characteristics of a beveled aileron on the tapered wing model, C_h , 0.20 C_h , at 0.02 C_h .

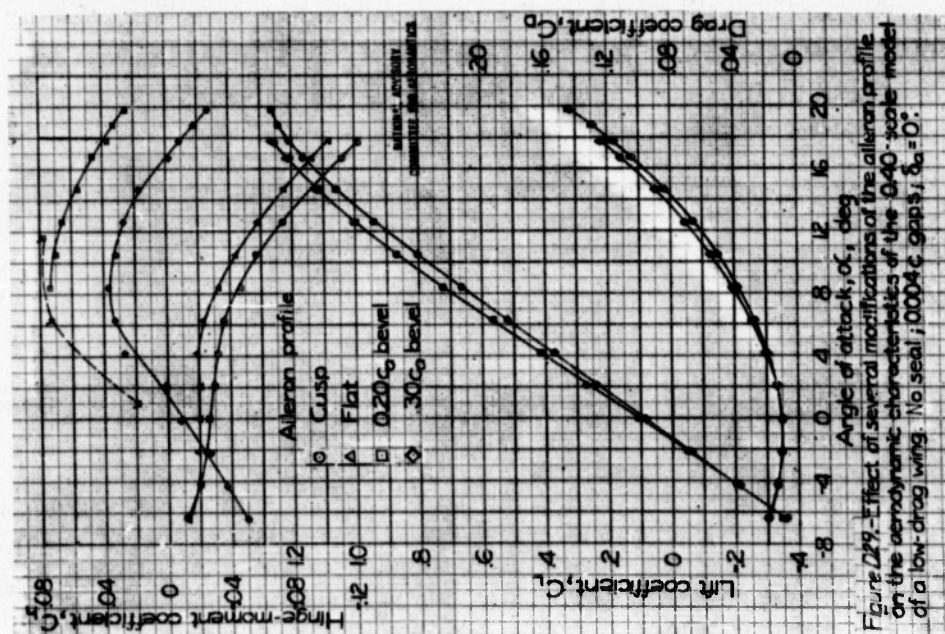


Figure 289. Effect of several modifications of the alleron profile on the aerodynamic characteristics of the 0.40-scale model of a low-drag wing. No seal; 0.004 c gaps; $\delta_a = 0$.

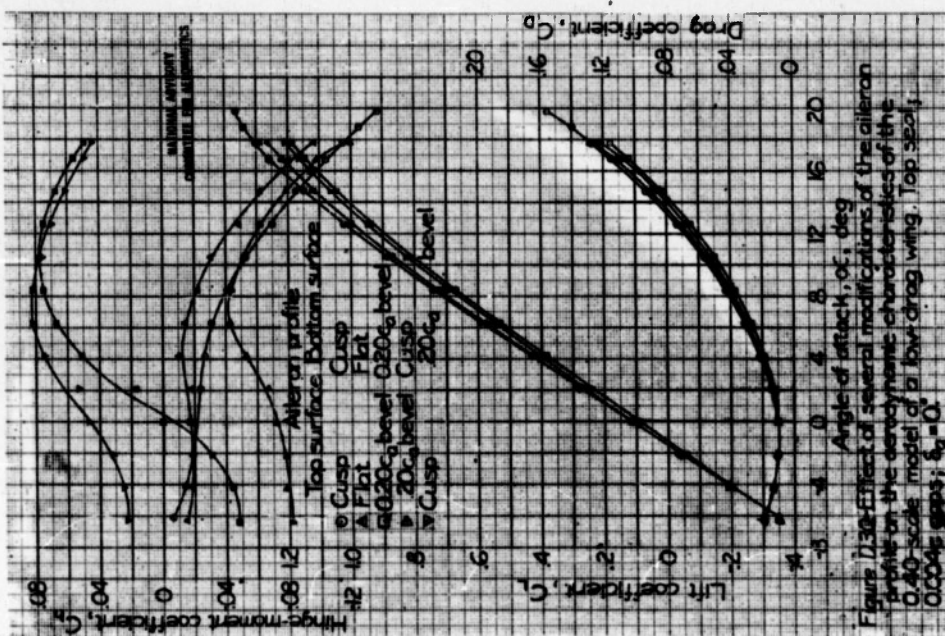


Figure 290. Effect of several modifications of the alleron profile on the aerodynamic characteristics of the 0.40-scale model of a low-drag wing. Top seal; 0.004 c gaps; $\delta_a = 0$.

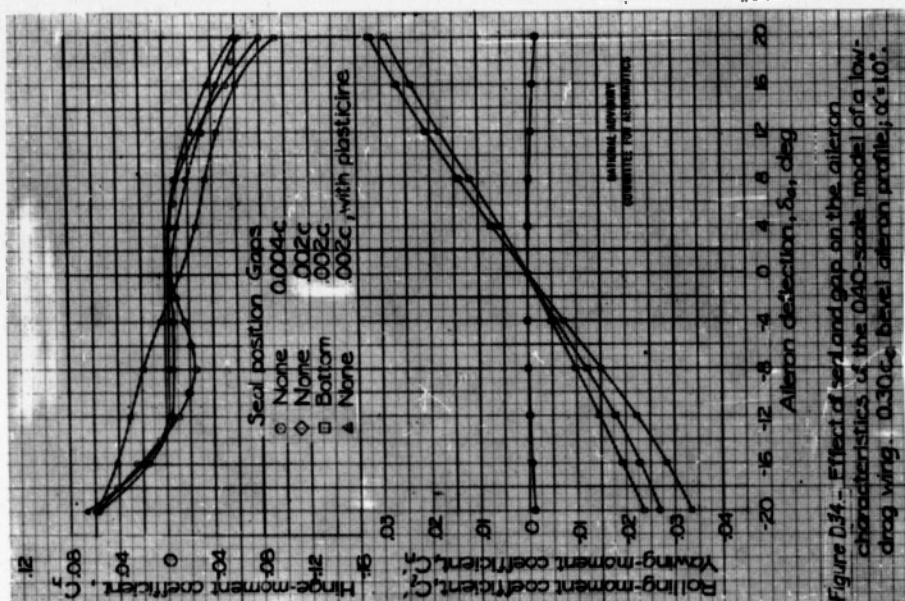


Figure D34. Effect of seal and gap on the alleron characteristics of the 0.80-scale model of a low-drag wing. 0.30c_a bi-level alleron profile, α : 10°.

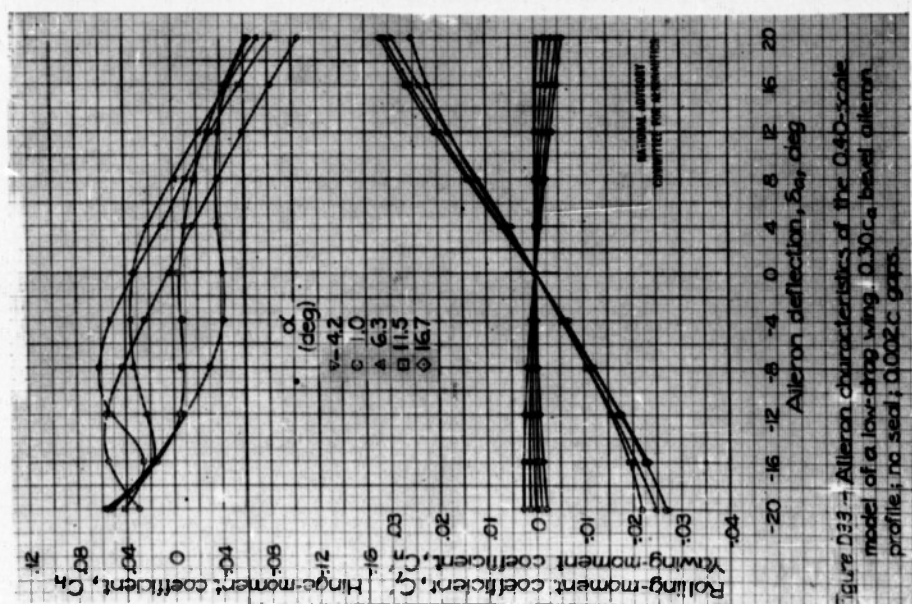


Figure D33. Alleron characteristics of the 0.80-scale model of a low-drag wing. 0.30c_a bi-level alleron profile; no seal; 0.002c gaps.

Model D-V

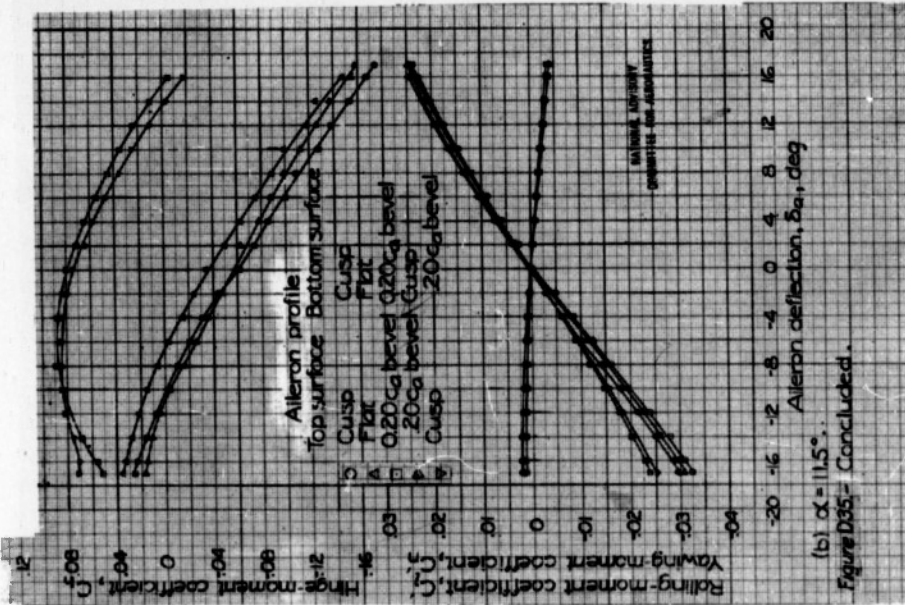


Figure D35- Effect of several modifications of the alleron profile on the alleron characteristics of the 0.40 scale model of a low-drag wing. Top seal: 0.004 c gaps.

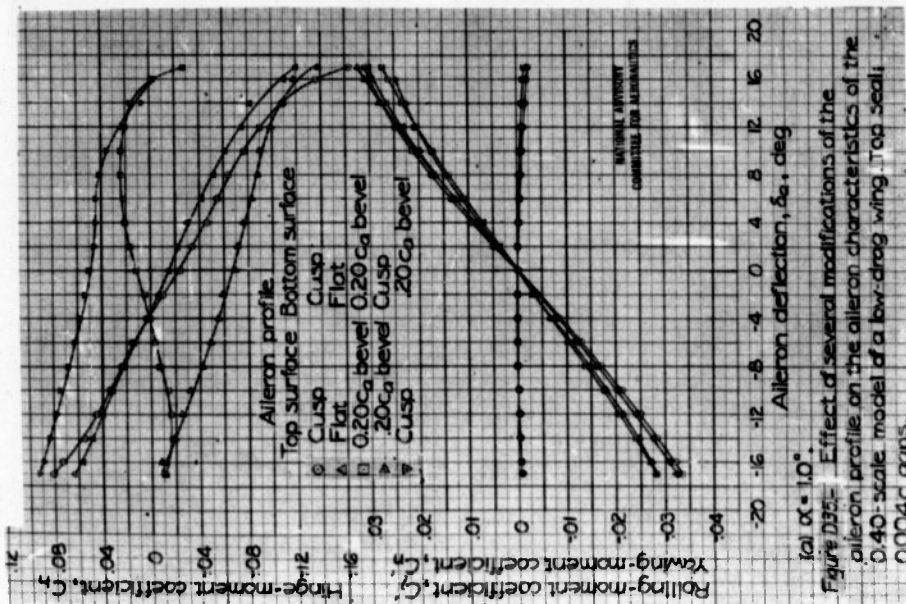
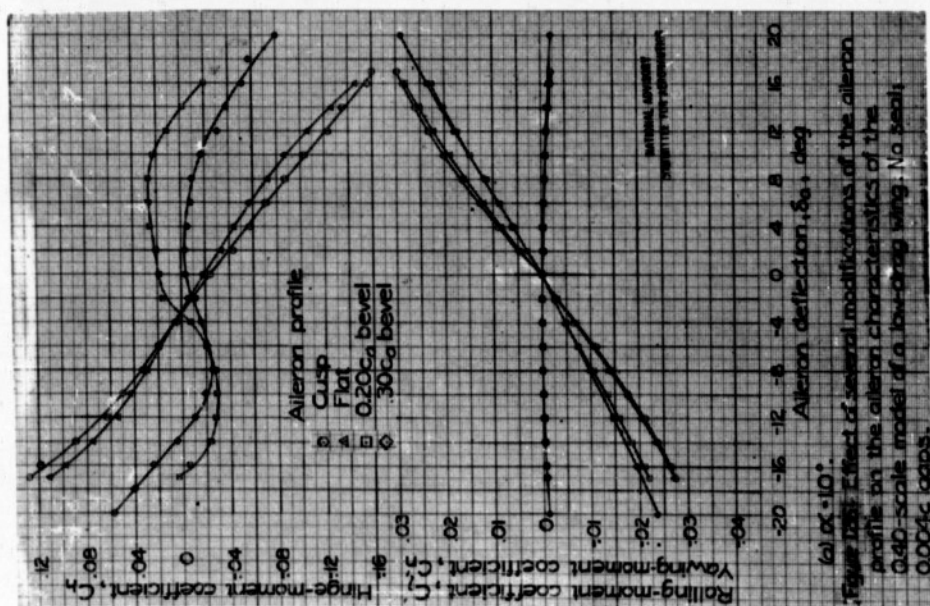
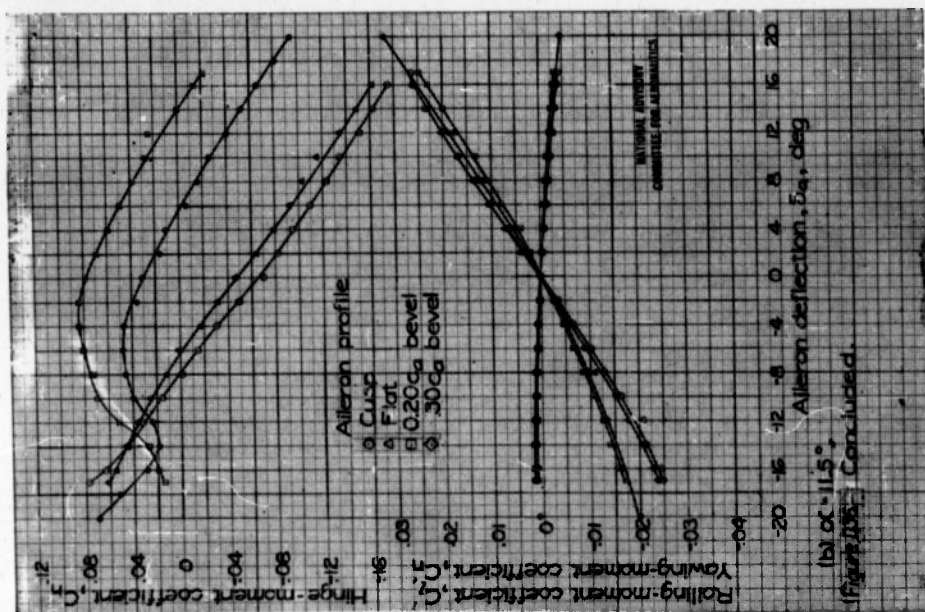
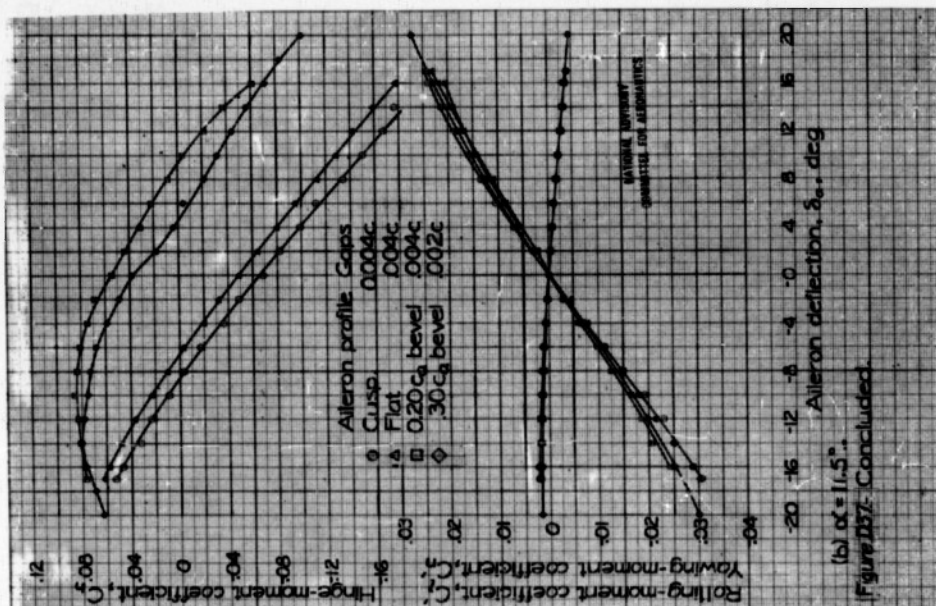


Figure D35- Effect of several modifications of the alleron profile on the alleron characteristics of the 0.40 scale model of a low-drag wing. Top seal: 0.004 c gaps.

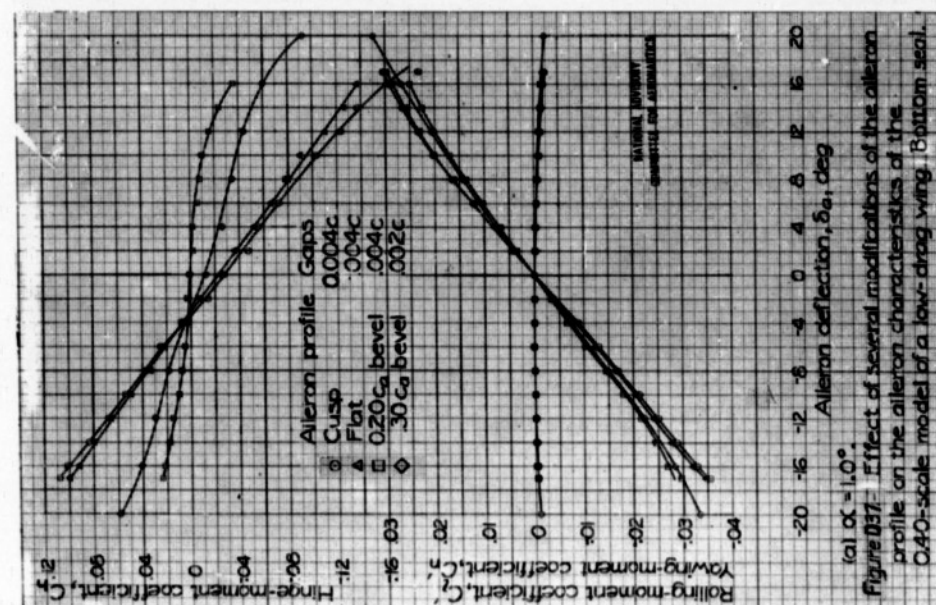
Model D-V



Model D-V

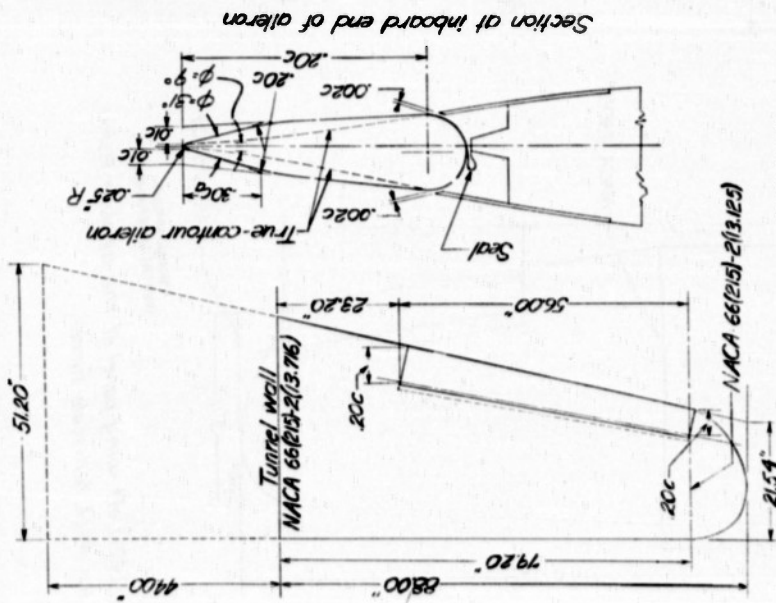


(a) $\alpha = 1.0^\circ$



(b) $\alpha = 1.5^\circ$

Figure 037: Concluded.



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Figure D32.-The 040-scale model of a tapered low-drag wing with round-nose ailerons. LMAL F by 10-foot tunnel.

