TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 449

WIND-TUNNEL RESEARCH COMPARING LATERAL CONTROL DEVICES, PARTICULARLY AT HIGH ANGLES OF ATTACK

IX. TAPERED WINGS WITH ORDINARY AILERONS

By Fred E. Weick and Carl J. Wenzinger
Langley Memorial Aeronautical Laboratory

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SUMMARY

This report is the ninth on a series of systematic tests in which various lateral control devices are compared, with particular reference to their effectiveness at high angles of attack. The present tests were made with ordinary flap-type ailerons on two wings with different amounts of taper, one medium and the other extreme. On each wing both medium-sized tapered ailerons and short wide tapered ailerons were tested and, in addition, on the wing with the extreme taper, medium and short wide ailerons having a constant chord were tested.

The tests, which were made in the N.A.C.A. 7 by 10 foot wind tunnel, showed the effect of the different plan forms on the general performance and lateral stability characteristics of the wings, as well as the effect of the different aileron shapes on the lateral controllability. It was found that the rolling control given by the ailerons on the wing with medium taper was about the same below the stall as that for corresponding ailerons on rectangular wings, but above the stall the rolling control was somewhat lower than on rectangular wings and well below an assumed satisfactory value. At angles of attack below the stall the yawing moments caused by the ailerons were somewhat lower on the wing with medium taper than on a rectangular wing, but just above the stall the adverse yawing moments were greater. The ailerons on the wing with extreme taper gave better lateral control at angles of attack below the stall in regard to rolling, yawing, and hinge moments than corresponding ailerons on rectangular wings or on the wing with medium taper, but just above the stall the rolling moments fell off almost completely and adverse yawing moments of great magnitude occurred.

INTRODUCTION

A series of systematic wind-tunnel investigations, one of which is covered by this report, is being made by the National Advisory Committee for Aeronautics in order to compare various lateral control devices. The various devices are given the same routine tests to show their relative merits in regard to lateral controllability and their effect on the lateral stability and on airplane performance. They are being tested first on rectangular Clark Y wings of aspect ratio 6, and then on wings with different plan forms and also wings with such variations as washout and sweepback, which affect lateral stability.

Part I of this series (reference 1) dealt with three different sizes of ordinary ailerons on rectangular wings. One of these ailerons was of medium size taken from the average of a number of conventional airplanes, one was extremely short and wide, and the other was extremely long and narrow. All the ailerons were proportioned to give approximately equal controllability at angles of attack below the stall with equal up-and-down deflection. The results were analyzed to show the relative merits of the three sizes of ailerons when set in the above manner and also when set with two differential movements, and with upward movement only. The narrow-chord ailerons were found to be definitely inferior to the medium and wide ones in regard to rolling moments at the high angles of attack.

Parts II and III (reference 1) deal with other forms of ailerons and lateral control devices on rectangular wings. Part VIII covers tests of medium and wide conventional ailerons on wings with rounded tips, and the present report deals with conventional ailerons on tapered wings. Model wings with medium and extreme taper were used, the first having the center-chord length five-thirds that of the tip chord, and the second having the center-chord length five times that of the tip chord. Since narrow-chord ailerons had given very low rolling moments at high angles of attack on a rectangular wing, the tapered wings were tested with medium chord and wide chord ailerons only.

APPARATUS

Wind tunnel.- The N.A.C.A. 7 by 10 foot wind tunnel, which is being used throughout the entire investigation, has an open jet and a single closed return passage. The tunnel, together with the regular balance and associated apparatus, is described in detail in reference 2.

Models.- The tests were made with flap-type ailerons on two wings, one wing having a 5:3 taper and the other a 5:1. Both wing models were constructed of laminated mahogany, with spans of 60 inches, aspect ratios of 6, and Clark Y airfoil sections along the entire span. The wings had equal taper of the leading and trailing edges, and the maximum ordinates of all sections were in a horizontal plane on the upper surface. On each wing both medium-sized tapered ailerons and short wide tapered ailerons were tested and, in addition, on the wing with 5:1 taper, medium and short wide ailerons having a constant chord were tested. Inasmuch as previous tests (reference 1) had shown that the moments caused by both right and left ailerons could be found separately and added together to give the total effect of both with a satisfactory accuracy, the present tests were made with the right aileron only. Each wing model was equipped with a removable tip portion as shown in Figures 1 and 2, and a different model of this portion of the wing was made for each of the ailerons.

The tapered ailerons were tapered with the wings, the chord of the medium-sized ones (A, figs. 1 and 2) at any longitudinal section being 25 per cent of the wing chord at the same section, and the chord of the short wide ones (B, figs. 1 and 2) being 40 per cent of the wing chord at any section. The ailerons with constant chord (C and D, fig. 2) had the same chord dimension as the average chord of the tapered ailerons on the wing with 5:1 taper. These constant chord ailerons on the tapered wing were of the nature of skewed ailerons on rectangular wings. The aileron spans were all selected to give approximately the same rolling control at angles of attack below the stall as the medium ailerons on a rectangular wing. (Part I, reference 1.)

TESTS

The tests were conducted in accordance with the standard procedure, and at the dynamic pressure and Reynolds Number employed throughout the entire series of investigations on lateral control. (Reference 1.) The dynamic pressure was 16.37 pounds per square foot, corresponding to an air speed of 80 miles per hour at standard density, and the Reynolds Number was 609,000, based on the average chord.

TABLE I

SIMULTANEOUS AILERON DEFLECTIONS WITH ASSUMED DIFFERENTIAL MOVEMENTS

Angles Measured about Aileron Axis

Average differential (No. 1)		Extreme differential (No. 2)	
Upward displacement	Downward displacement	Upward displacement	Downward displacement
Degrees	Degrees	Degrees	Degrees
0	0	0	0
10	8.5	10	7
20	13	20	12
30	15	30	14
35	15	40	11.5
		50	7

The regular force tests were made, at 0° yaw, with a sufficient number of angles of attack to determine the maximum lift coefficient, the minimum drag coefficient, and the drag coefficient at $C_L = 0.70$, which is used to give a rate-of-climb criterion. Because of the large effect of yaw on the lateral stability, tests were made not only at 0° yaw, but also with an angle of yaw of 20°, which represents the conditions in a fairly severe sideslip. Free-autorotation tests were made to determine the angle of attack above which autorotation was self-starting with ailerons neutral. Forced-rotation tests were also made in which the rolling moment while rolling was measured at the rotational velocity corresponding to $\frac{p'b}{2V} = 0.05$, the highest rate likely to be obtained in gusty air, and at angles of yaw of both 0° and ±20°.

Aileron movements.- From tests with the single ailerons deflected upward and downward various amounts, data were obtained from which the results were computed for four aileron movements: the equal up-and-down, average differential, extreme differential, and up-only movements. These movements were the same as those used in Part I. (Reference 1.) The relative up-and-down displacements with the two differential movements are given in Table I and the assumed linkages to obtain all of the movements in Figure 3. The deflection of the ailerons was measured in a plane perpendicular to the hinge axis, and is slightly greater than the projected angle of deflection in a longitudinal plane.

Accuracy.- The accuracy of the results presented in this report is the same as that obtained in Part I. It is considered satisfactory at all angles of attack except in the burbled region between 20° and 25° when the rolling and yawing moments are relatively unreliable due to the critical, and often unsymmetrical, condition of the burbled air flow around the wing.

RESULTS

Coefficients.- The force-test results are given in the form of absolute coefficients of lift and drag and of the rolling and yawing moments:

$$C_L = \frac{\text{lift}}{q\ S}$$

$$C_D = \frac{\text{drag}}{q\ S}$$

$$C_l{}' = \frac{\text{rolling moment}}{q\ b\ S}$$

$$C_n{}' = \frac{\text{yawing moment}}{q\ b\ S}$$

where S is the total wing area, b is the wing span, and q is the dynamic pressure. The coefficients are obtained directly from the balance and refer to the wind (or tunnel) axes. In special cases in the discussion where the moments are used with reference to body axes, the coefficients are not primed. Thus the symbols for the rolling and yawing moment coefficients about body axes are C_l and C_n. The results as given are not corrected for tunnel-wall effect.

The results of the forced-rotation tests are given, also about the wind axes, by a coefficient representing the rolling moment due to rolling:

$$C_\lambda = \frac{\lambda}{q\ b\ S}$$

where λ is the rolling moment measured while the wing is rolling, and the other factors have the usual significance. This coefficient may be used as a measure of the degree of lateral stability or instability of a wing under various rolling conditions. In the present case, it is used to indicate the characteristics of a wing when it is subjected to a rolling velocity equal to the maximum likely to be encountered in controlled flight in very gusty air. This rolling velocity may be expressed in terms of the wing span as

$$\frac{p'b}{2\ V} = 0.05$$

where V is the air speed at the center section of the wing, and p' is the angular velocity in roll about the wind axis.

Tables.- The results of the tests are given in Tables II to XV. Table II gives values of C_L, C_D, C_l', and C_n' for all aileron deflections (one aileron only) at 0° yaw for the wing with 5:3 taper, and medium aileron. Table III contains similar data for the same wing and aileron combination, but with -20° yaw. Tables IV and V are similar to II and III, but contain the data for the short wide ailerons on the same wing. Table VI contains the results of the rotation tests for the same wing. Similarly, Tables VII to XV give the results for the wing with 5:1 taper.

DISCUSSION IN TERMS OF CRITERIONS

For a comparison of the different lateral control arrangements, the results of the tests are discussed in terms of criterions, which are explained in detail in Part I and briefly in the following paragraphs. By use of these criterions a comparison of the effect of the different control devices on the general performance, the lateral controllability, and the lateral stability may be made. The values of the criterions summarizing the results of the present tests are given in Table XVI, and the values for the standard and the short, wide ailerons of Part I (rectangular wings) are included for comparison.

General Performance

(Ailerons Neutral)

Wing area required for desired landing speed.- The value of the maximum lift coefficient is used as a criterion of the wing area required for the desired landing speed, or conversely for the landing speed obtained with a given wing area. The value of the maximum lift coefficient was nearly the same for the tapered wings as for the rectangular, but the wing with 5:3 taper had a very slightly higher value than the rectangular wing, and the wing with 5:1 taper had a very slightly higher value than that with 5:3 taper.