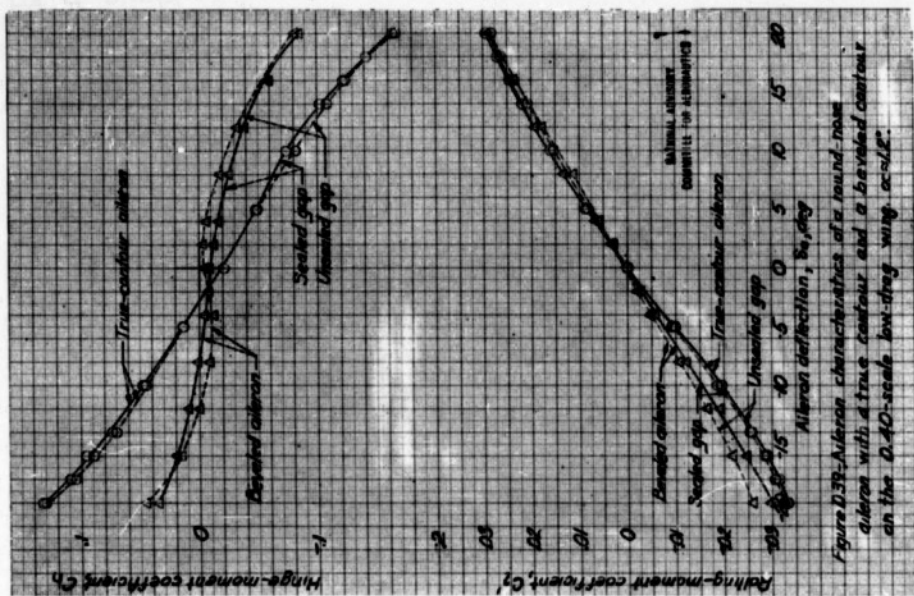
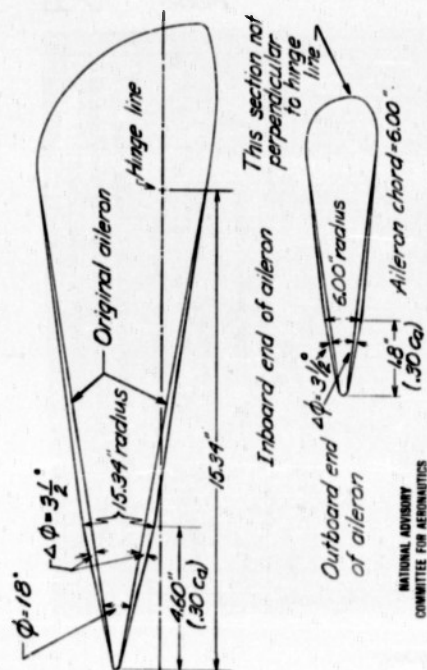


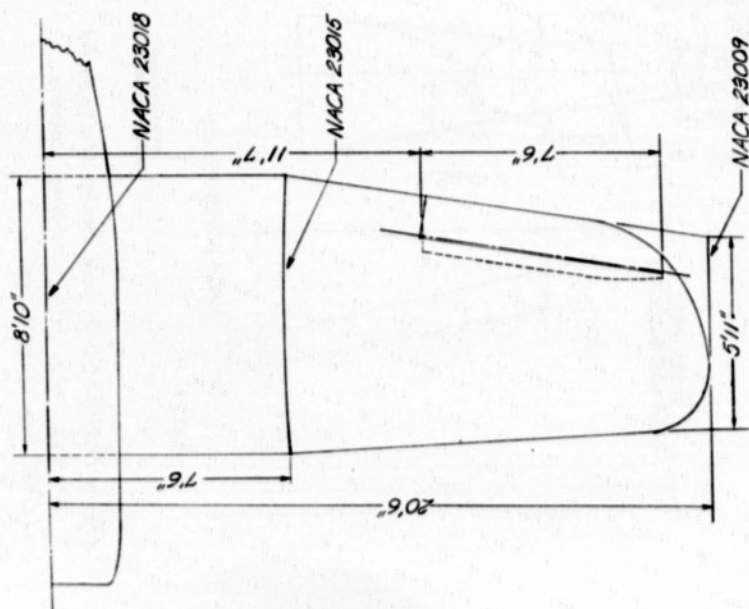
Figure D33.-Aileron characteristics of a round nose aileron with a true contour and a beveled contour on the 0.40-scale low-drag wing, ac412.

Model D-VI



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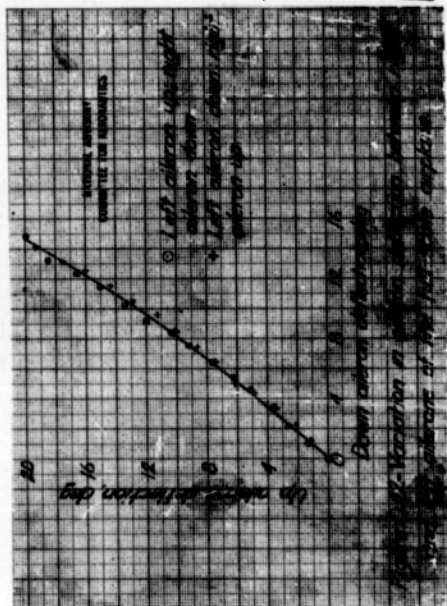
Figure D41.-Aileron sections of the full-scale airplane.

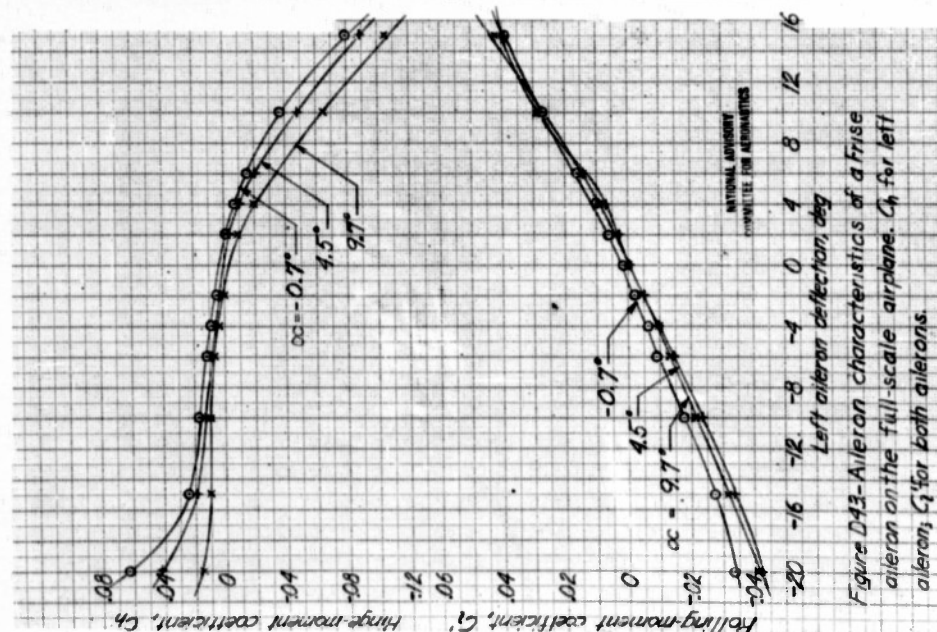
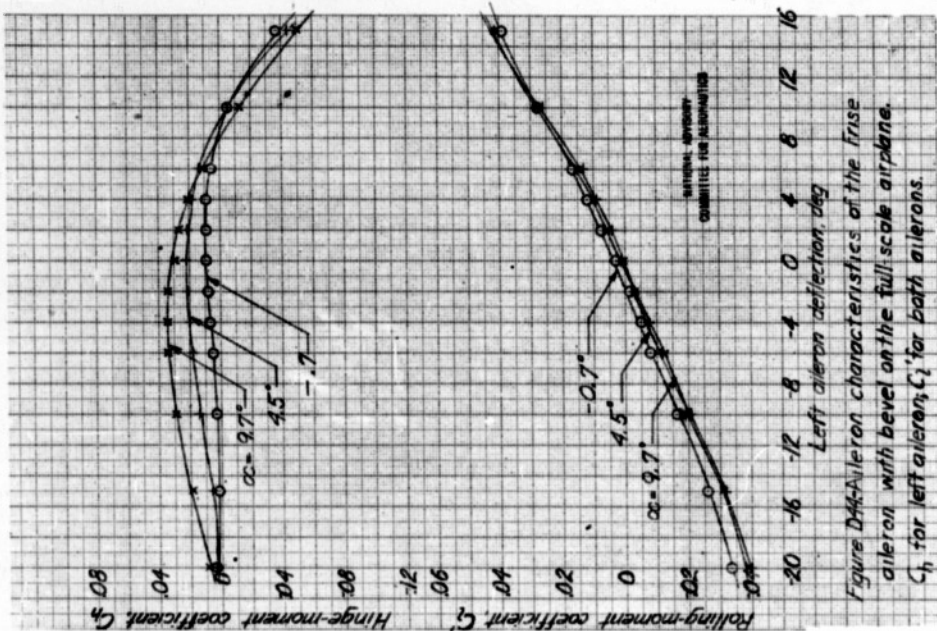


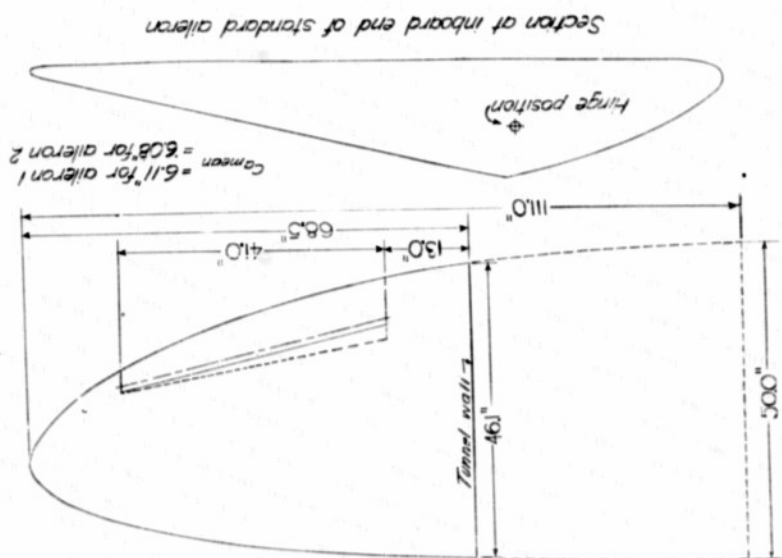
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Figure D40.-Left wing panel of the airplane tested in the NACA full-scale tunnel.

Airplane D-VII







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Figure D45-The 0.50-scale model of an elliptical wing with the standard Frise aileron. NACA Duplex tunnel.

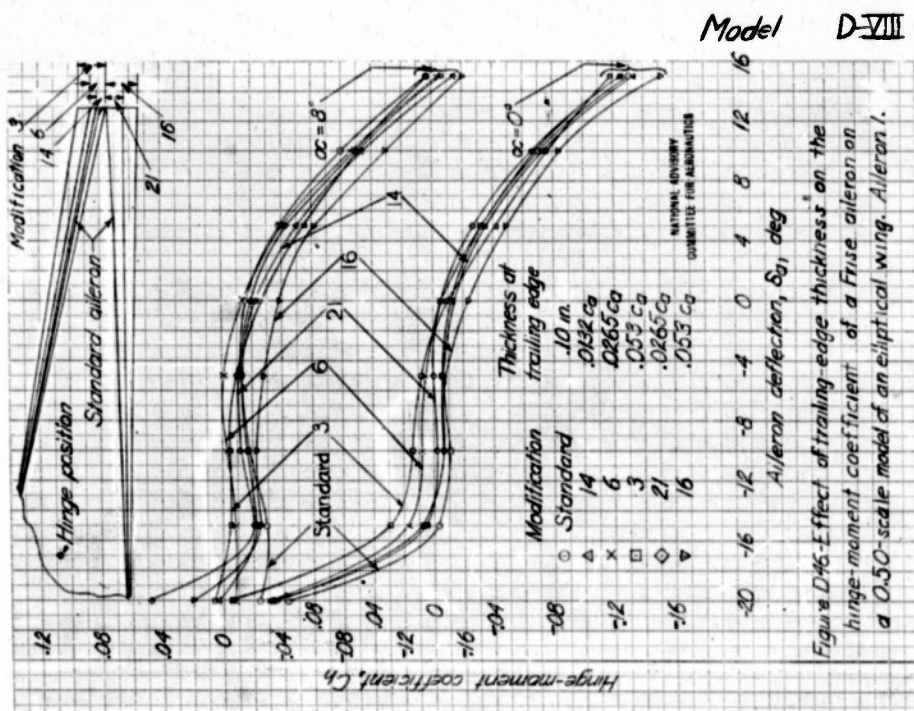
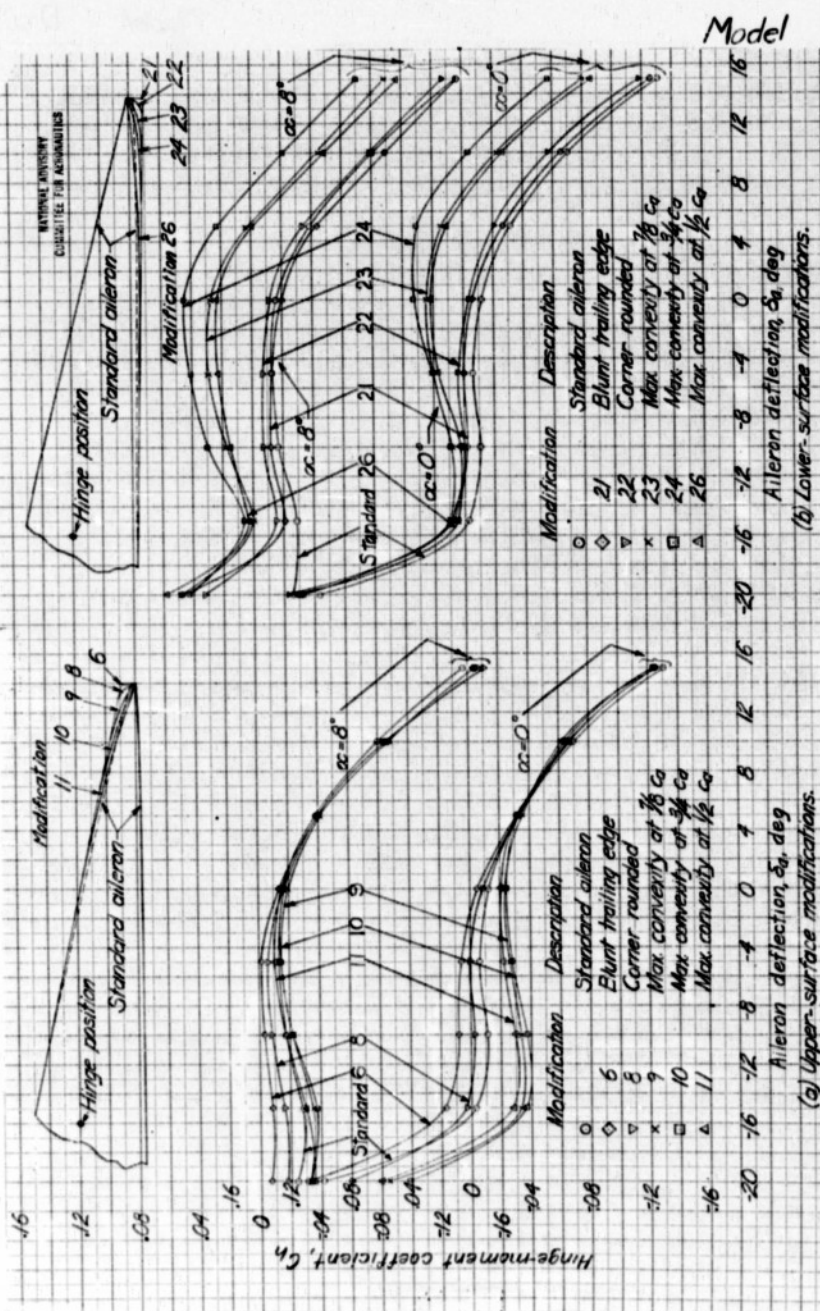
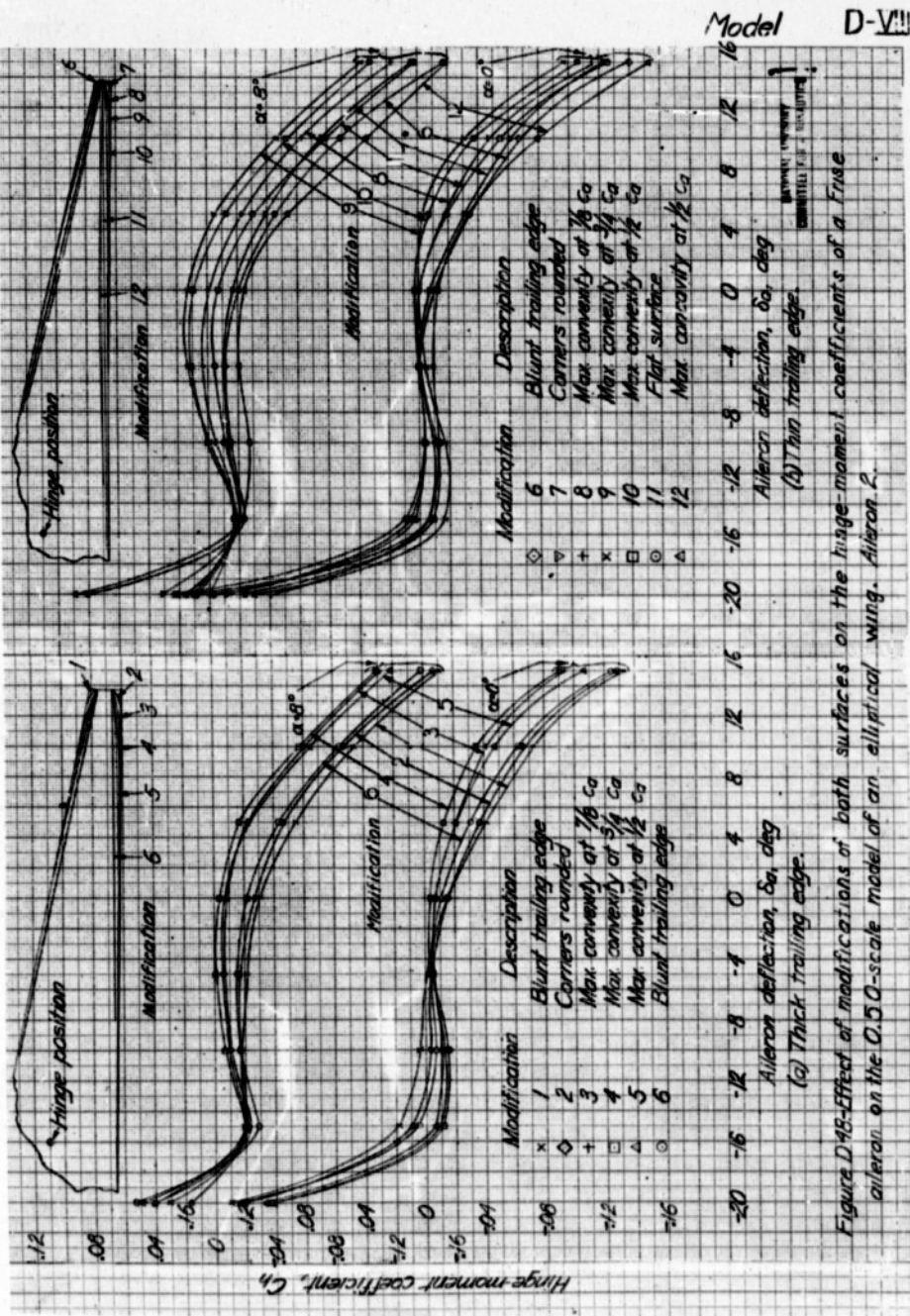
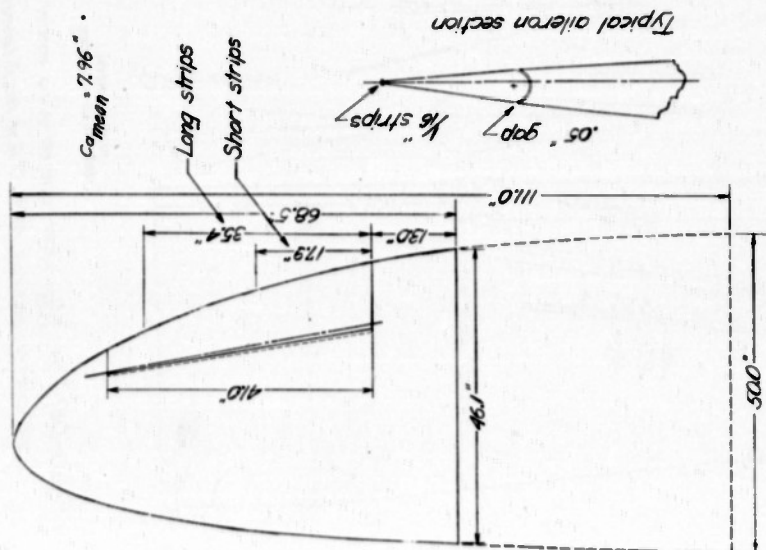


Figure D46-Effect of trailing-edge thickness on the hinge-moment coefficient of a Frise aileron on a 0.50-scale model of an elliptical wing. Aileron 1.