Speed range.- The ratio $C_{L_{max}}/C_{D_{min}}$ is a convenient figure of merit for comparison of the relative speed range obtained with various wings. The value of the speed-range ratio was slightly greater for the wing with 5:3 taper than for the rectangular wing, and was still greater for the wing with 5:1 taper. It was about the same for the wing with 5:1 taper as for the straight wing with long rounded tips tested in Part VIII. (Reference 1.)

Rate of climb.- In order to establish a suitable criterion for the effect of the wing and the lateral control devices on the rate of climb of an airplane, the performance curves of a number of types and sizes of airplanes were calculated, and the relation of the maximum rate of climb to the lift and drag curves was studied. This investigation showed that the L/D at $C_L = 0.70$ gave a consistently reliable figure of merit for this purpose. The numerical value of this criterion was slightly lower for the wing with extreme taper than for the wings with either 5:3 taper or rectangular form.

Lateral Controllability

(Maximum Assumed Aileron Deflection)

Rolling criterion.- The rolling criterion upon which the control effectiveness of each of the aileron arrangements is judged is a figure of merit which is designed to be proportional to the initial acceleration of the wing tip that follows instantaneous deflection of the ailerons from neutral, regardless of the air speed or the plan form of the wing. Expressed in coefficient form, this rolling criterion is

$$\underline{RC} = \frac{C_l \ S \ b^2}{12 \ C_L \ I_x}$$

where C_l is the coefficient of rolling moment due to the ailerons with respect to the body axes (which axis for the wing alone is taken as the midspan chord line), and I_x is the area moment of inertia of the wing about the midspan chord line. A more detailed explanation of the derivation of RC and the assumptions upon which it is based is given in Part I, reference 1.

The numerical value of this criterion that is assumed to represent satisfactory control conditions is approximately 0.075, the value given by the standard ordinary ailerons with the assumed maximum deflection of ±25° at an angle of attack of 10°. (See Part I, reference 1.)

The comparison of the criterions for the various ailerons and movements is given in Table XVI for four representative angles of attack: 0°, 10°, 20°, and 30°. The 0° angle represents the high-speed attitudes; $\alpha = 10°$ represents the highest angle of attack in which entirely satisfactory control with ordinary ailerons is obtained; $\alpha = 20°$ is the condition of greatest lateral instability and is probably about the greatest obtainable angle of attack in a steady glide with most present-day airplanes; and finally, $\alpha = 30^\circ$ is given only for a comparison with controls for possible future types of airplanes.

At $\alpha = 0^\circ$ all the ailerons give values of RC greatly in excess of that considered necessary, the values for the wing with the 5:1 taper being about one-third higher than those for the wings with the 5:3 taper or rectangular forms.

At $\alpha = 10^\circ$ the ailerons on the wing with 5:3 taper, as well as those on the rectangular wings, gave values of RC reasonably close to the assumed satisfactory value, but the ailerons on the wing with the 5:1 taper all gave values substantially higher - on the average about one-third higher. Thus, all the ailerons on the wing with 5:1 taper had spans too great, although they were proportioned, to give the same rolling control as the medium ailerons on the rectangular wing at angles of attack below the stall. This condition favors the ailerons on the wing with extreme taper in the comparisons of Table XVI, but inasmuch as these ailerons, even with their large size, give very poor control moments at high angles of attack, the comparison serves the purpose of the present investigation reasonably well.

At $\alpha = 20^\circ$ the ailerons on the wing with 5:3 taper gave definitely lower values of RC than the corresponding ailerons on rectangular wings, and the values for the ailerons on the wing with 5:1 taper were in most cases so low as to make these ailerons useless for lateral control. The short wide ailerons with both the extreme differential and the up-only movements gave the highest values, those for the tapered ailerons with constant percentage chord being higher than those for the straight ailerons having constant absolute chord, but the highest was only about 60 per cent of the assumed satisfactory value. None of the ailerons gave moments of useful magnitude with the more conventional equal up-and-down and ordinary differential movements. These tests indicate that ailerons on tapered wings give excellent rolling-control moments at angles of attack below the stall, but that these moments decrease very rapidly as the stalling angle is exceeded so that the control above the stall is very poor.

At $\alpha = 30^\circ$ the ailerons on the tapered wings gave higher values of RC than those on the rectangular wings, but for the wing with 5:1 taper this fact means little, for the values were very low and in some cases negative for the angles of attack between that for the stall and 30°.

Lateral control with sideslip.- If a wing is yawed appreciably, a rolling moment is set up that tends to raise the forward tip. The magnitude of this rolling moment is always greater at very high angles of attack than the available rolling moment due to ordinary ailerons. The highest angle of attack at which the aileron can balance the rolling moment due to 20° yaw is tabulated for all the arrangements tested as a criterion of control with sideslip. As previously mentioned, 20° yaw represents the conditions in a fairly severe sideslip. The rolling control against the effect of 20° sideslip for any of the ailerons on the tapered wings was from 1° to 3° lower than for the corresponding ailerons on rectangular wings.