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Figure D43-Plan aileron on a 0.50-scale model of an elliptical wing. NPL 7-foot tunnel.

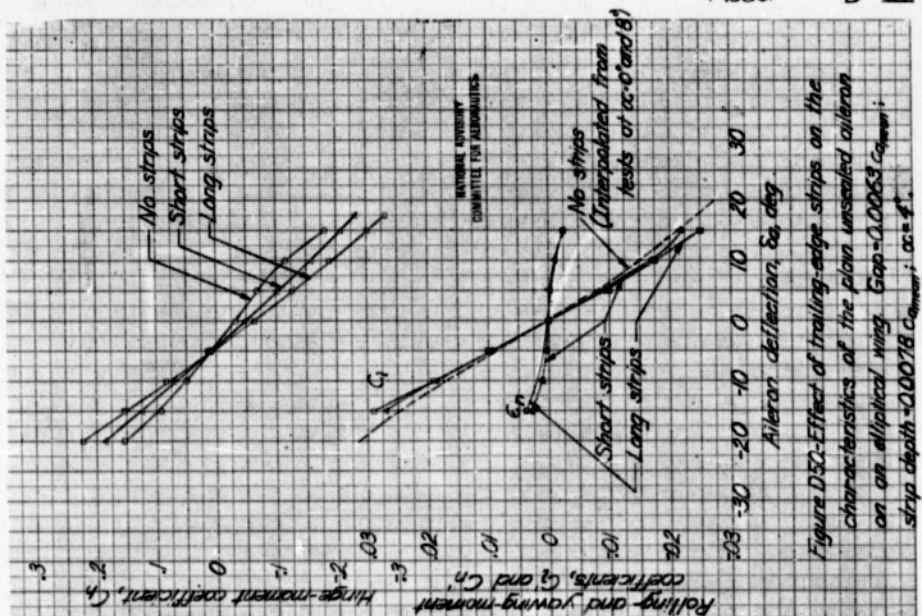
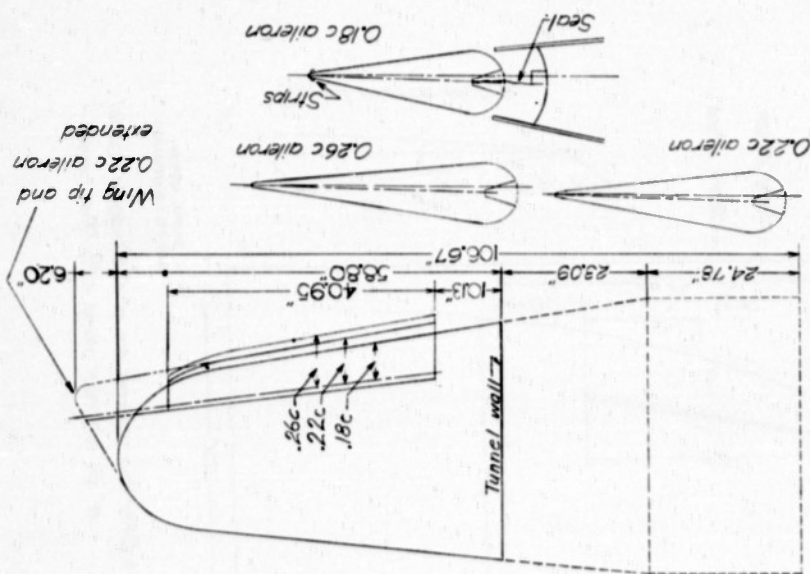


Figure D52-Effect of trailing-edge strips on the characteristics of the plain unswept aileron on an elliptical wing. Gap $= 0.0063 C_{m, mean}$; strip depth $= 0.0078 C_{m, mean}$; $\alpha = 8^\circ$.



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Figure D51.—The $\frac{1}{2.25}$ -scale tapered-wing model and aileron sections, NPL, 7 foot No 2 tunnel.

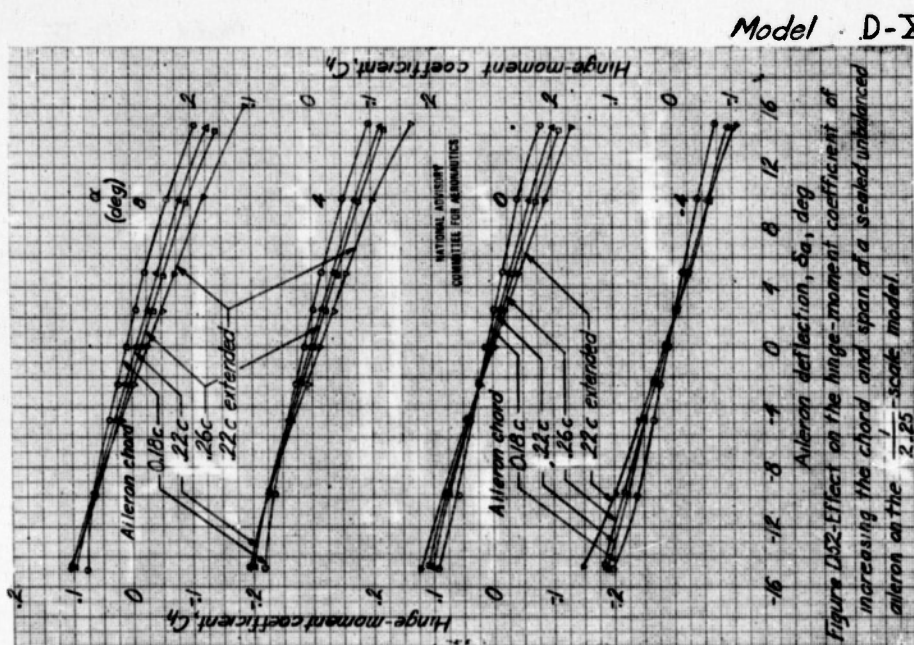


Figure D52.—Effect on the hinge-moment coefficient of increasing the chord and span of a sealed unbalanced aileron on the $\frac{1}{2.25}$ -scale model.

Model D-X

Model D-X

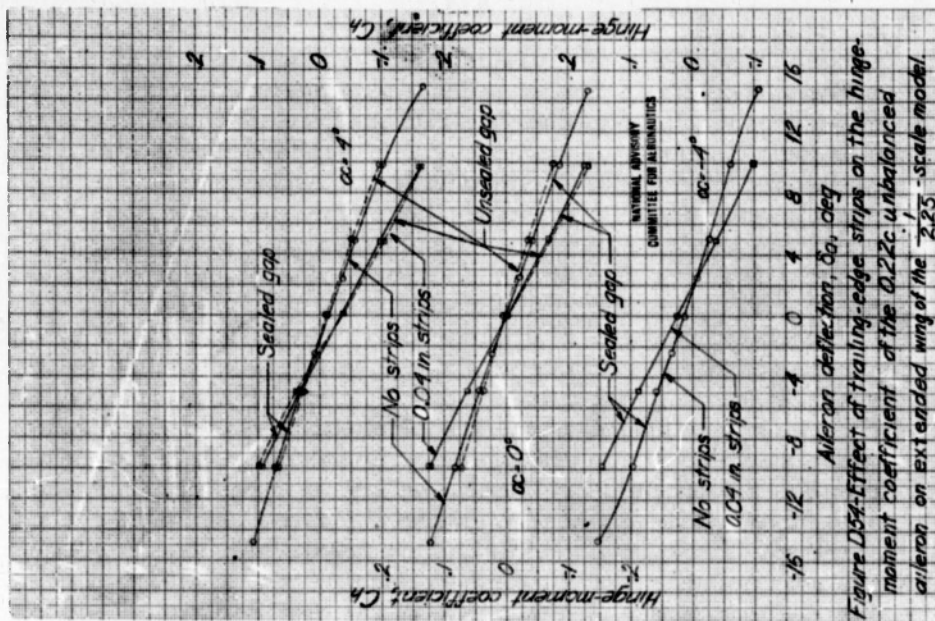


Figure D54: Effect of trailing-edge strips on the hinge-moment coefficient of the Q22c unbalanced aileron on extended wing of the 225-scale model.

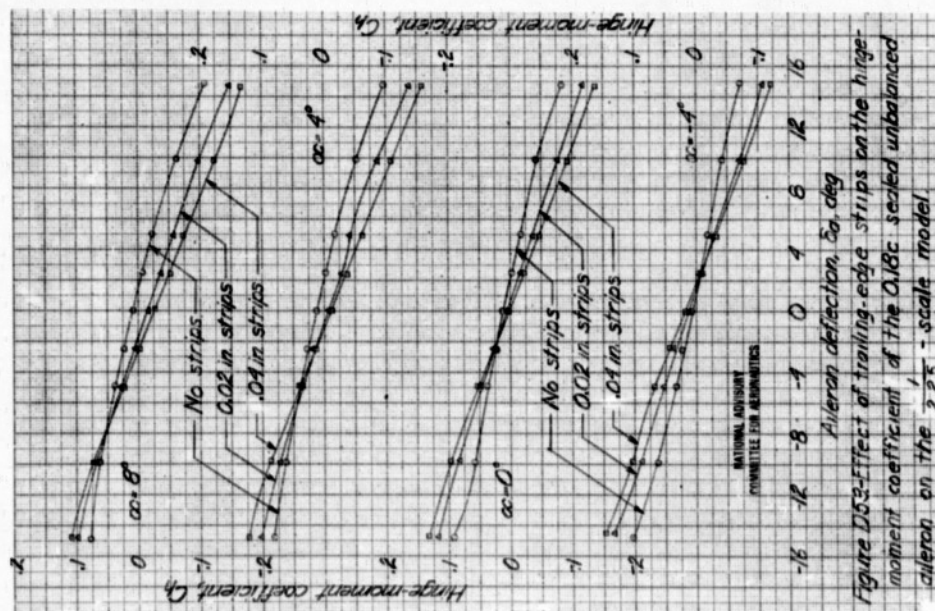


Figure D53: Effect of trailing-edge strips on the hinge-moment coefficient of the Q18c sealed unbalanced aileron on the 225-scale model.

Airplane D-XI

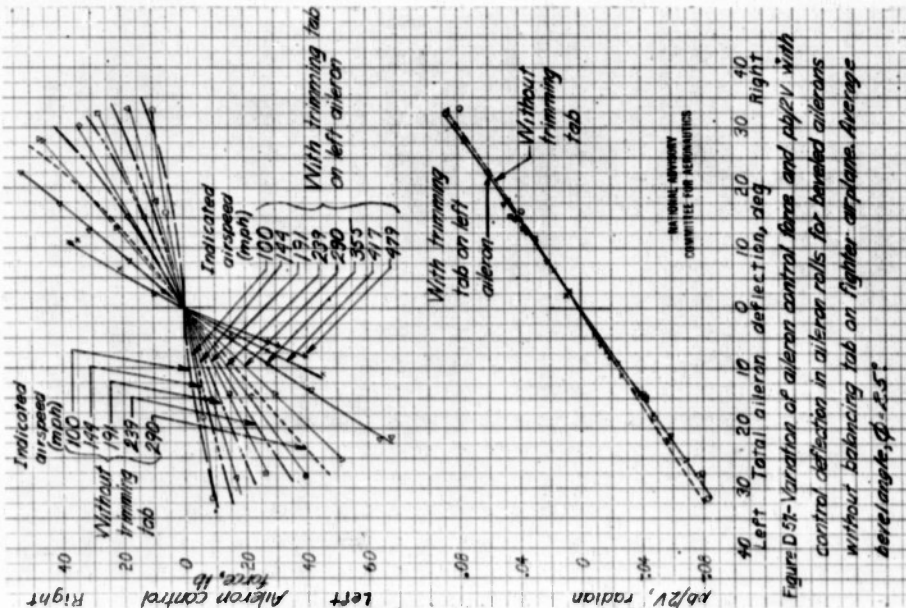
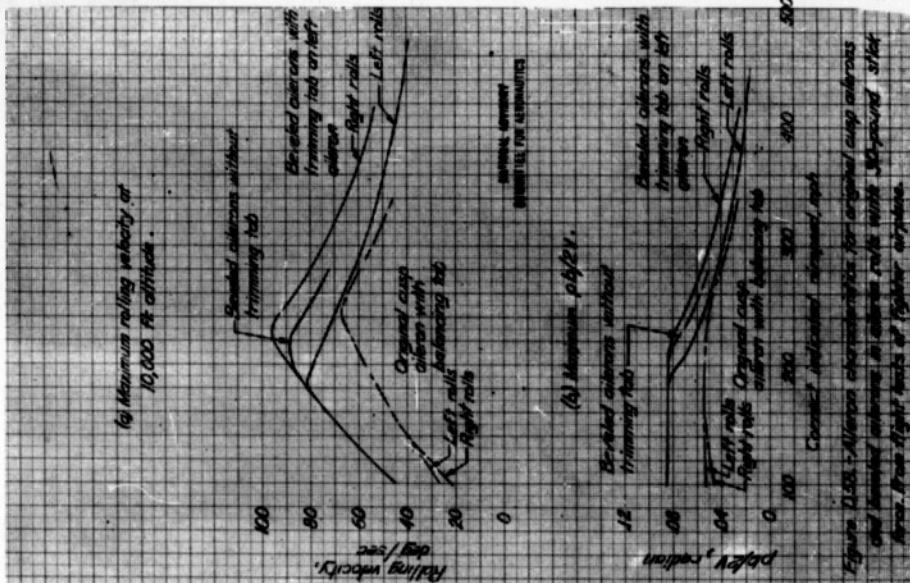


Figure D51—Variation of aileron control force and p/q_{25V} with control deflection in aileron rolls for levelled ailerons without balancing tab on fighter airplane. Average: 2 bevel angle, $\phi = 2.5^\circ$

Airplane D-XI

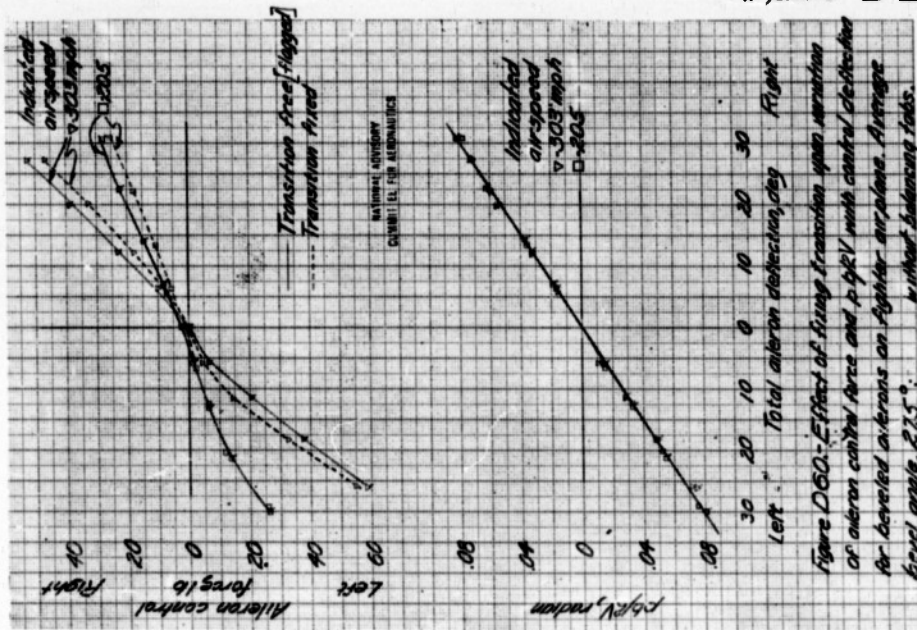


Figure D-60: Effect of flying transition upon variation of aileron control force and $p/q/V$ with control deflection for beveled ailerons on fighter airplane. Average bevel angle, 27.5°; without balancing tabs.

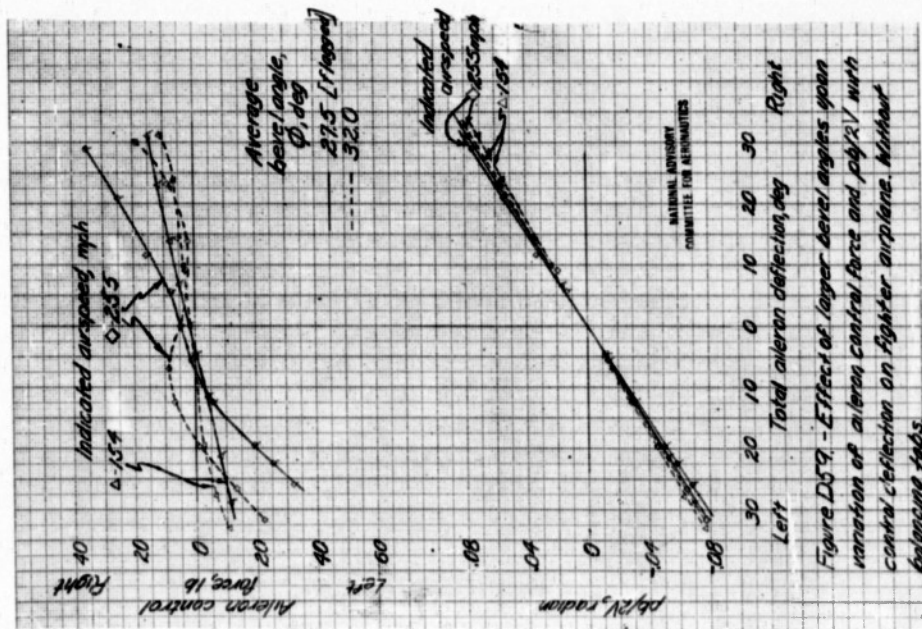


Figure D-59: Effect of larger bevel angles upon variation of aileron control force and $p/q/V$ with control deflection on fighter airplane. Without balancing tabs.

L-419

Model E-1

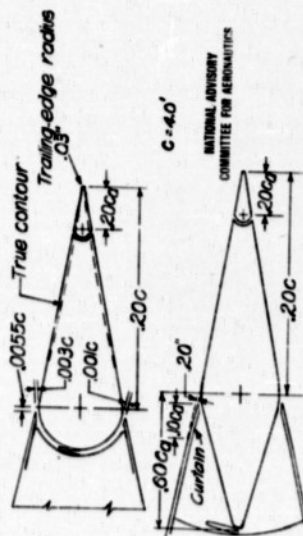
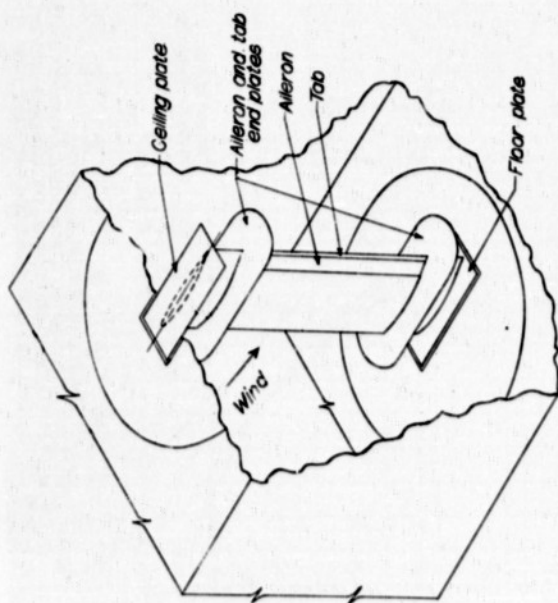
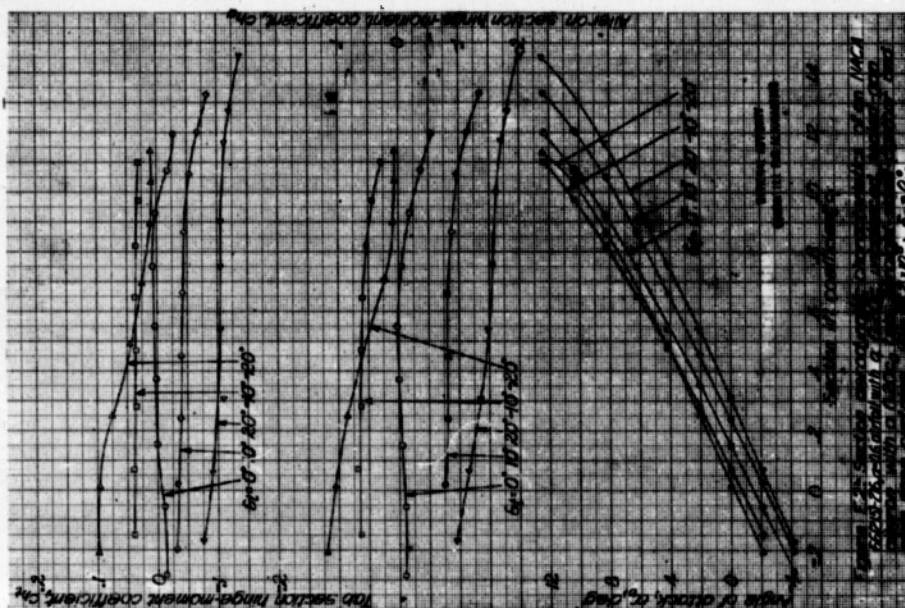


Figure E1.-Two-dimensional test installation and the 0.20c_a tab tested on a 0.20c straight-sided aileron with two balance arrangements. NACA 66(25)-26, a=0.05 camber. AAL 7 by 10-foot tunnel.