Yawing moment due to ailerons.- The desirable yawing moment due to ailerons depends to some extent upon the type of airplane that is being considered. It is obvious that a yawing moment tending to retard the high wing when the airplane is banked is never desirable. For highly maneuverable military or acrobatic machines, complete independence of the controls as they effect turning moments about the various body axes is probably a desirable feature. On the other hand, at high angles of attack a yawing moment of the proper magnitude tending to retard the low wing would, under certain circumstances, be an appreciable aid to safe flying for large transport airplanes or for machines to be operated by relatively inexperienced pilots. The yawing moments caused by the ailerons on the wing with 5:3 taper were slightly smaller below the stall than those for the corresponding ailerons on rectangular wings, but just above the stall at an angle of attack of 20° the adverse yawing moments were greater than for the corresponding ailerons on rectangular wings. In fact, for all the aileron deflections except the up-only, the adverse yawing moments above the stall were greater than could be overcome by an average rudder.

On the wing with 5:1 taper at an angle of attack of 0° the ailerons produced smaller values of the yawing moment coefficient than the ailerons on either the rectangular or 5:3 tapered wings, and they produced no adverse yawing moments of serious magnitude. At $\alpha = 10°$ no adverse yawing moments of appreciable magnitude were produced by any of the ailerons on the wing with 5:1 taper, regardless of the form of movement. Just above the stall, at $\alpha = 20°$, however, all the ailerons with all of the movements except the up-only gave enormous adverse yawing moments, the values being from three to four times those produced by an average rudder.

Lateral Stability

(Ailerons Neutral)

Angle of attack above which autorotation is self-starting.- This criterion is a measure of the range of angles of attack above which autorotation will start from an initial condition of practically zero rate of rotation. The limiting angle of attack was 3° lower for both of the tapered wings than for the rectangular wings.

Stability against rolling caused by gusts.- Test flights have shown that in severe gusts a rolling velocity such that $\frac{p'b}{2V} = 0.05$ may be obtained. Consequently, the rolling moment of a wing due to rolling at this value of $\frac{p'b}{2V}$ gives a measure of its stability characteristics in rough air. In the present case, the angle at which this rolling moment becomes zero is used as a more severe criterion than the previously mentioned angle at which autorotation is self-starting, to indicate the practical upper limit of the useful angle-of-attack range. With 0° yaw the angle of attack for initial instability is also 3° lower for either of the tapered wings than for the rectangular. The actual value of the limiting angle is 14°, which it is interesting to note is 2° below the angle of attack for maximum lift. With 20° yaw the limiting angle for the wing with 5:3 taper was about the same as that for the rectangular wings, but for the wing with 5:1 taper the limiting angle was 3° higher, and had the same value as for 0° yaw.

The above criterion shows the critical range below which stability is such that any rolling is damped out, and above which instability exists. The criterion, maximum C_λ, indicates the degree of this instability. With 0° yaw both of the tapered wings had maximum values of C_λ which come within the range found for various rectangular wings tested. The range of these values is fairly wide because they depend in a very critical manner on the exact dimensions of the airfoil, and are affected by variations which are well within the ordinary limits of accuracy of construction for wing models.

The maximum autorotational moment with 20° yaw is of importance only in the condition in which the airplane is skidded and the forward wing tip is rolled upward or the rear tip downward by a gust. With 20° yaw the value for the wing with 5:3 taper was about the same as those for the rectangular wings, but with the wing having the 5:1 taper this autorotational moment had only one-half the value of those for the other wings.

Control Force Required

The hinge moments of the ailerons on the tapered wings were not measured in this investigation but were computed from the results of previous tests on hinge moments. Using data from reference 3 as a basis, the effect of wing taper on the hinge moments of the required shapes of ailerons was determined, assuming that the hinge moments varied as the square of the aileron chord and directly as the aileron span. The hinge moments of the ailerons on rectangular wings, reported in Part I, reference 1, were computed from reference 4, since those tests were made on similar wings under similar test conditions. The actual hinge moments of the ailerons on the present tapered wings were calculated using the moments of the ailerons on the rectangular wings as a standard, and the effects of taper as determined by the above method.

A coefficient representing the force required on the control stick was then computed in accordance with the following formula:

$$C_F = \frac{F \times l}{q \times c \times S \times C_L}$$

where F is the control force required, and l represents the length of the control lever. Similarly to the rolling criterion, the C_L in the denominator gives the value of the coefficient the proper relation regardless of the angle of attack or air speed, steady flight being assumed. Although the tests described in reference 3 were made at a relatively low Reynolds Number, the control forces as computed are believed to be accurate within about 10 per cent. Values of the coefficient are given in Table XVI at 0° and 10° angle of attack for the assumed maximum aileron deflections, the top of the control stick being given the same maximum travel in all cases.

It will be noted that the control forces for ailerons on the wings tapered 5:3 are reduced by about 32 per cent of the values for corresponding ailerons on rectangular wings. The control forces for the tapered-chord ailerons on wings tapered 5:1 are reduced by about 57 per cent and the forces for the constant-chord ailerons are reduced by about 65 per cent of the values for the corresponding ailerons on rectangular wings.

CONCLUSIONS

1. The general performance of the tapered wings was slightly better than for the rectangular in regard to speed range, but was slightly poorer in regard to climb, the effects being greater for the wing having 5:1 taper than for that with 5:3 taper.

2. The rolling control given by the ailerons on the wing with 5:3 taper was about the same below the stall as that for corresponding ailerons on rectangular wings, but above the stall it was somewhat lower than for the rectangular wings, and also well below the assumed satisfactory value. At the angles of attack below the stall, the yawing moments caused by the ailerons were somewhat lower than with the rectangular wings, but just above the stall the adverse yawing moments were greater.