Model E-1

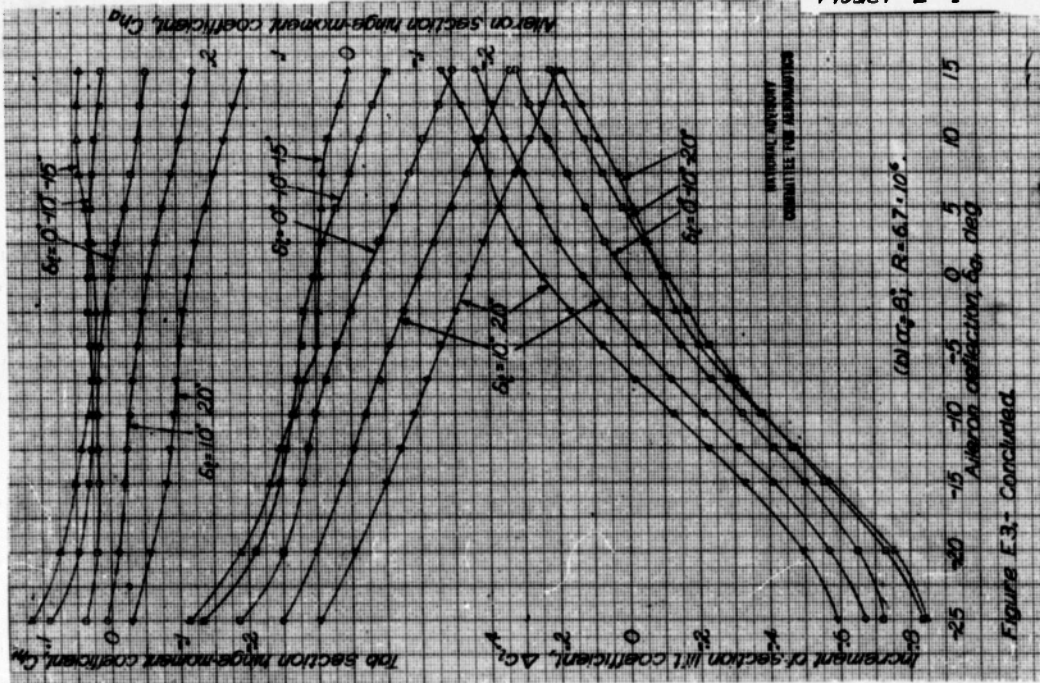


Figure E.3: Concluded

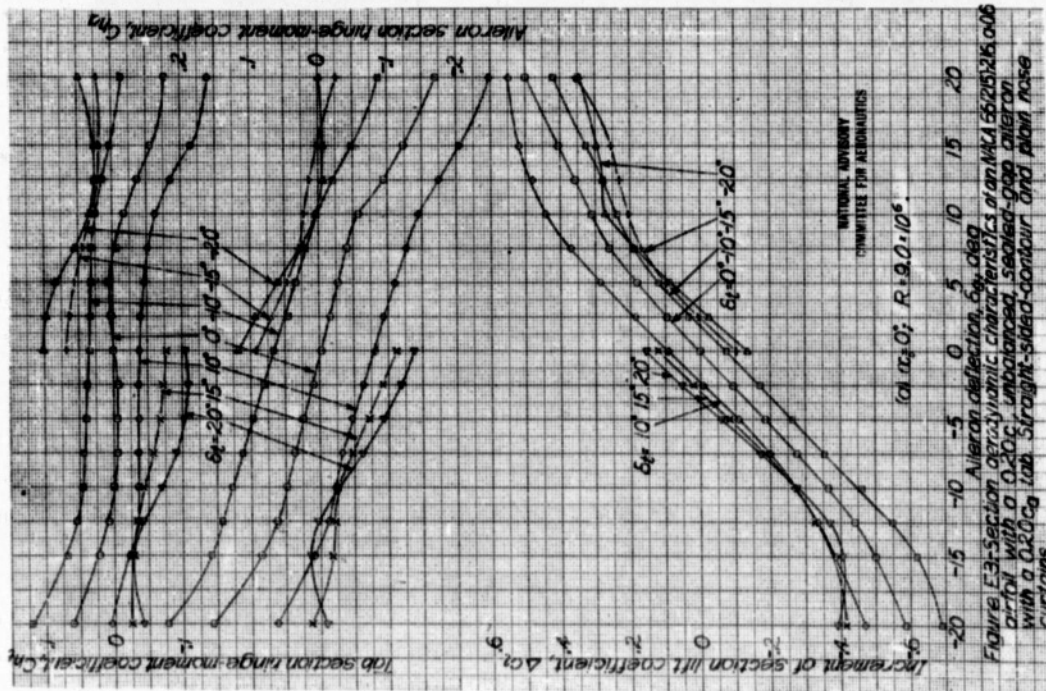


Figure E.3: Section aerodynamic characteristics of an NACA 651015 airfoil with a 0.20c tab, untabbed, sealed-gap aileron with a 0.20c tab. Straight-tapered and plain nose curtains.

Model E-I

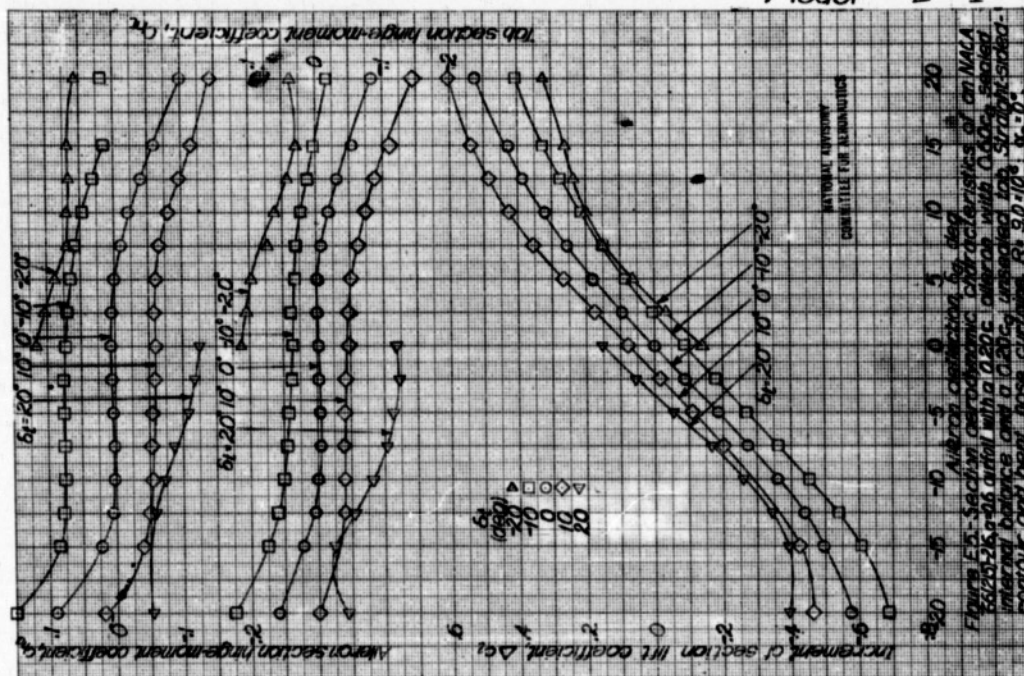


Figure E-1. Section aerodynamic characteristics of an NACA 6520-26 airfoil with a 0.20% camber line, 0.60% leading edge camber, and a 0.20% trailing edge camber. The graph shows the lift coefficient C_l , the section lift coefficient C_{l_s} , and the section hinge-moment coefficient C_{h_s} as a function of the angle of attack α for various section lift coefficients C_{l_s} .

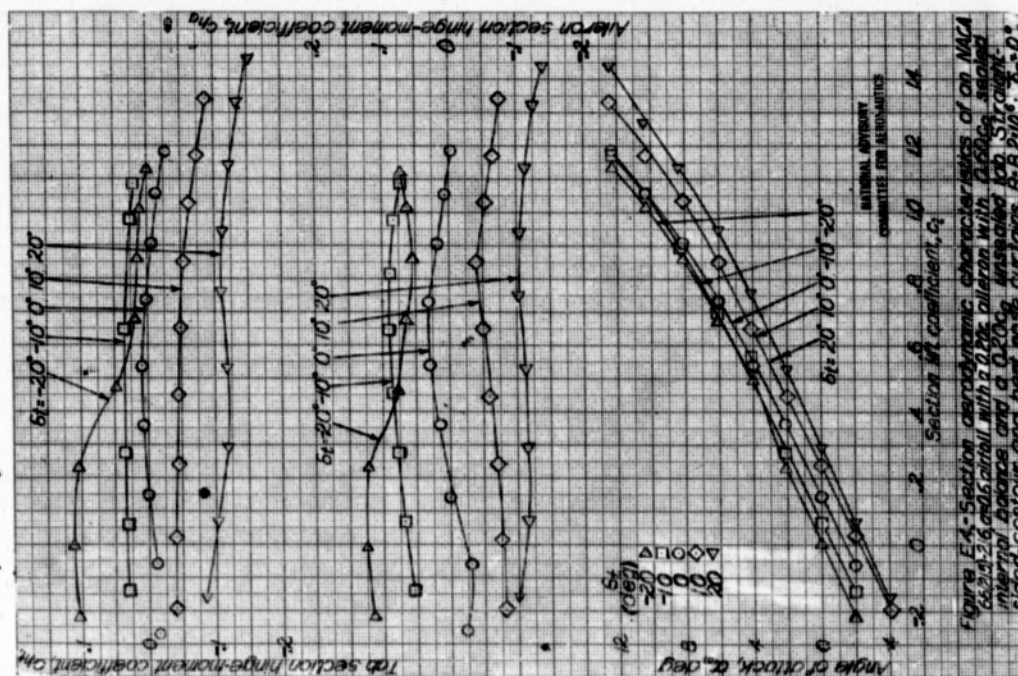
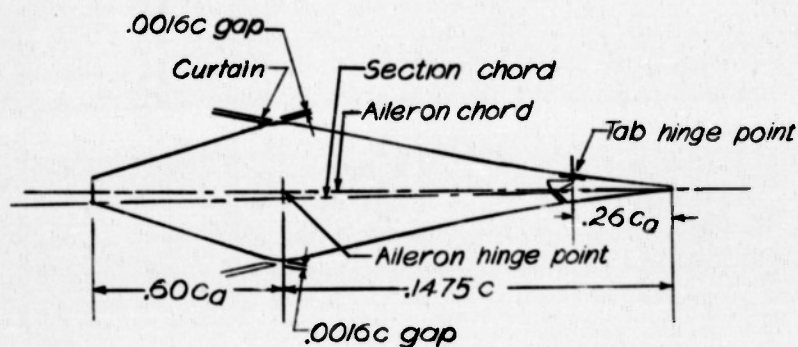


Figure E-2. Section aerodynamic characteristics of an NACA 6520-26 airfoil with a 0.20% camber line, 0.60% leading edge camber, and a 0.20% trailing edge camber. The graph shows the lift coefficient C_l , the section lift coefficient C_{l_s} , and the section hinge-moment coefficient C_{h_s} as a function of the angle of attack α for various section lift coefficients C_{l_s} .

Model E-II



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Figure E6: 0.1475c, sealed, internally balanced aileron with a 0.26c_a tab tested on NACA 66,2-118, $\alpha = 1.0$ (approx) airfoil section. Effective aileron balance, 0.689c_a; NACA two-dimensional low-turbulence tunnel.

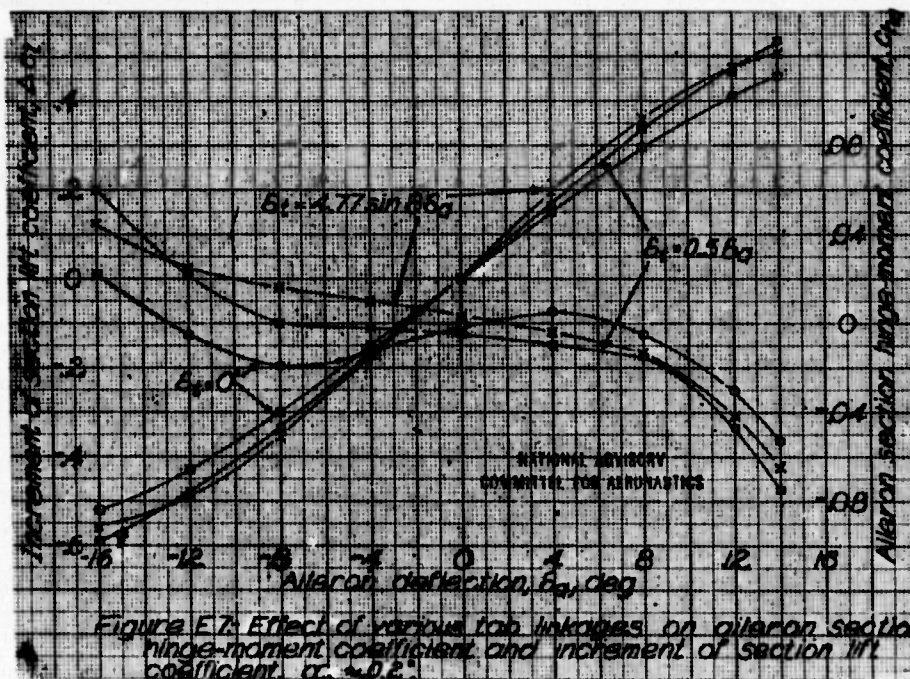
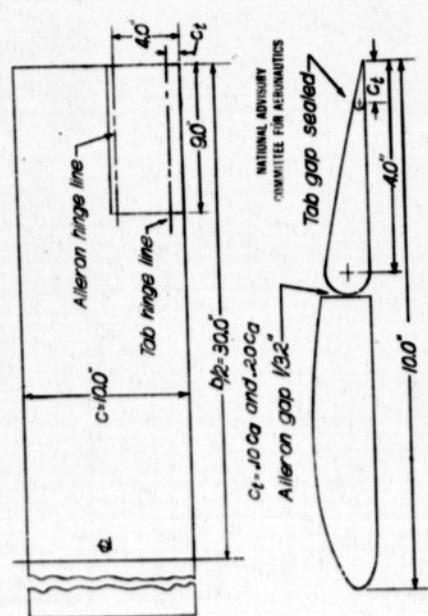
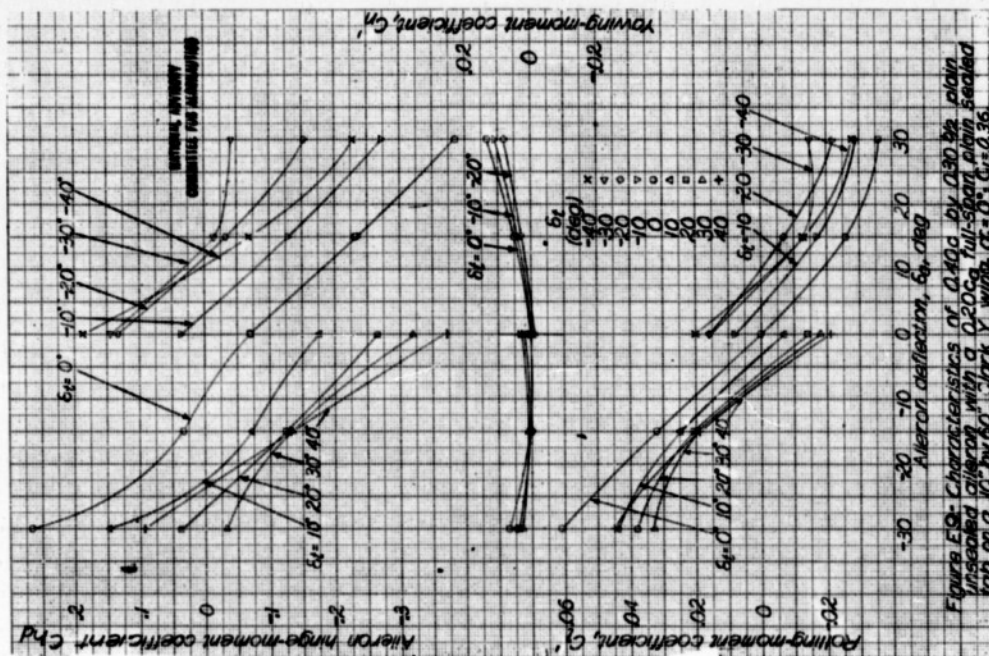
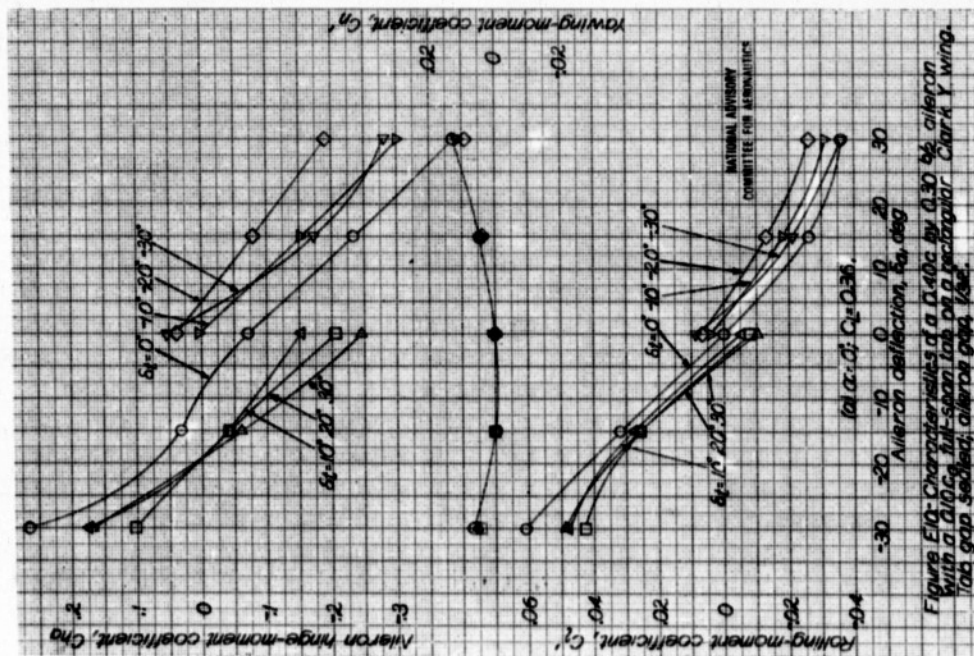
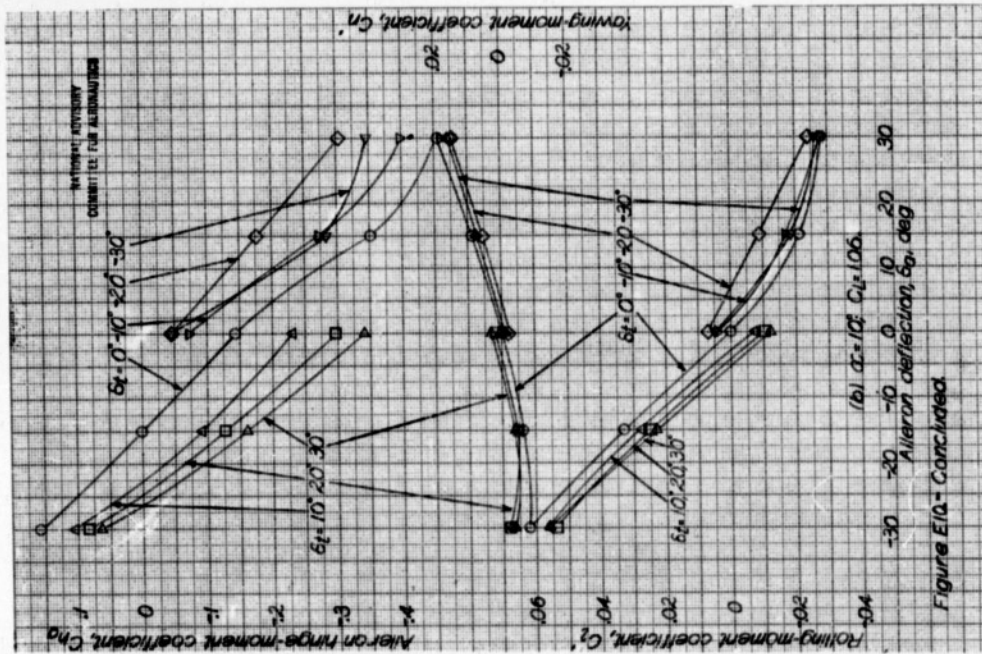


Figure E7: Effect of various tab linkages on aileron section hinge-moment coefficient and increment of section lift coefficient, $\alpha = 0.2^\circ$



Model E-III



617-1

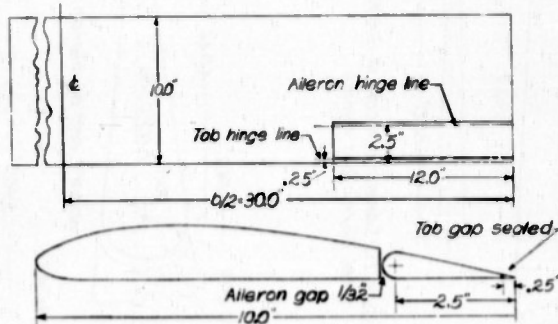
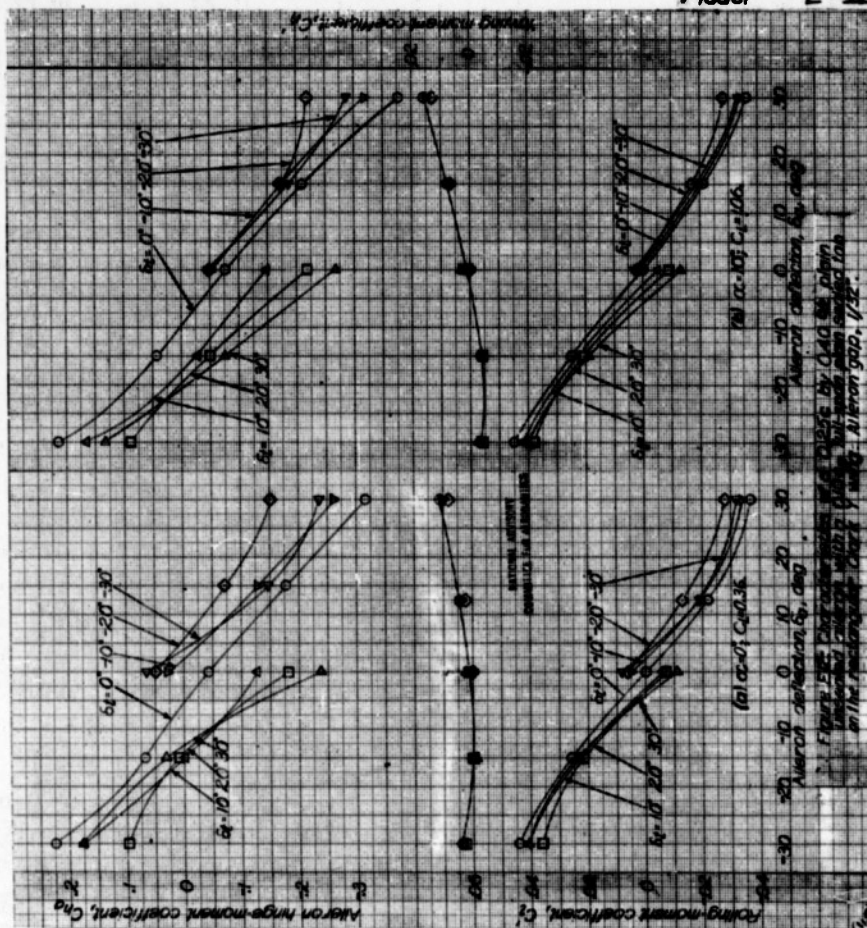


Figure E11: 0.25c by 0.40 1/2 aileron with 0.00c_g full-span tab on a 10 by 60 Clark Y wing. LMAL 7-by 10-foot tunnel.

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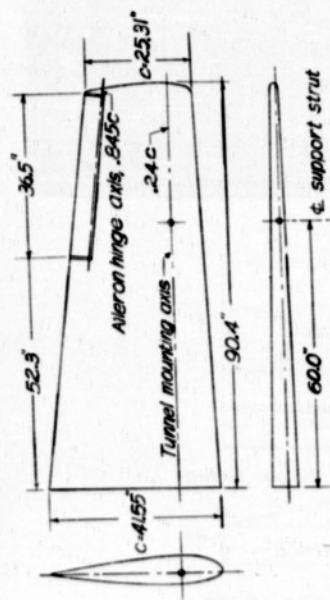


Figure E13: Semispan model of tapered wing.
LMAL 7 by 10-foot tunnel.

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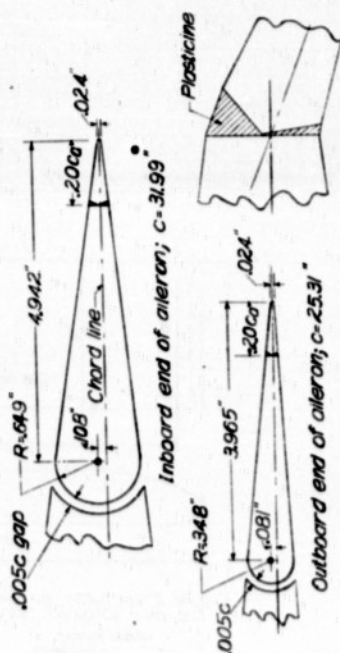


Figure E14: 0.155 by 0.405 by 0.20Cg by 10Cg inset tab.

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Model E-V

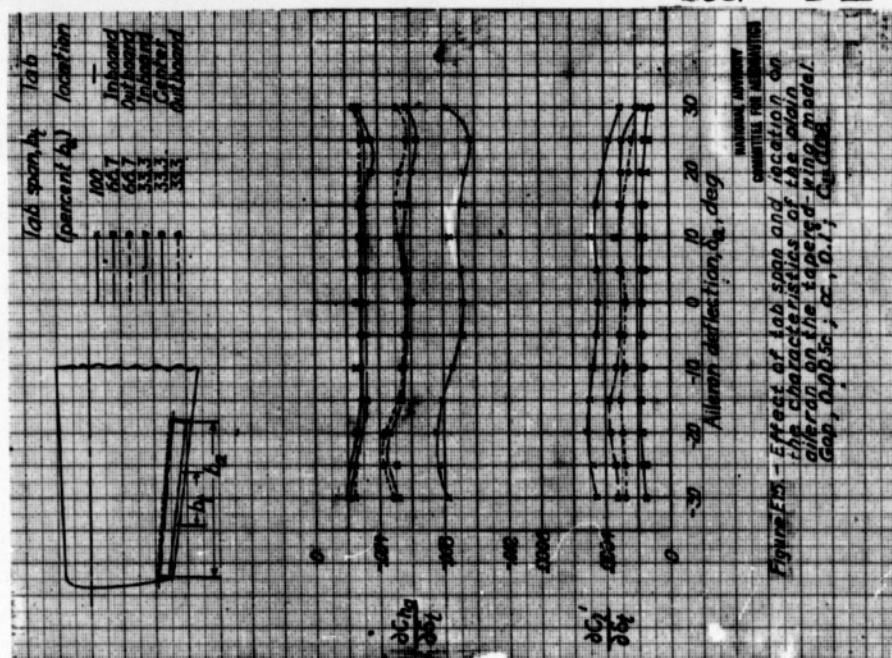
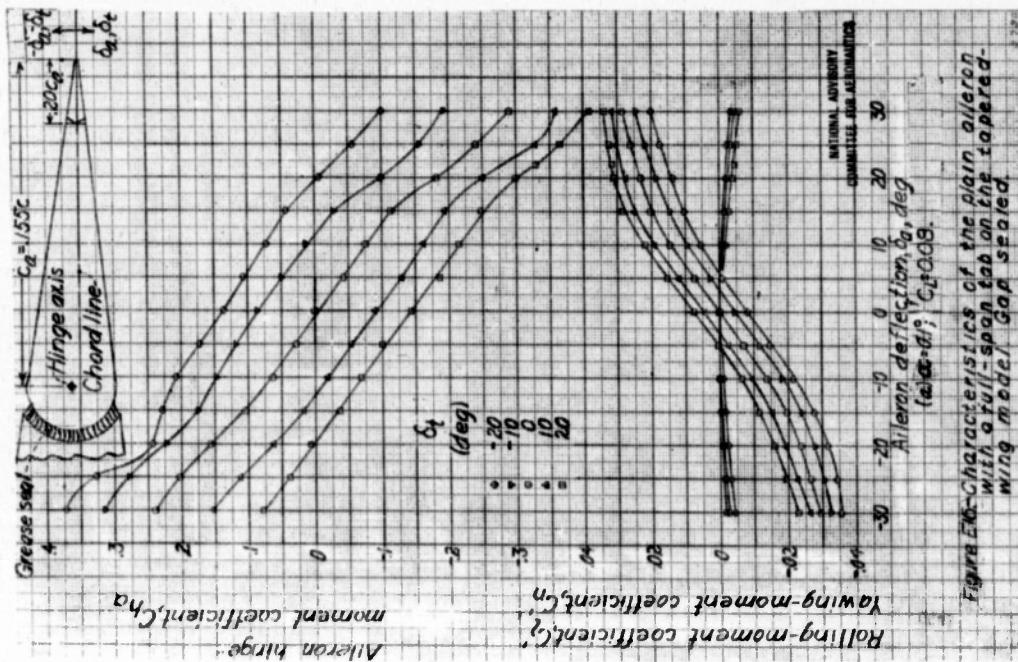
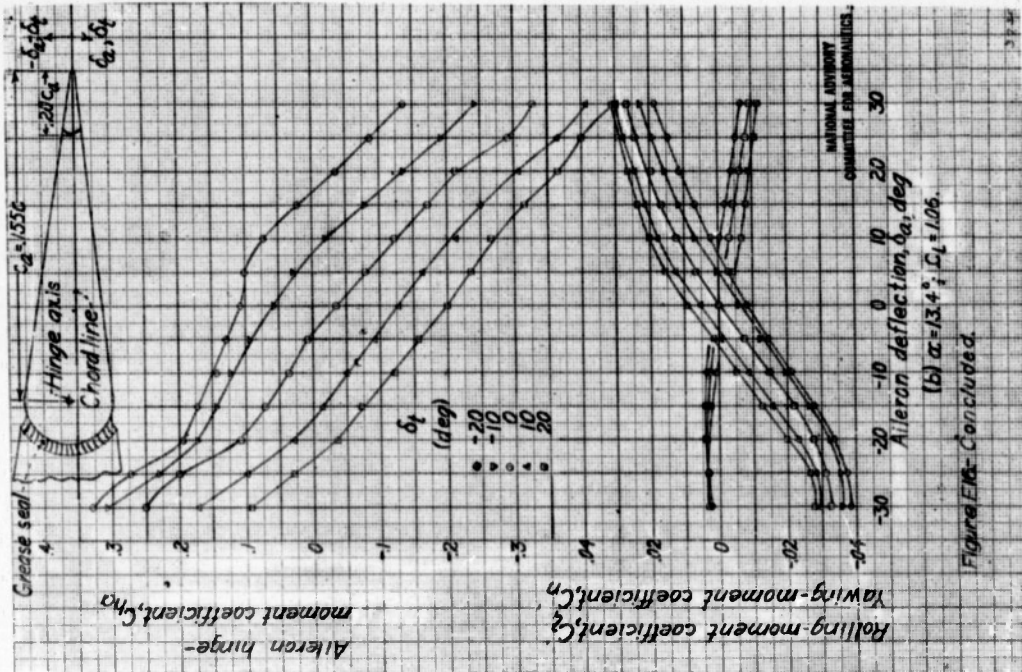


Figure E15: Effect of tab span and location on the characteristics of the plain aileron on the tapered-wing model. Gap, 0.005C; α , 0.1; $C_{L0.05}$.

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Model E-V





Model E-VI

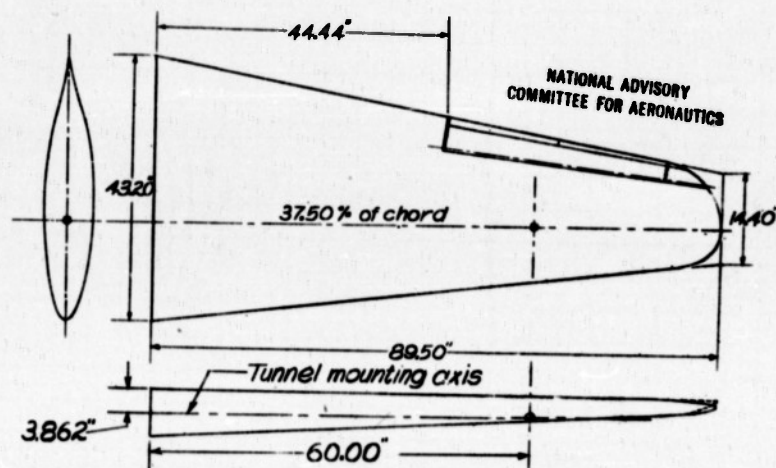


Figure E18: 0.36-scale semispan model of a tapered low-drag wing. LMAL 7-by-10-foot tunnel.

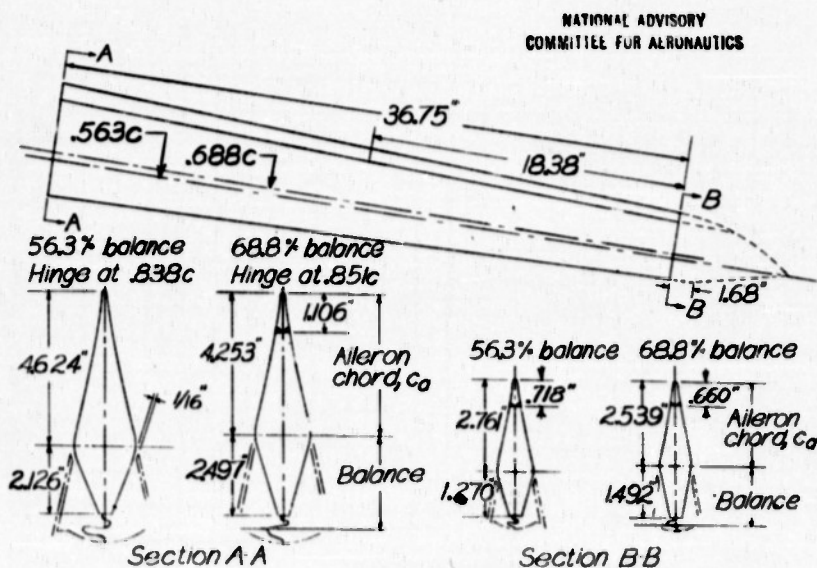
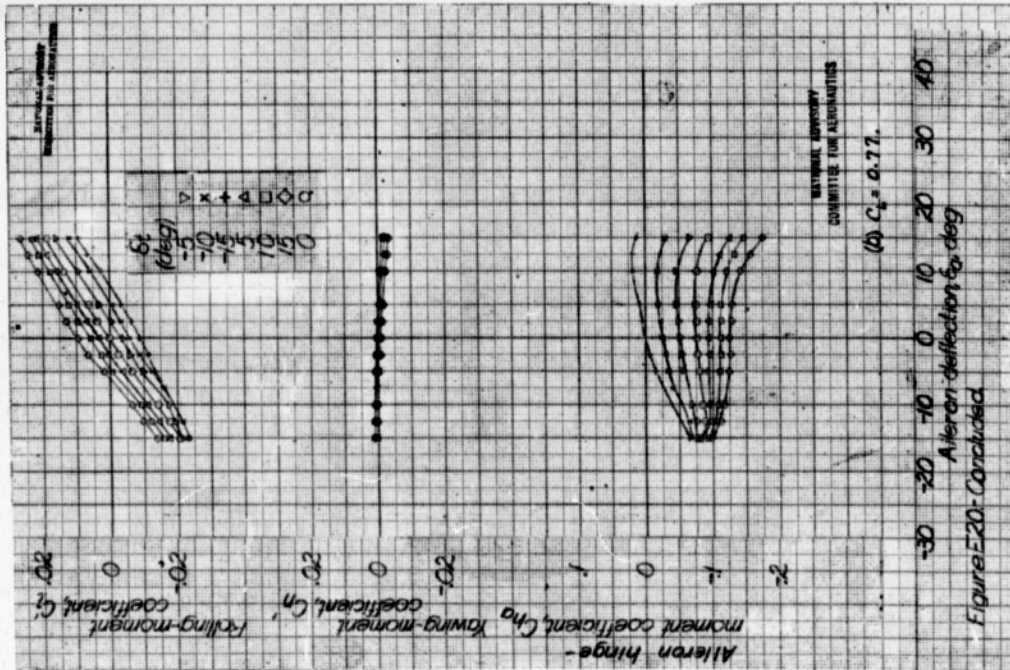
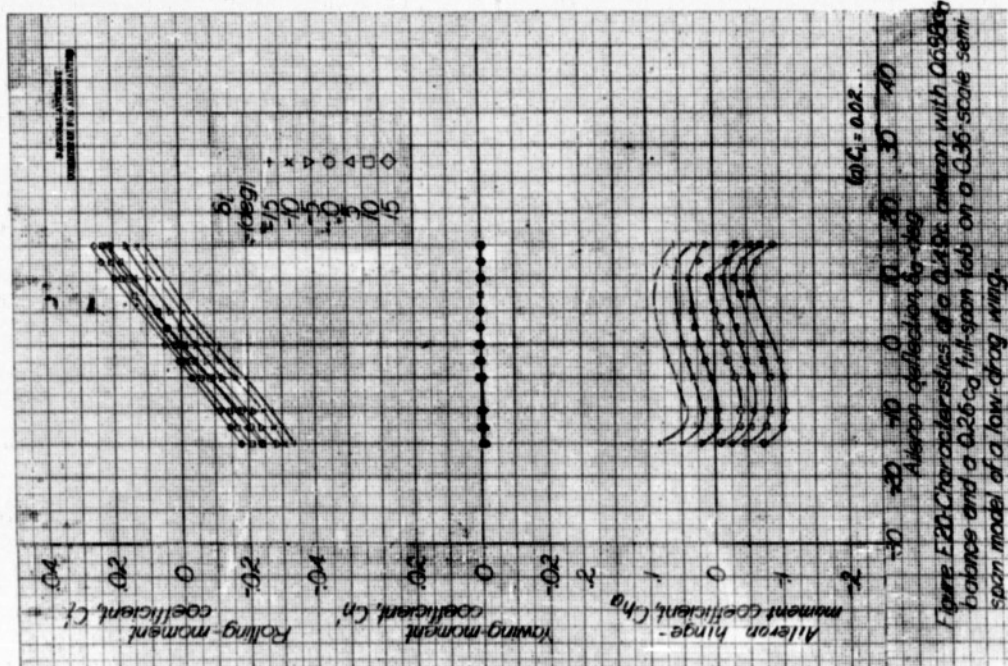


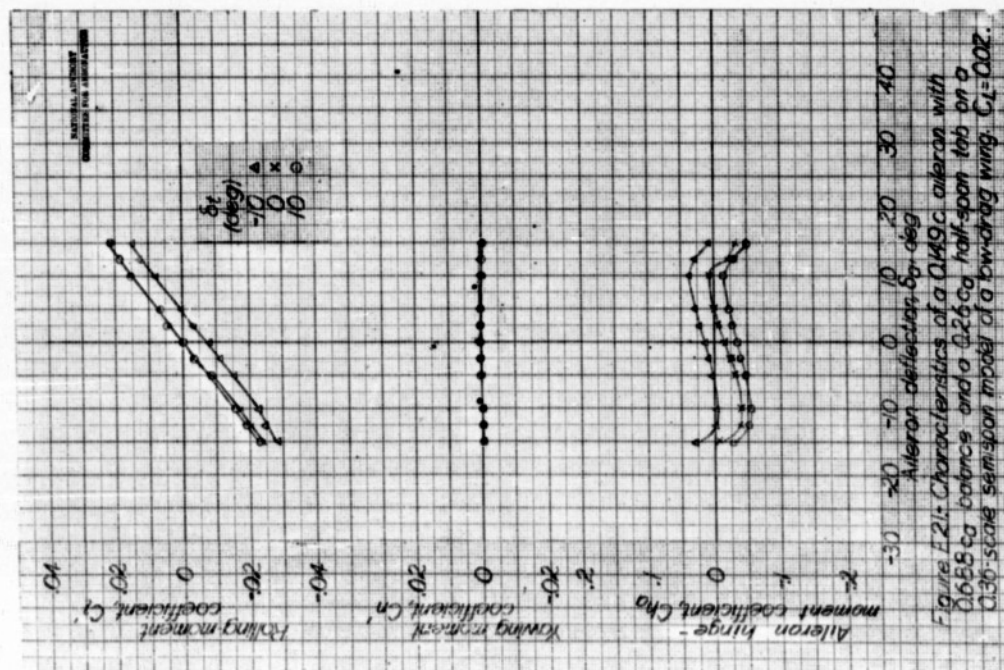
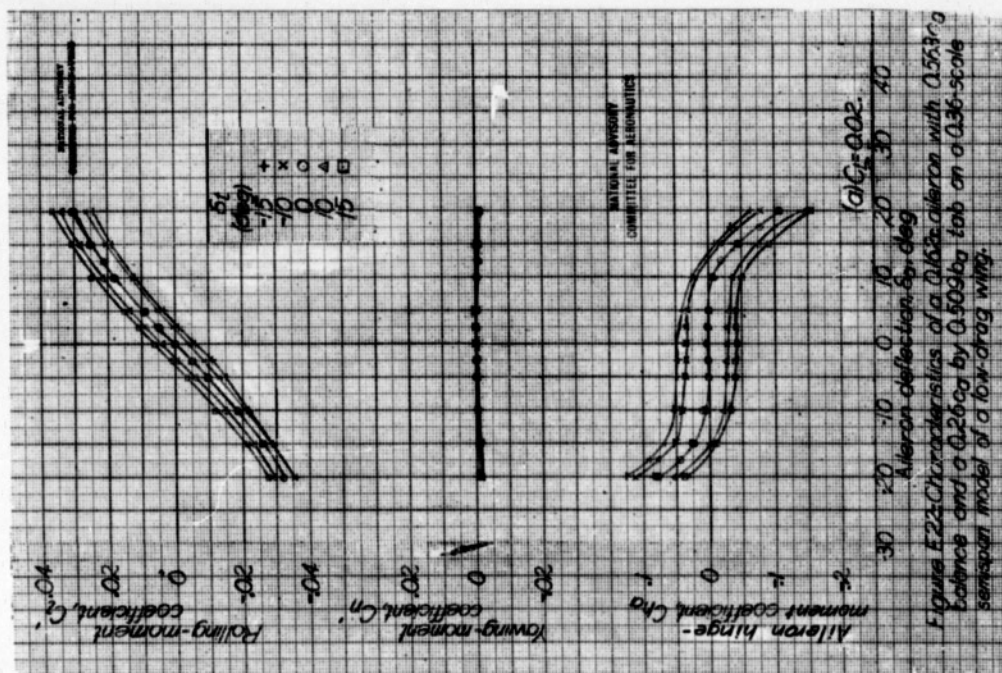
Figure E19: Aileron-tab arrangements tested on a 0.36-scale semispan model of a low-drag wing.