3. The ailerons on the wing with 5:1 taper gave better lateral control at angles of attack below the stall in regard to rolling, yawing, and hinge moments than the corresponding ailerons on rectangular wings or on the wing with 5:3 taper, but just above the stall the rolling moments fell off almost completely and adverse yawing moments of great magnitude occurred.

4. The autorotational tendencies of both tapered wings were about the same magnitude as those of the rectangular wings, but started at an angle of attack about 3° lower than for the rectangular wings and about 2° below that for maximum lift coefficient.

Langley Memorial Aeronautical Laboratory,
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Langley Field, Va., November 16, 1932.

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TABLE II

FORCE TESTS. CLARK Y WING TAPERED 5 : 3 WITH TAPERED CHORD MEDIUM AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = 0°

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	15°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral																		
C_L	0°	0.007	0.077	0.148	0.363	0.718	1.060	1.162	1.249	1.282	1.275	1.230	1.193	1.096	1.028	0.741	0.752	0.748	0.700	0.580
C_D	0°	.016	.016	.017	.021	.047	.068	.107	.128	.138	.153	.176	.197	.237	.269	.393	.480	.668	.856	1.018
		Right aileron up																		
C_l'	10°				0.018		0.017							-.001			0.005	.003		
C_n'	10°				-.001		-.004							-.005			-.005	-.005		
C_l'	20°				.031		.033							.009			.012	.008		
C_n'	20°				.000		-.005							-.009			-.008	-.009		
C_l'	25°				.038		.040		0.039		0.034		0.027	.015	0.008	0.014	.016	.012		
C_n'	25°				.002		-.004		-.007		-.008		-.010	-.011	-.010	-.008	-.010	-.011		
C_l'	30°				.044		.046							.019			.022	.017		
C_n'	30°				.004		-.003							-.011			-.011	-.013		
C_l'	35°				.046		.049		.045		.042		.034	.018	.017	.018	.025	.019		
C_n'	35°				.005		-.002		-.004		-.006		-.008	-.009	-.009	-.008	-.010	-.014		
C_l'	40°				.053		.055							.024			.020	.024		
C_n'	40°				.006		-.001							-.008			-.008	-.014		
C_l'	50°				.060		.064		.062		.057		.048	.032	.027	.012	.013	.015		
C_n'	50°				.009		.002		-.002		-.004		-.006	-.007	-.007	-.005	-.007	-.009		
C_l'	60°				.064		.069		.068		.064		.053	.038	.033	.012	.010	.013		
C_n'	60°				.013		.005		.001		-.001		-.004	-.005	-.005	-.005	-.007	-.009		
		Right aileron down																		
C_l'	7°				-.010		-.010		-.009		-.008		-.003	-.002	0.001	-.001	-.002	-.001		
C_n'	7°				.001		.002		.003		.003		.003	.003	.001	.001	.002	.002		
C_l'	8½°				-.012		-.011							-.004			-.002	-.002		
C_n'	8½°				.001		.003							.004			.003	.003		
C_l'	10°				-.016		-.013							-.004			-.003	-.001		
C_n'	10°				.002		.004							.004			.004	.003		
C_l'	11½°				-.018		-.015							-.004			-.003	-.002		
C_n'	11½°				.002		.005							.005			.004	.004		
C_l'	12°				-.019		-.017							-.005			-.003	-.002		
C_n'	12°				.002		.005							.005			.004	.004		
C_l'	13°				-.021		-.017							-.003			-.003	-.002		
C_n'	13°				.003		.005							.006			.004	.004		
C_l'	14°				-.022		-.018							-.002			-.003	-.001		
C_n'	14°				.003		.005							.006			.005	.004		
C_l'	15°				-.023		-.019		-.017		-.014		-.003	-.002	.003	-.002	-.003	-.001		
C_n'	15°				.003		.006		.006		.007		.008	.006	.003	.004	.005	.005		
C_l'	20°				-.028		-.024							-.002			-.004	-.002		
C_n'	20°				.005		.009							.008			.007	.007		
C_l'	25°				-.032		-.029		-.022		-.013		-.004	.001	.005	-.002	-.003	-.001		
C_n'	25°				.007		.011		.011		.010		.012	.009	.007	.008	.009	.008		
C_l'	30°				-.037		-.031							.001			-.004	-.001		
C_n'	30°				.009		.013							.011			.011	.011		
C_l'	35°				-.040		-.031							.005			-.002	.001		
C_n'	35°				.011		.014							.011			.012	.011		

TABLE III

FORCE TESTS. CLARK Y WING TAPERED 5 : 3 WITH TAPERED CHORD MEDIUM AILERON (ONE AILERON ONLY)