Model E-VI



677-7





Model E-VI

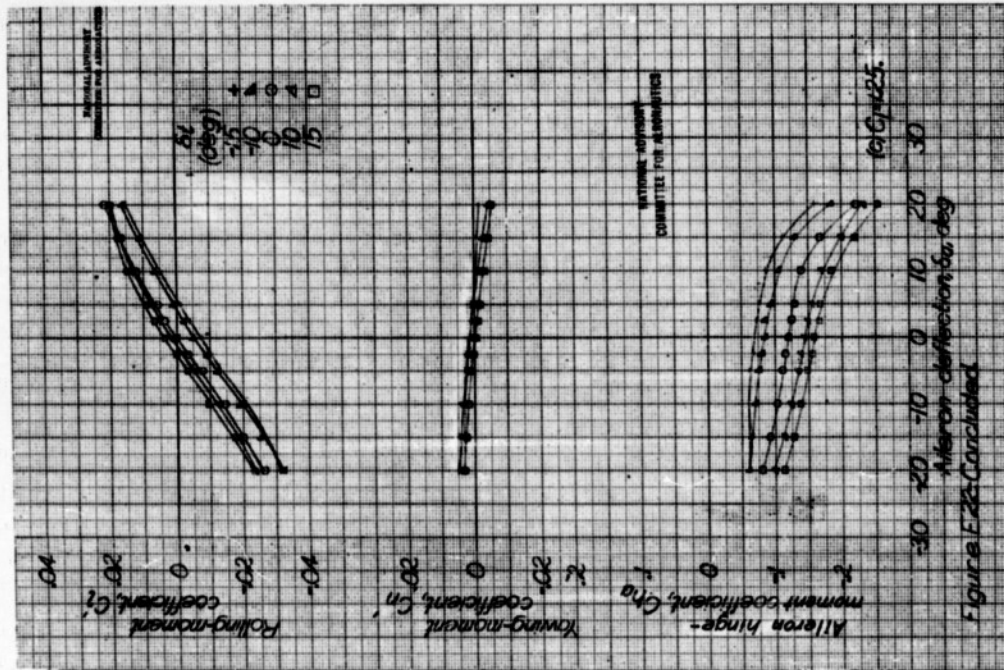


Figure E25-Continued

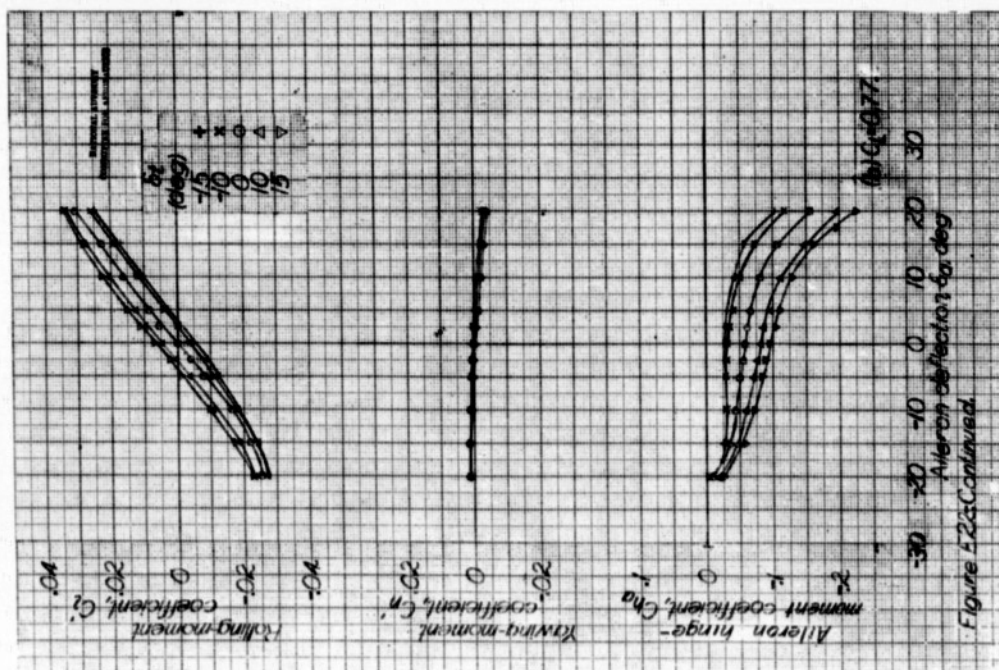
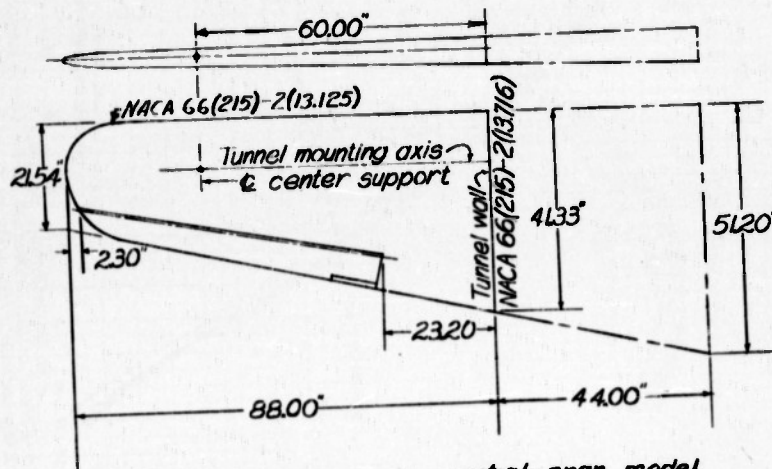


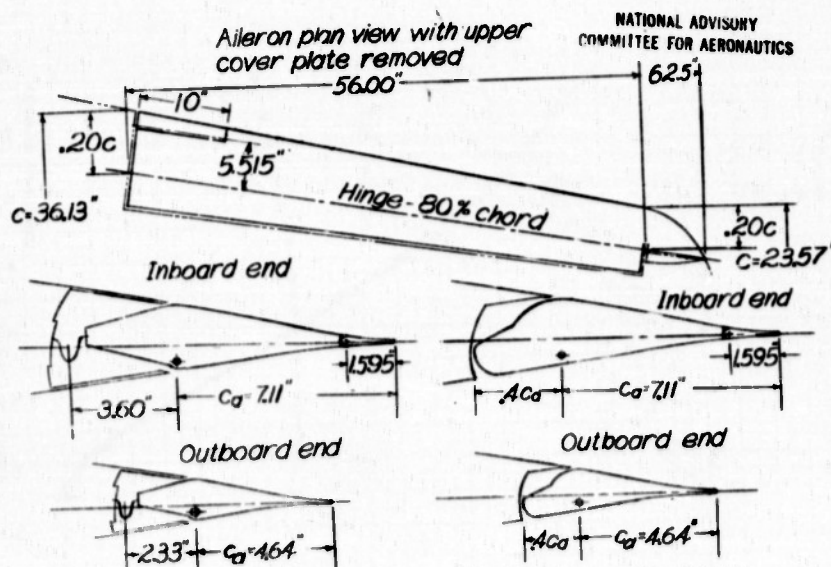
Figure E25-Continued

Model E-VII



(a) Plan form of 0.40-scale partial-span model.

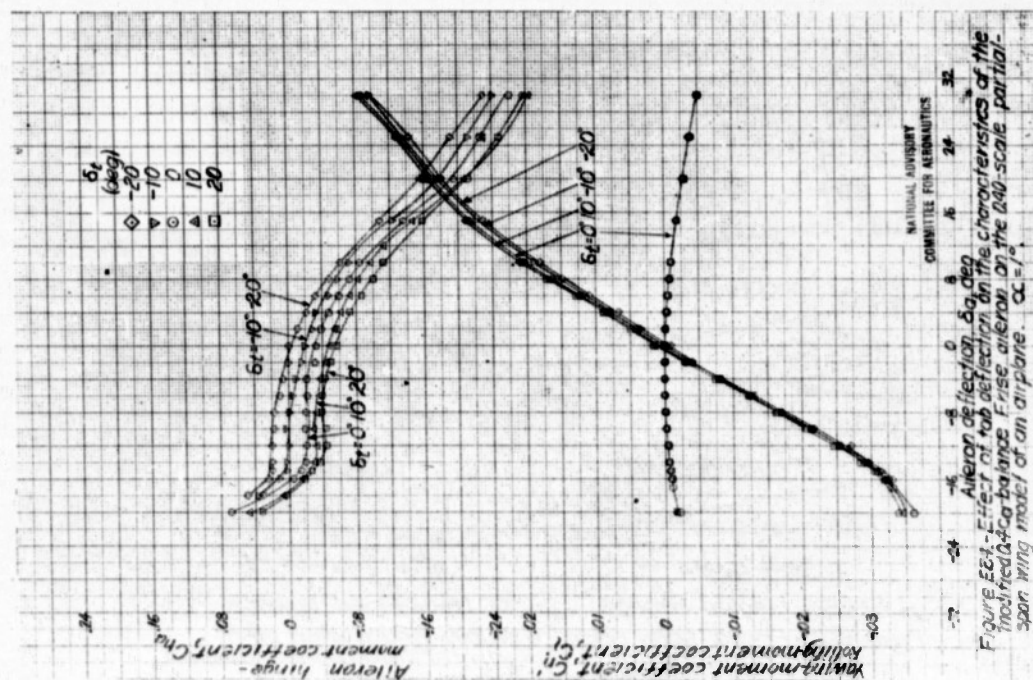
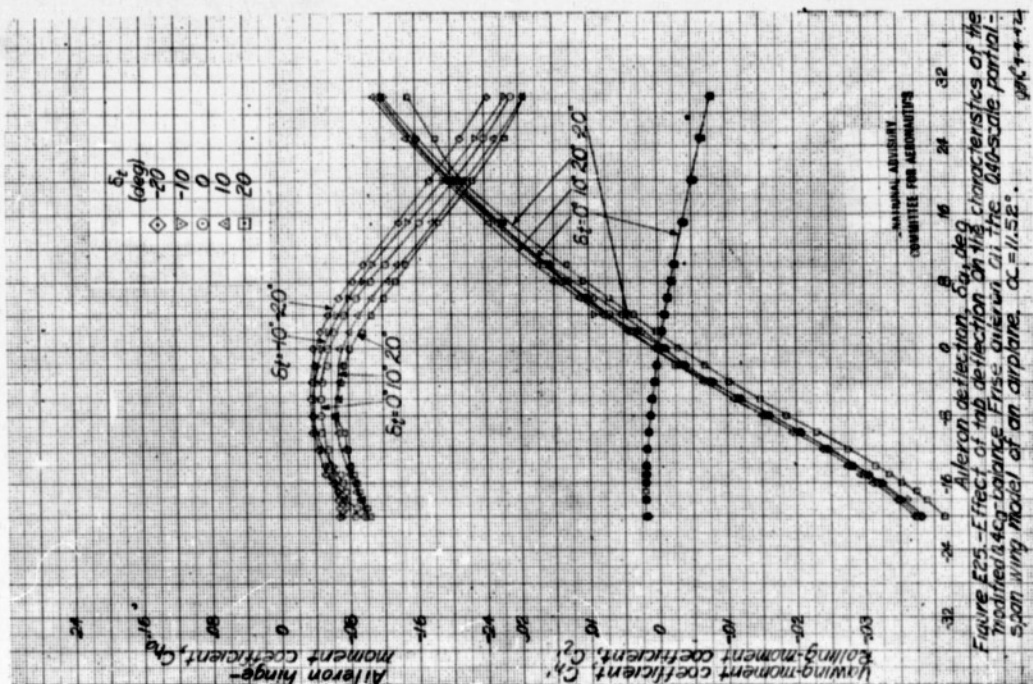
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(b) 0.505 c_a sealed balance

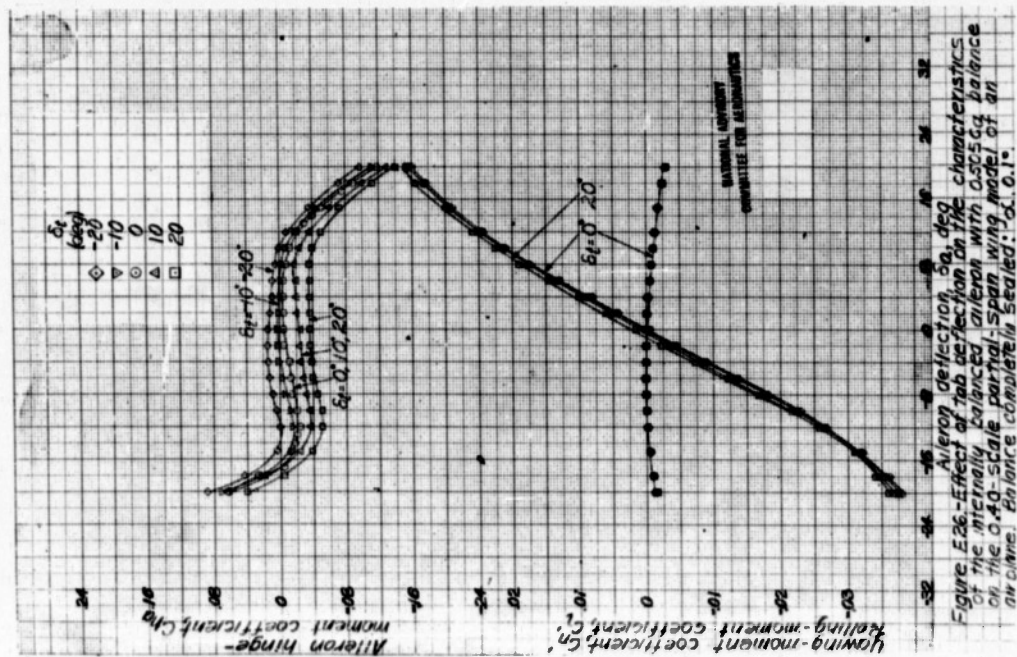
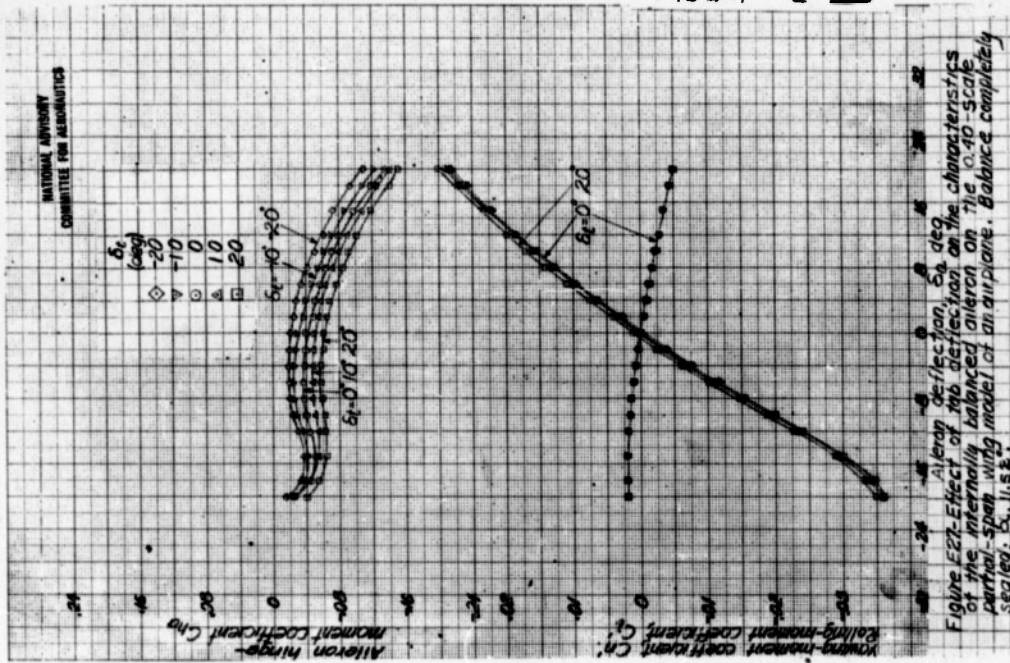
(c) 0.4 c_a Frise balance.

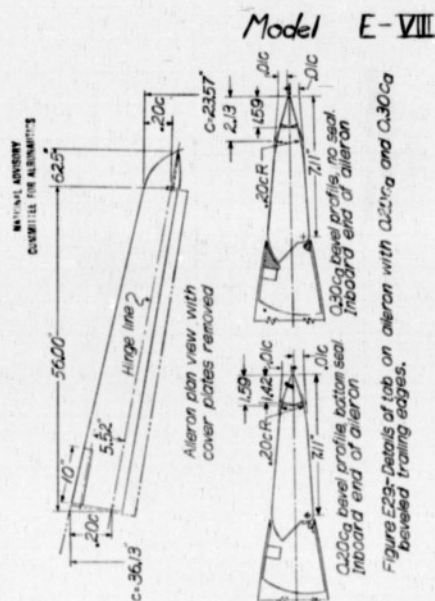
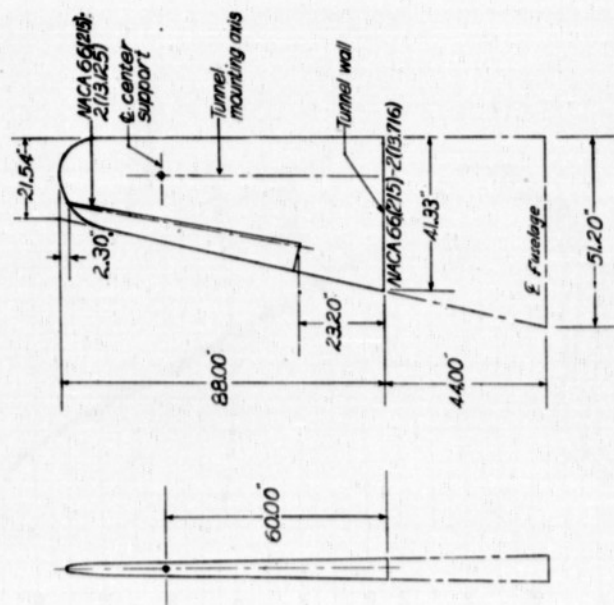
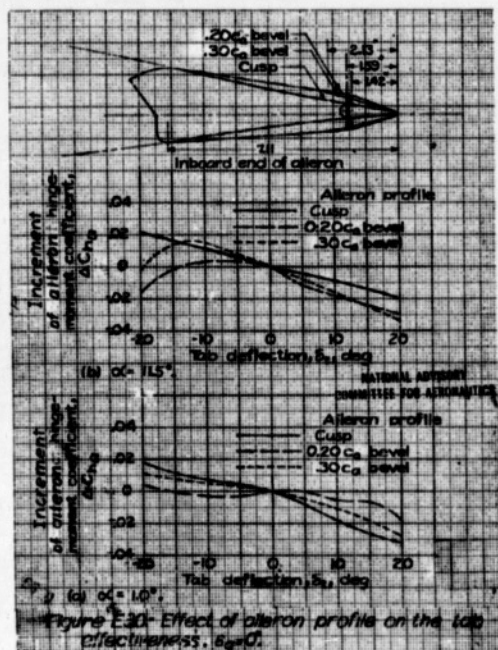
Figure E23: Partial-span model of a low-drag wing and tab arrangement on a sealed internal-balance aileron and a Frise aileron. LMAE 7 by 10-foot tunnel.