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	15°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral 20° yaw																		
C_L	0°	0.006		0.135	0.322	0.643	0.942	1.041	1.121		1.160		1.176	1.155	0.887	0.849	0.822	0.783	0.722	0.600
C_D	0°	.017		.017	.020	.041	.079	.094	.112		.130		.161	.213	.346	.404	.485	.653	.836	1.002
C_l'	0°	.005		.006	.008	.010	.014	.017	.022		.038		.070	.103	.110	.094	.076	.054	.047	.044
C_n'	0°	-.003		-.002	-.003	-.003	-.005	-.007	-.009		-.012		-.014	-.022	-.030	-.040	-.043	-.041	-.046	-.054
		Aileron locked and neutral -20° yaw																		
C_L	0°	0.001		0.122	0.312	0.625	0.929	1.023	1.105		1.157		1.181	1.173	0.857	0.854	0.838	0.788	0.730	0.620
C_D	0°	.020		.018	.021	.042	.078	.095	.111		.131		.161	.207	.339	.401	.493	.658	.849	1.017
C_l'	0°	-.006		-.007	-.009	-.012	-.016	-.020	-.015		-.033		-.041	-.069	-.083	-.092	-.082	-.054	-.047	-.044
C_n'	0°	.001		.001	.001	.002	.005	.006	.008		.012		.014	.015	.028	.037	.043	.038	.044	.052
		Right aileron up -20° yaw																		
C_l'	25°				0.038		0.039		0.040		0.041		0.044	0.045	0.028	0.021	0.011	0.010		
C_n'	25°				.002		-.004		-.007		-.009		-.010	-.013	-.031	-.018	-.012	-.009		
C_l'	35°				.051		.052		.052		.054		.057	.059	.040	.035	.020	.016		
C_n'	35°				.005		-.002		-.005		-.008		-.010	-.013	-.024	-.021	-.017	-.011		
C_l'	50°				.059		.067		.067		.069		.071	.075	.049	.044	.027	.004		
C_n'	50°				.010		.002		-.002		-.006		-.007	-.010	-.024	-.021	-.017	-.009		
C_l'	60°				.061		.072		.075		.077		.080	.083	.056	.049	.031	.006		
C_n'	60°				.013		.005		.001		-.001		-.004	-.007	-.023	-.020	-.016	-.008		
		Right aileron down 20° yaw																		
C_l'	7°				-.009		-.006		-.009		-.006		-.005	-.003	.000	-.001	-.002	-.001		
C_n'	7°				.001		.002		.003		.003		.002	.003	.003	.003	.003	.003		
C_l'	15°				-.019		-.014		-.014		-.014		-.012	-.008	-.002	-.004	.001	.007		
C_n'	15°				.004		.005		.006		.006		.006	.006	.005	.006	.005	.006		
C_l'	25°				-.036		-.022		-.021		-.020		-.018	-.014	-.004	-.006	-.003	-.002		
C_n'	25°				.006		.010		.011		.010		.010	.011	.015	.010	.009	.010		

TABLE IV

FORCE TESTS. CLARK Y WING TAPERED 5 : 3
WITH TAPERED CHORD SHORT WIDE AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = 0°

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	15°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral																		
C_L	0°	0.010	0.074	0.145	0.328	0.716	1.055	1.158	1.247	1.273	1.282	1.245	1.180	1.105	1.033	0.740	0.755	0.750	0.693	0.576
C_D	0°	.018	.016	.016	.021	.048	.086	.105	.126	.137	.152	.176	.197	.227	.264	.392	.481	.663	.851	1.000
		Right aileron up																		
C_l'	10°				0.017		0.018							0.004			0.004	0.002		
C_n'	10°				-.001		-.003							-.004			-.004	-.004		
C_l'	20°				.031		.034							.018			.010	.007		
C_n'	20°				.001		-.004							-.009			.000	.001		
C_l'	25°				.038		.041		0.038		0.037	0.032	0.028	.026	0.021	0.010	.013	.010		
C_n'	25°				.003		-.003		-.005		-.007	-.008	-.009	-.009	-.011	-.008	-.009	-.010		
C_l'	30°				.043		.048							.035			.017	.014		
C_n'	30°				.005		-.001							-.010			-.010	-.012		
C_l'	35°				.047		.052		.050		.049		.038	.032	.036	.015	.019	.017		
C_n'	35°				.007		.000		-.003		-.004		-.007	-.009	-.011	-.010	-.011	-.013		
C_l'	40°				.053		.059							.037			.023	.022		
C_n'	40°				.010		.003							-.007			-.011	-.015		
C_l'	50°				.060		.068		.069	0.068	.067	.062	.054	.048	.045	.024	.018	.028		
C_n'	50°				.014		.007		.004	.003	.002	.001	-.002	-.003	-.005	-.006	-.007	-.016		
C_l'	60°				.063		.076		.078		.076	.072	.065	.058	.049	.030	.017	.020		
C_n'	60°				.018		.010		.007		.006	.005	.003	.002	.000	-.004	-.006	-.011		
		Right aileron down																		
C_l'	7°				-.012		-.009		-.009		-.010	-.003	-.004	0.000	0.003	0.000	-.002	-.001		
C_n'	7°				.002		.003		.004		.004	.004	.004	.004	.003	.003	.003	.004		
C_l'	8½°				-.015		-.011							.002			-.002	-.001		
C_n'	8½°				.002		.004							.005			.004	.004		
C_l'	10°				-.017		-.012							.001			-.001	-.001		
C_n'	10°				.002		.005							.005			.005	.005		
C_l'	11½°				-.020		-.016							.002			-.001	-.001		
C_n'	11½°				.003		.006							.006			.005	.006		
C_l'	12°				-.018		-.015							.002			-.002	-.001		
C_n'	12°				.003		.006							.006			.005	.006		
C_l'	13°				-.020		-.017							.002			-.002	-.001		
C_n'	13°				.004		.006							.006			.005	.006		
C_l'	14°				-.021		-.018							.001			-.002	-.001		
C_n'	14°				.004		.007							.007			.006	.007		
C_l'	15°				-.022		-.018		-.018		-.016	-.009	-.009	.002	.007	-.002	-.001	.000		
C_n'	15°				.005		.008		.006		.009	.010	.009	.007	.005	.006	.007	.007		
C_l'	20°				-.027		-.023							.001			.000	.000		
C_n'	20°				.007		.010							.009			.008	.010		
C_l'	25°				-.030		-.027		-.027		-.022	-.013	-.011	.001	.009	.000	.001	.001		
C_n'	25°				.009		.013		.014		.015	.015	.014	.011	.006	.009	.010	.011		
C_l'	30°				-.034		-.030							.004			.002	.002		
C_n'	30°				.011		.015							.013			.012	.013		
C_l'	35°				-.037		-.030							.006			.003	.003		
C_n'	35°				.013		.016							.013			.013	.014		

TABLE V

FORCE TESTS. CLARK Y WING TAPERED 5 : 3
WITH TAPERED CHORD SHORT WIDE AILERON (ONE AILERON ONLY)

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	15°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral 20° yaw																		
C_L	0°	0.002		0.130	0.318	0.639	0.940	1.042	1.122	1.150	1.161	1.178	1.178	1.170	1.128	0.853	0.827	0.785	0.727	0.610
C_D	0°	.017		.017	.031	.041	.077	.092	.112	.120	.130	.143	.160	.208	.263	.403	.485	.656	.839	1.002
C_l'	0°	.005		.006	.008	.010	.015	.015	.019	.023	.032	.047	.059	.102	.117	.094	.075	.053	.049	.045
C_n'	0°	-.002		-.002	-.002	-.003	-.005	-.006	-.008	-.010	-.011	-.012	-.014	-.020	-.026	-.040	-.042	-.040	-.045	-.054
		Aileron locked and neutral -20° yaw																		
C_L	0°	.000		.120	.308	.625	.916	1.025	1.099	1.130	1.155	1.156	1.168	1.170	0.875	0.843	0.830	0.783	0.728	0.620
C_D	0°	.018		.017	.021	.041	.076	.092	.109	.118	.129	.139	.158	.203	.241	.398	.485	.653	.861	1.018
C_l'	0°	-.006		-.007	-.008	-.010	-.015	-.019	-.024	-.027	-.033	-.034	-.046	-.065	-.084	-.101	-.073	-.051	-.048	-.045
C_n'	0°	.002		.001	.001	.002	.005	.006	.008	.010	.011	.013	.013	.015	.028	.038	.041	.039	.045	.052
		Right aileron up -20° yaw																		
C_l'	25°				0.038		0.037		0.037		0.036	0.036	0.037	0.041	0.029	0.029	0.040	0.001		
C_n'	25°				.004		-.003		-.005		-.007	-.008	-.008	-.011	-.021	-.020	-.012	-.008		
C_l'	35°				.054		.055		.054		.054		.056	.060	.043	.045	.020	.007		
C_n'	35°				.009		.000		-.004		-.005		-.008	-.012	-.026	-.025	-.019	-.011		
C_l'	50°				.061		.078		.061		.083		.085	.090	.071	.068	.043	.020		
C_n'	50°				.016		.009		.004		.002		-.002	-.007	-.022	-.025	-.021	-.016		
C_l'	60°				.080		.077		.088		.091		.098	.106	.026	.080	.053	.039		
C_n'	60°				.019		.013		.010		.008		.004	-.001	-.017	-.020	-.018	-.016		
		Right aileron down 20° yaw																		
C_l'	7°				-.009		-.010		-.008		-.008		-.007	-.005	-.008	-.003	-.001	-.001		
C_n'	7°				.002		.003		.004		.004		.003	.003	.003	.003	.003	.004		
C_l'	15°				-.009		-.019		-.019		-.017		-.015	-.010	-.011	-.003	-.002	.000		
C_n'	15°				.004		.007		.008		.009		.008	.007	.003	.007	.005	.006		
C_l'	25°				-.030		-.027		-.035		-.024		-.022	-.015	-.010	-.006	-.001	.000		
C_n'	25°				.009		.013		.014		.015		.013	.013	.012	.011	.009	.010		

TABLE VI

ROTATION TESTS. CLARK Y WING TAPERED 5 : 3

C_λ is given for forced rotation at $\frac{p'b}{2V} = 0.05$ $\begin{cases}(+) \text{ aiding rotation} \\ (-) \text{ damping rotation}\end{cases}$

R.N. = 609,000 Velocity = 80 m.p.h.