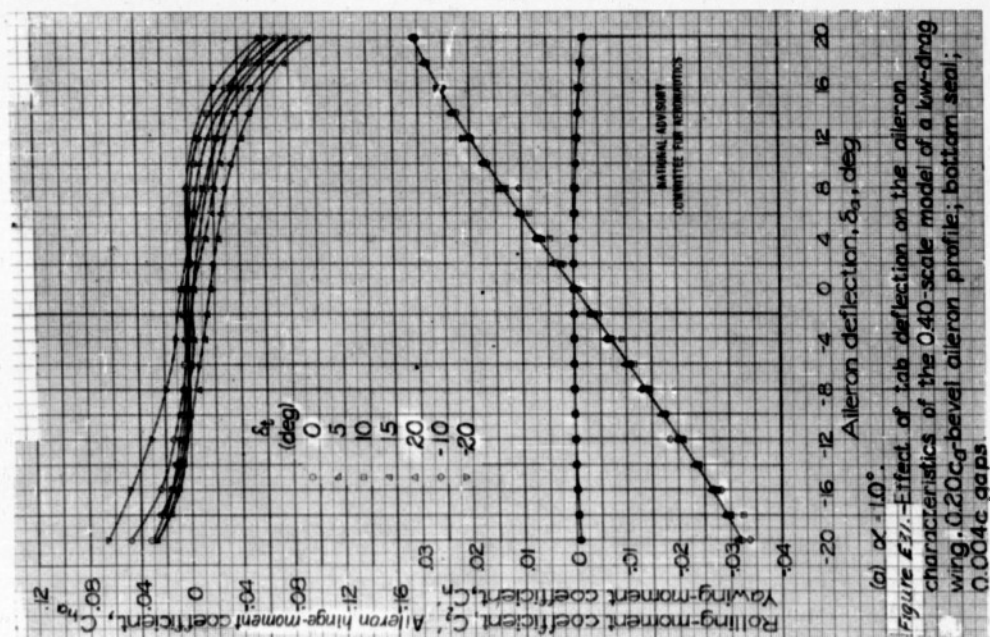
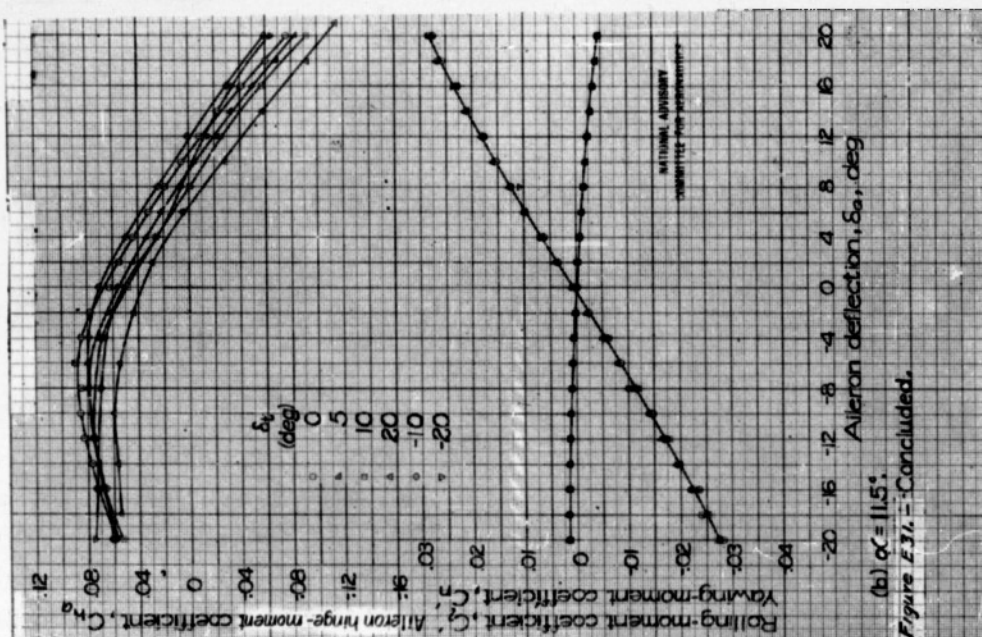


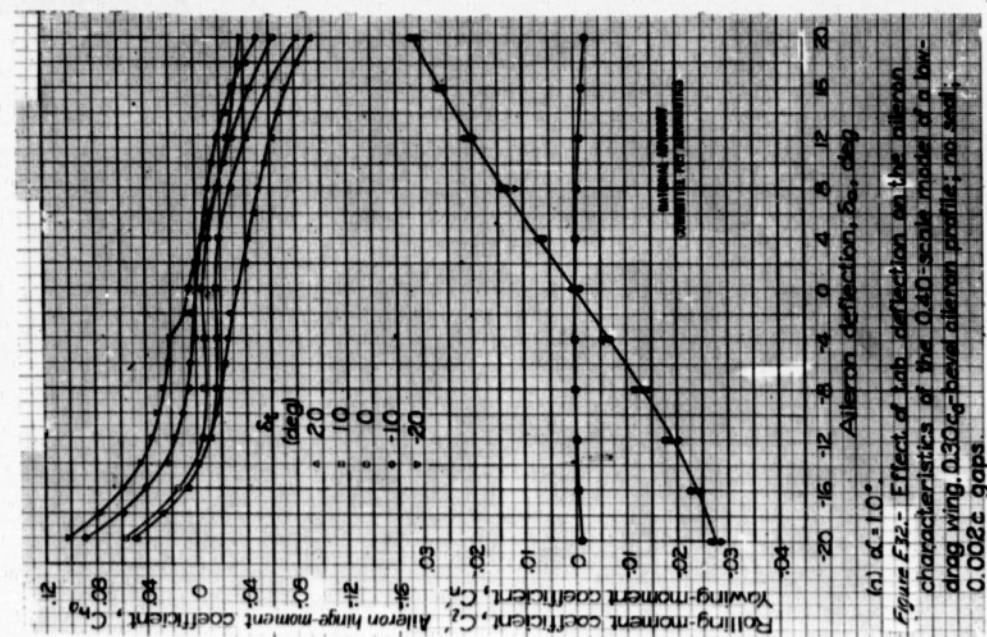
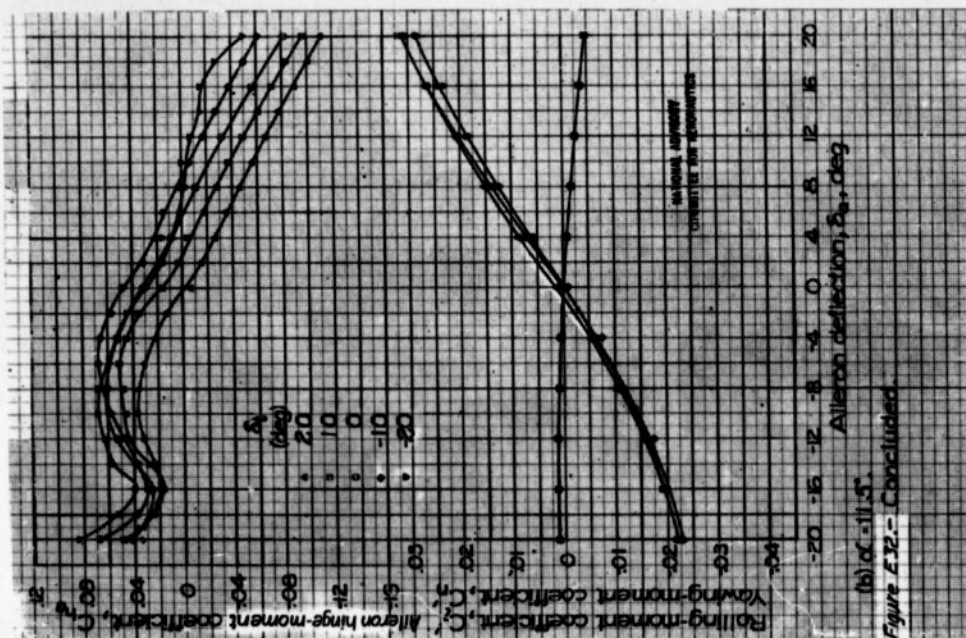
Model E-VII

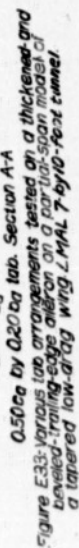
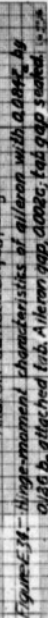
1-419



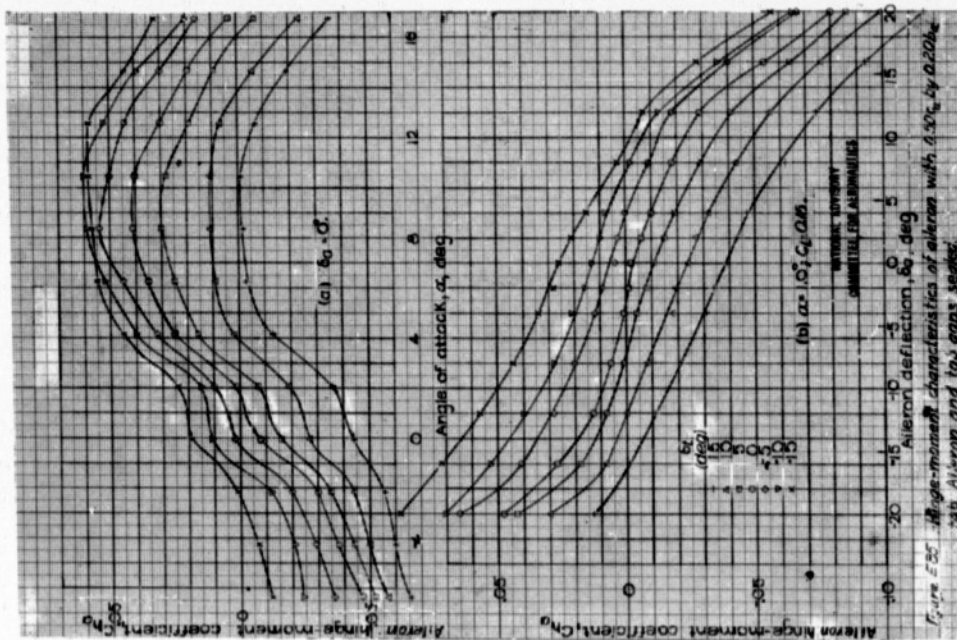
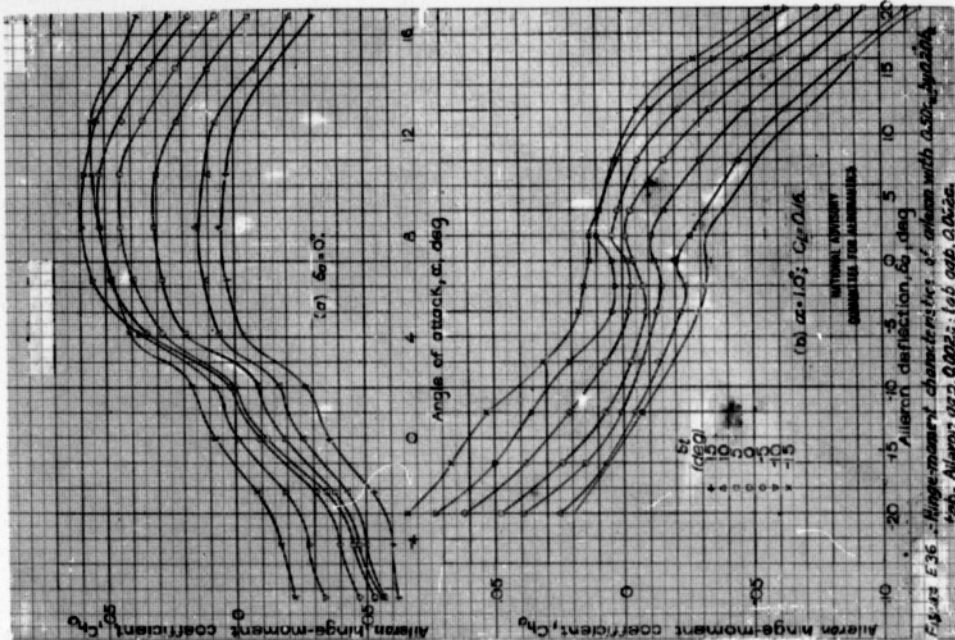








Model E-IX



Model E-IX

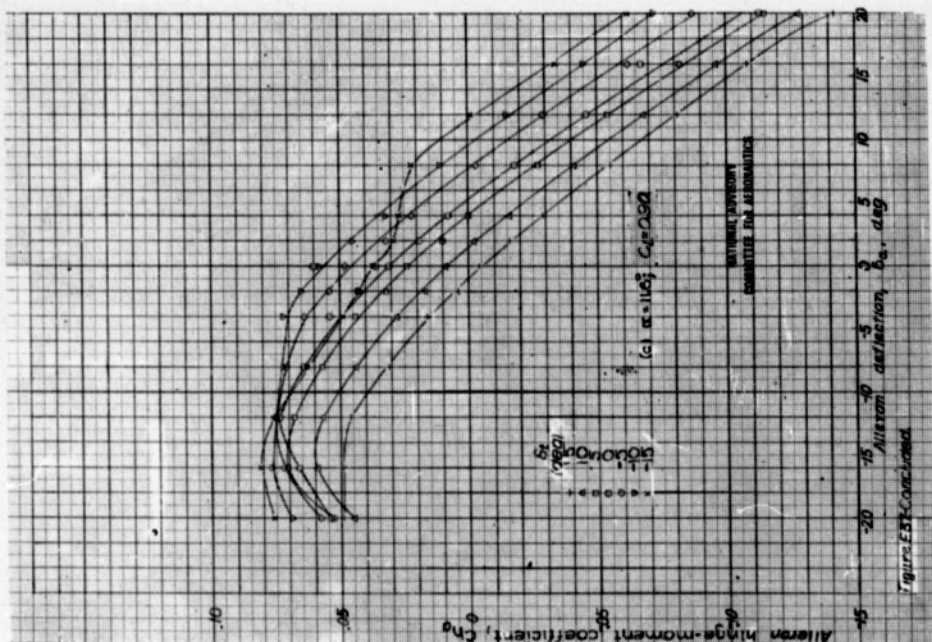


Figure E-57 (continued)

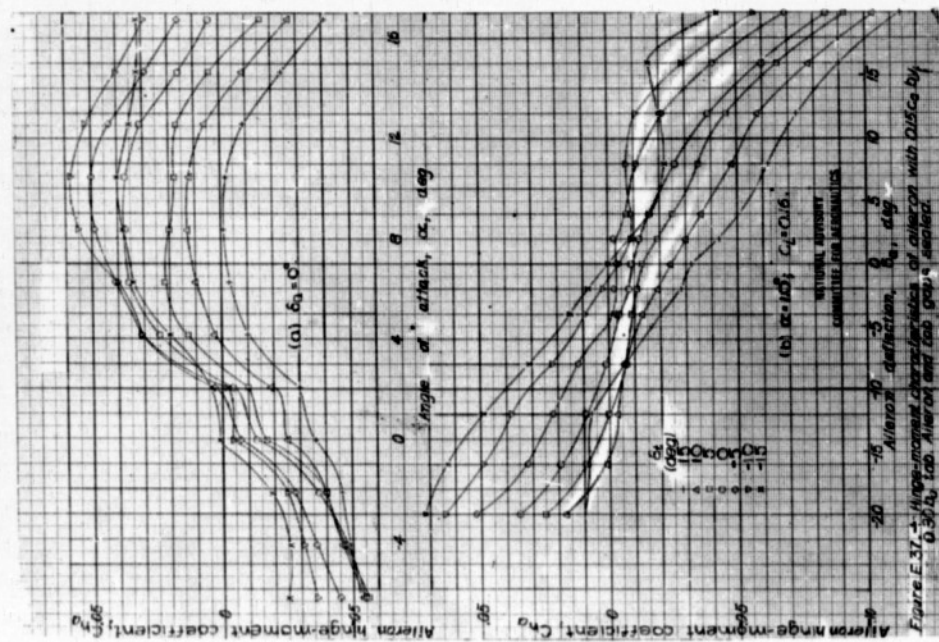


Figure E-57. Hinge-moment characteristics of alleron with D16C6 by 0.50 in. 100 Alleron and 100 gap, 1 inch.

Model E-3

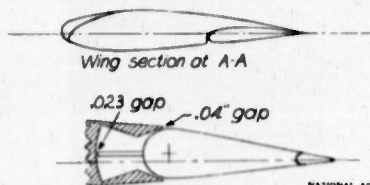
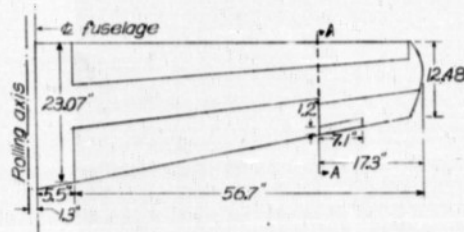
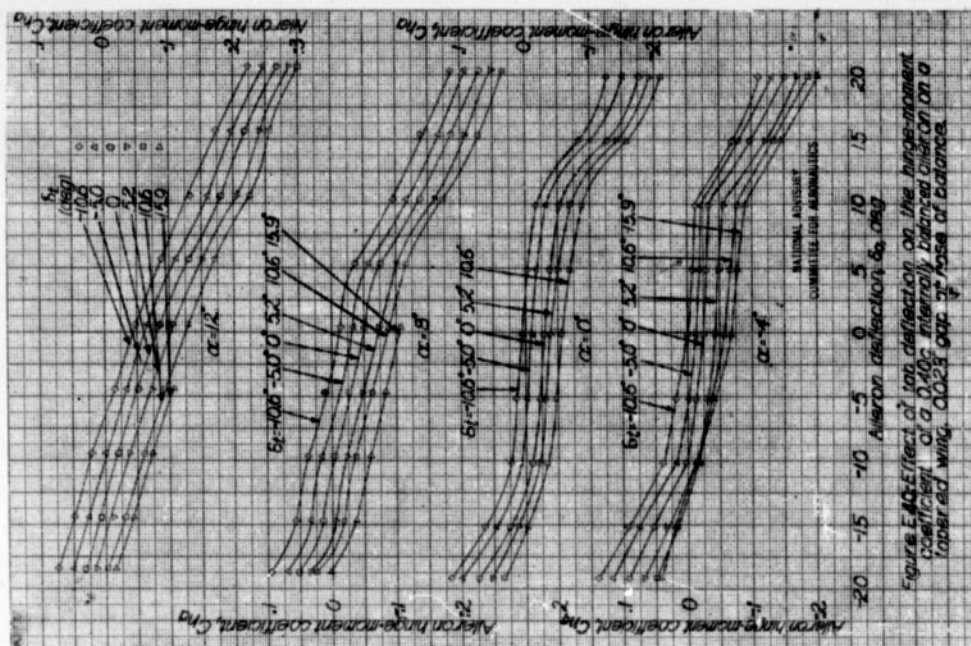
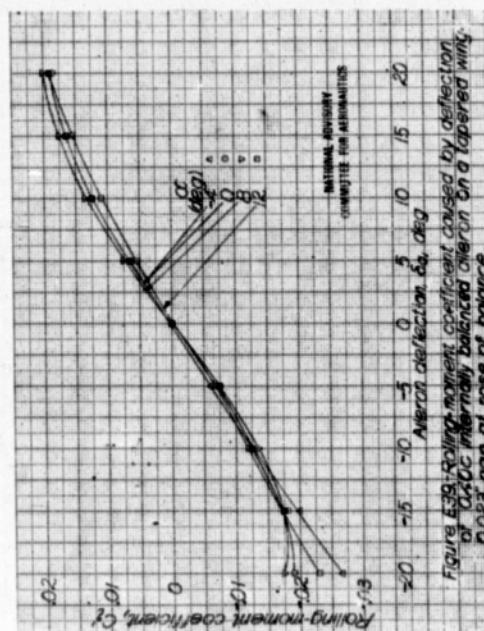


Figure E-38: 1/50 scale model of an airplane wing with internally balanced 0.40c aileron NPL 7-foot No. 2 tunnel.

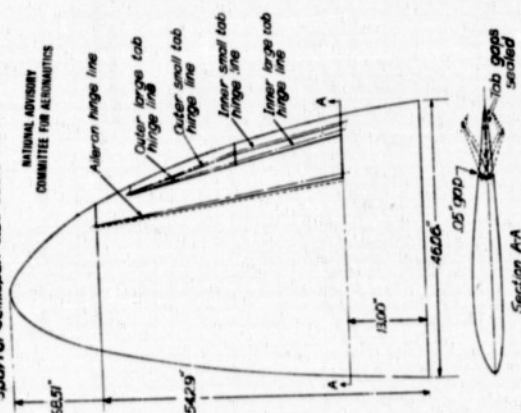


Geometric characteristics
of aileron and tabs

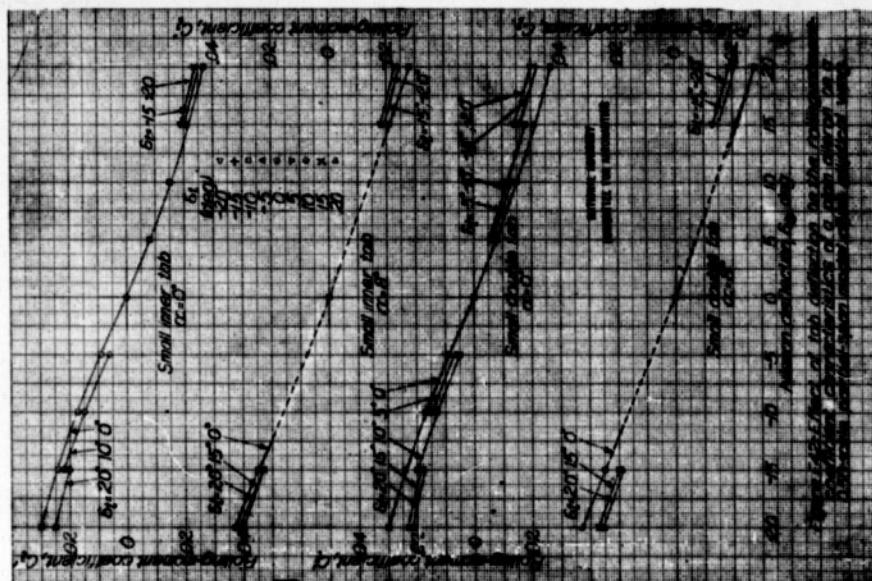
	Area of hinge line	Mean chord
Aileron	2.275 sq ft	0.663 ft
Small inner tab	.177 sq ft	.119 ft
Large inner tab	.367 sq ft	.246 ft
Small double tab	.363 sq ft	.123 ft
Large double tab	.663 sq ft	.225 ft

Wing thickness at aileron
span of semi-span Q50-scale model 111.06"

9%

NATIONAL ADVISORY
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on a Q50-scale partial-span model of
elliptical wing, NPL 7-foot tunnel

Model E-XI



Model E-XI

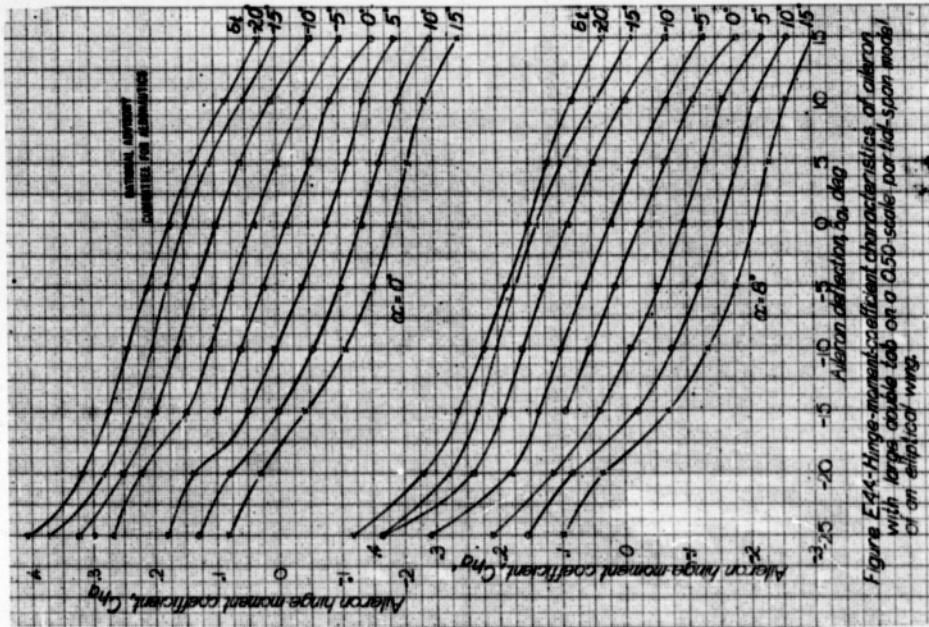


Figure E-44. Hinge-moment coefficient characteristics of aileron with large control tab on a Q50-scale partial-span model of an elliptical wing.

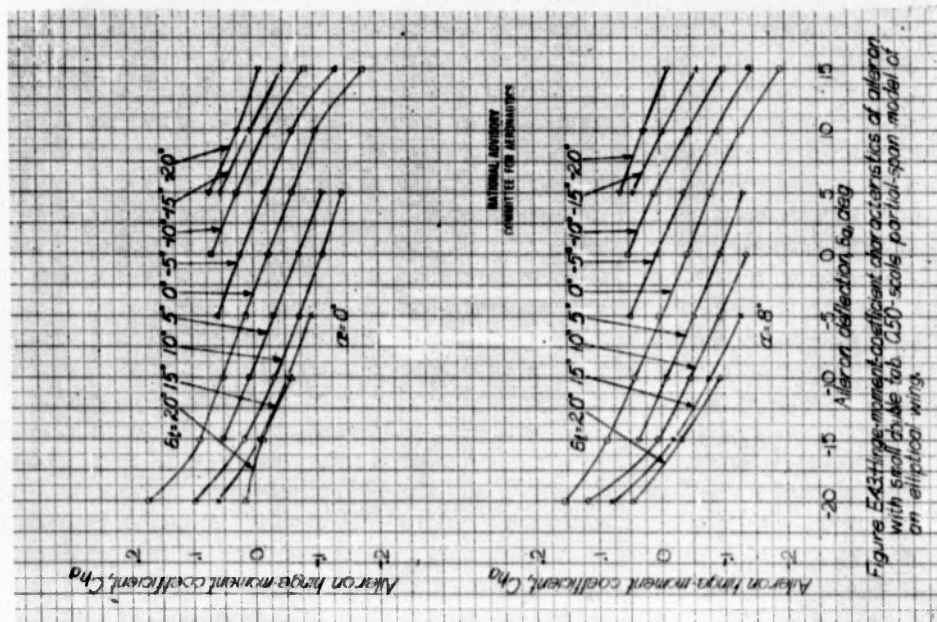


Figure E-43. Hinge-moment coefficient characteristics of aileron with small control tab on a Q50-scale partial-span model of an elliptical wing.

Model E-XI

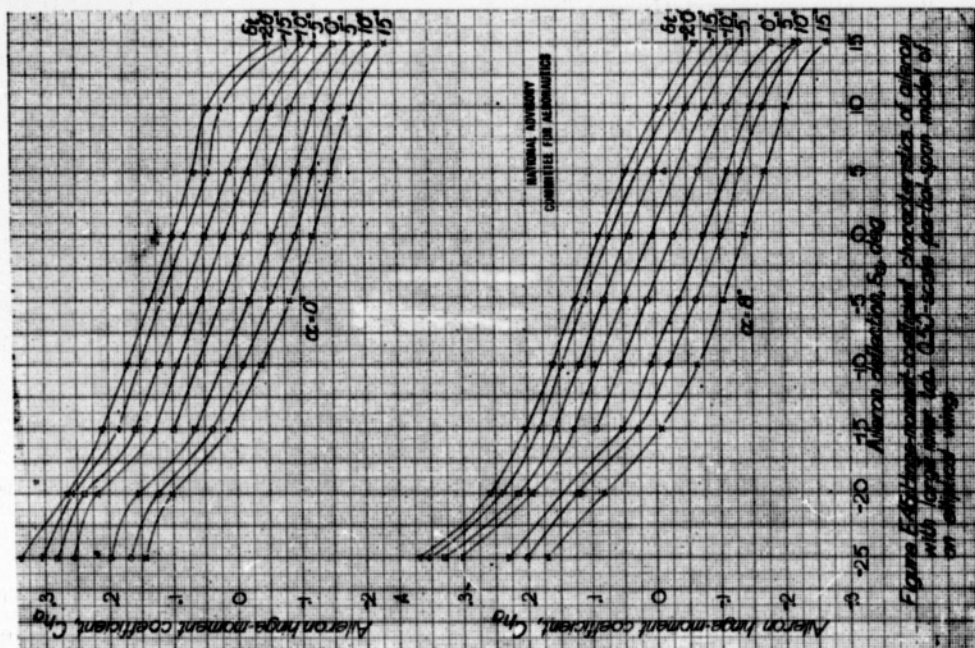


Figure E-419 Hinge-moment characteristics of aileron with large inner tab. 0.50-scale partial-span model of an elliptical wing.

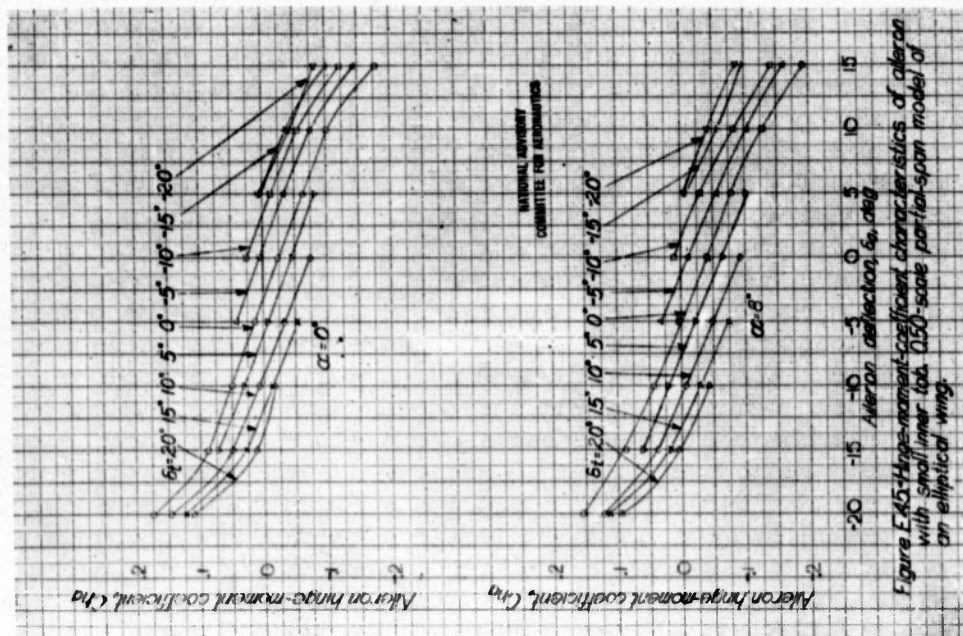


Figure E-45 Hinge-moment characteristics of aileron with small inner tab. 0.50-scale partial-span model of an elliptical wing.

Airplane E-XII

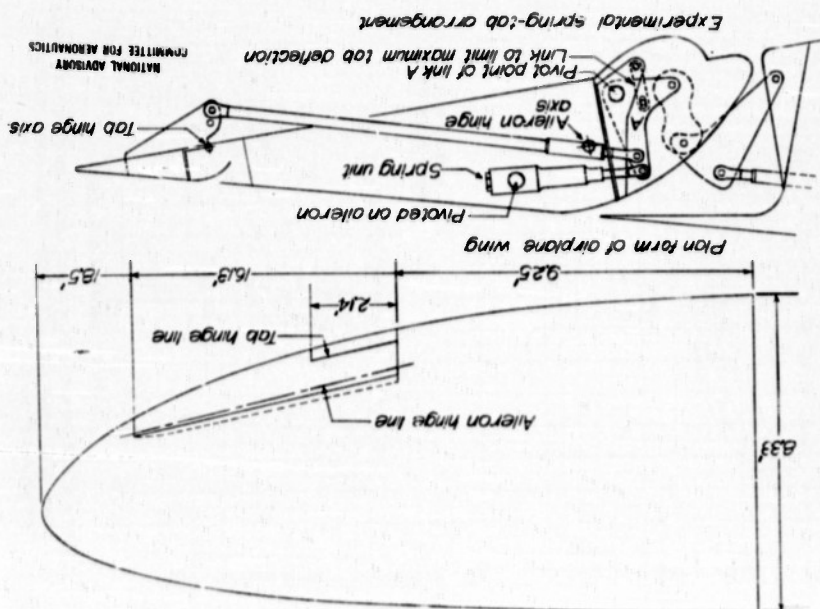
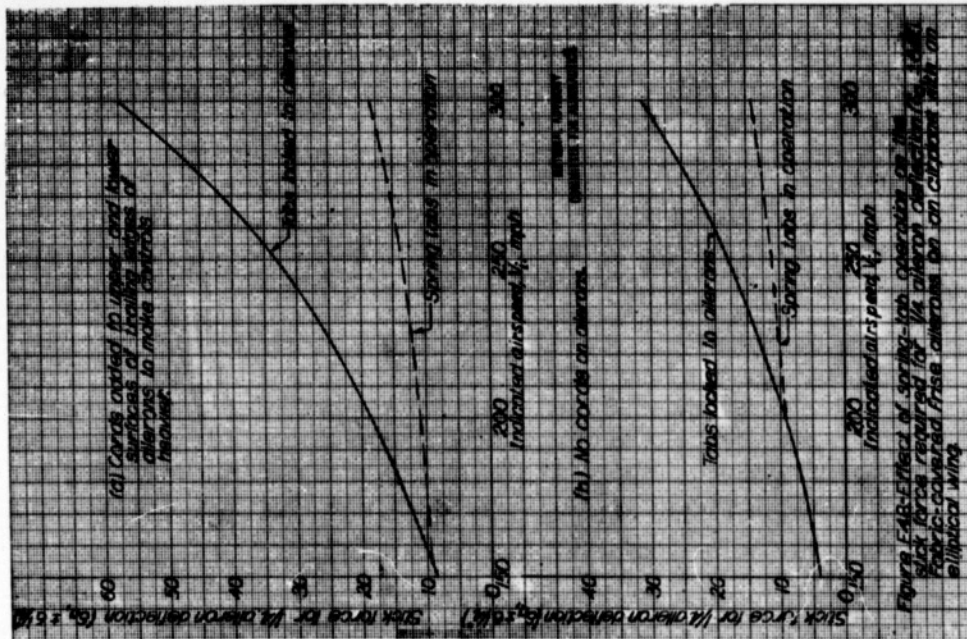


Figure E47: Plan form of elliptical wing of airplane and spring-tab arrangement used in flight tests in England.

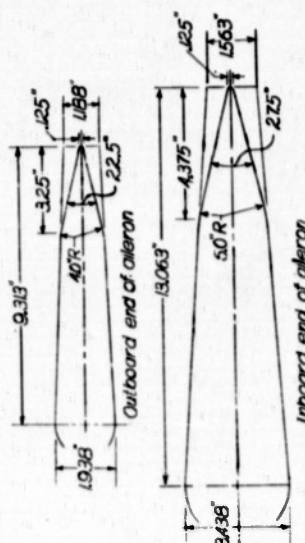
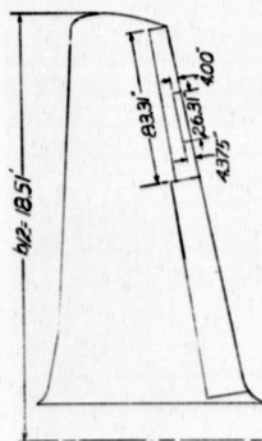
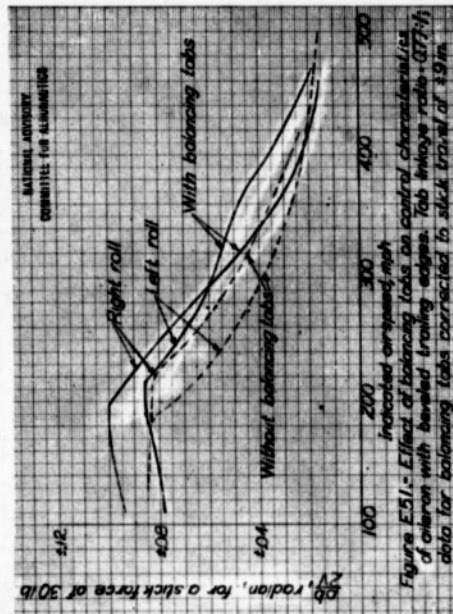
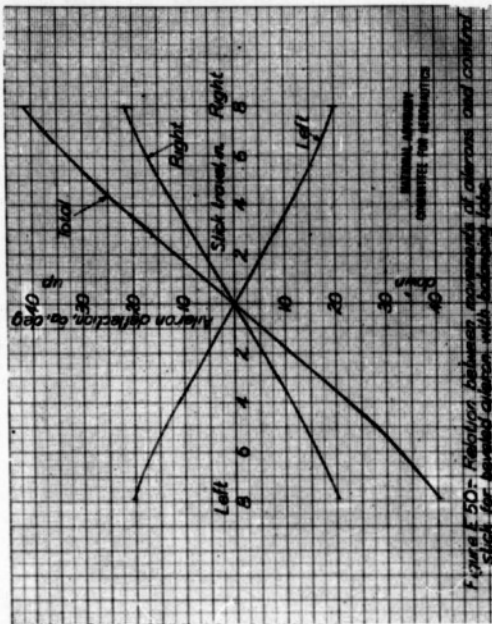
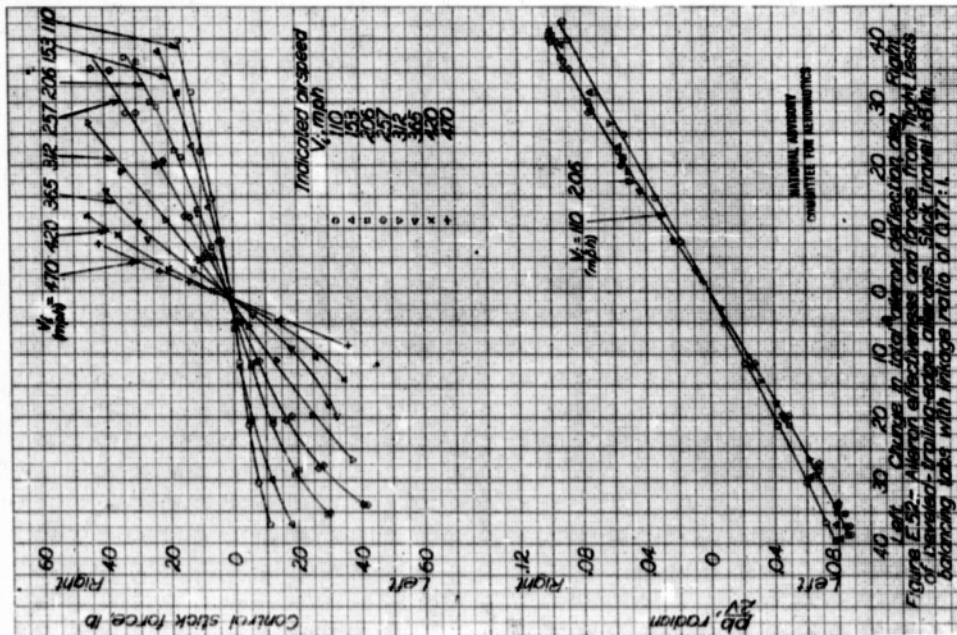
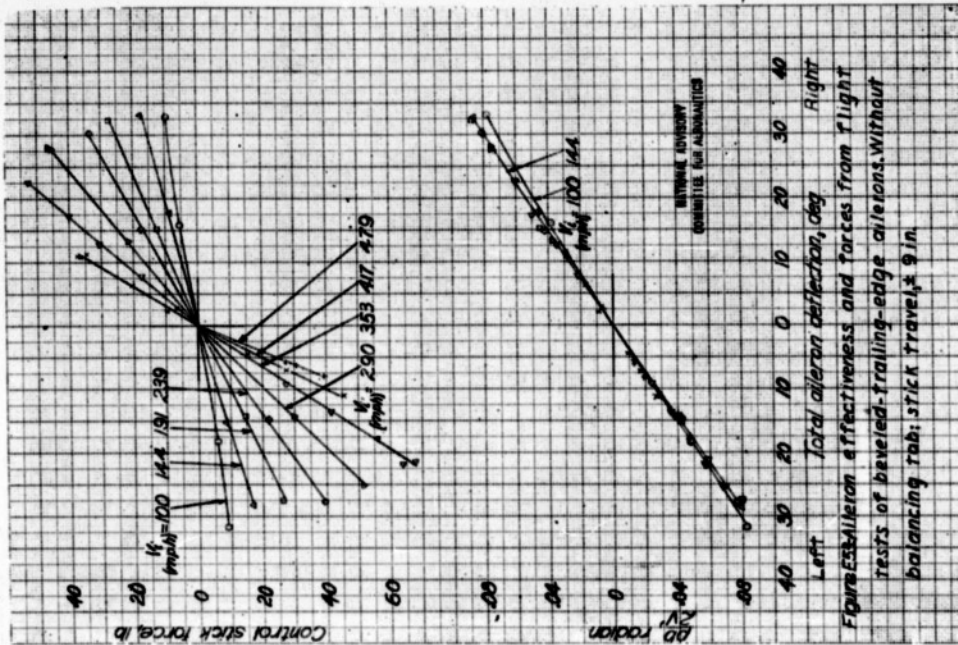


Figure E-49: Details of beveled trailing edge ailerons with balancing tabs and plan form of wing of airplane used in flight tests at LVAL.

Airplane E-XIII



REEL - C

792

A.T.I.

20960

NDIN FORM 63 (13 MAR 47)

Rogallo, F. M.

DIVISION: Aerodynamics (2)

SECTION: Control Surfaces (3)

CROSS REFERENCES: Ailerons - Balance data (03202)

ATI- 20960

ORIG. AGENCY NUMBER
ACR 4411

REVISION

AUTHOR(S)

AMER. TITLE: Collection of balanced-aileron test data

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