	α	0°	10°	12°	14°	16°	18°	19°	20°	21°	23°	24°	25°	26°	28°	30°	32°	35°	40°
Ailerons neutral Yaw = 0°																			
(+) Rotation (clockwise)	C_λ	-0.023		-.019	-.012	-.003	.000	.030	.036	.035		.000		-.002	-.003	-.003	-.003	-.002	-.003
(-) Rotation (counterclockwise)	C_λ	-.021		-.011	.003	.017	.022	.024	.045	.040		.004		.004	.001	.000	.000	.000	.000
Ailerons neutral Yaw = -20°																			
(+) Rotation (clockwise)	C_λ	-.026	-.028	-.030		-.052	-.076	-.084	-.045	-.057	-.074		-.072		-.063	-.054	-.051	-.047	-.043
(-) Rotation (counterclockwise)	C_λ	-.012	-.003	.004		-.028	-.059	-.071	-.084	-.084	-.078		-.072		-.067	-.061	-.056	-.044	-.037

TABLE VII

FORCE TESTS. CLARK Y WING TAPERED 5 : 1
WITH TAPERED CHORD MEDIUM AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = 0°

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral																	
C_L	0°	-0.010	0.061	0.132	0.336	0.683	1.005	1.114	1.214	1.278	1.288	1.273	1.213	0.970	0.779	0.713	0.718	0.666	0.553
C_D	0°	.017	.016	.016	.021	.045	.081	.102	.122	.144	.162	.172	.220	.338	.391	.456	.651	.843	1.004
Right aileron up																			
C_l'	10°				.017		.014						.004			.004	.004		
C_n'	10°				-.001		-.002						-.003			-.004	-.004		
C_l'	20°				.031		.031						.008			.009	.009		
C_n'	20°				.001		-.003						-.007			-.007	-.009		
C_l'	25°				.036		.035		.032	.027		.018	.010	-.011	-.003	.013	.013		
C_n'	25°				.002		-.003		-.004	-.005		-.008	-.007	-.015	-.002	-.008	-.011		
C_l'	30°				.041		.040						.014			.017	.017		
C_n'	30°				.002		-.002						-.008			-.009	-.013		
C_l'	35°				.045		.045		.040	.030		.017	.010	-.007	.001	.020	.021		
C_n'	35°				.003		-.002		-.003	-.004		-.006	-.006	-.015	-.004	-.010	-.014		
C_l'	40°				.050		.050						.008			.012	.017		
C_n'	40°				.006		.001						-.005			-.006	-.011		
C_l'	50°				.058		.058		.053	.045		.028	.008	-.017	-.010	.007	.012		
C_n'	50°				.008		.002		.000	-.002		-.005	-.005	-.012	.000	-.005	-.006		
C_l'	60°				.062		.064		.060	.052		.035	.013	-.014	-.011	.007	.011		
C_n'	60°				.011		.005		.002	.001		-.003	-.005	-.013	-.010	-.006	-.006		
Right aileron down ✓																			
C_l'	7°				-.011		-.009		-.008	-.007		-.001	-.002	-.003	-.016	-.003	-.002		
C_n'	7°				.001		.003		.002	.003		.002	.003	.002	.004	.002	.003		
C_l'	8½°				-.015		-.011						-.002			-.003	-.002		
C_n'	8½°				.001		.003						.002			.002	.003		
C_l'	10°				-.017		-.013						-.003			-.001 .003	-.003		
C_n'	10°				.002		.003						.004			.001 .003	.004		
C_l'	11½°				-.019		-.015						-.002			.004	-.003		
C_n'	11½°				.002		.003						.004			.001	.005		
C_l'	12°				-.019		-.016						-.003			-.003 .003	-.003		
C_n'	12°				.002		.003						.005			.004 .002	.005		
C_l'	13°				-.020		-.018						-.003			.003	-.003		
C_n'	13°				.002		.004						.005			.002	.005		
C_l'	14°				-.021		-.018						.018			.003	.003		
C_n'	14°				.003		.004						.014			.004	.006		
C_l'	15°				-.023		-.019		-.015	-.011		-.003	.017	-.006	-.020	.003	-.003		
C_n'	15°				.003		.004		.004	.005		.003	.015	.005	.008	.002	.007		
C_l'	20°				-.026		-.024						.016			.002	-.003		
C_n'	20°				.004		.006						.016			.004	.007		
C_l'	25°				-.028		-.027		-.019	-.011		-.003	.015	-.008	-.022	.003	-.003		
C_n'	25°				.005		.008		.008	.008		.009	.019	.009	.013	.006	.010		
C_l'	30°				-.029		-.031						.015			.003	-.003		
C_n'	30°				.006		.009						.020			.006	.011		
C_l'	35°				-.034		-.030						.014			.003	-.002		
C_n'	35°				.008		.011						.021			.011	.014		

TABLE VIII

FORCE TESTS. CLARK Y WING TAPERED 5 : 1
WITH TAPERED CHORD MEDIUM AILERON (ONE AILERON ONLY)
R.N. = 609,000 Velocity = 80 m.p.h. Yaw = ± 20°

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral 20° yaw																	
C_L	0°	-0.004		0.117	0.288	0.602	0.893	0.990	1.082	1.158		1.176	1.200	1.213	0.918	0.783	0.757	0.694	0.576
C_D	0°	.016		.015	.018	.038	.072	.088	.104	.126		.166	.206	.264	.396	.461	.638	.820	.987
C_l'	0°	.008		.008	.010	.013	.019	.021	.023	.029		.046	.064	.095	.040	.063	.051	.048	.044
C_n'	0°	-.002		-.002	-.001	-.002	-.004	-.005	-.006	-.008		-.001	-.002	-.003	-.021	-.033	-.033	-.039	-.046
Aileron locked and neutral -20° yaw																			
C_L	0°	-.010		.108	.284	.591	.872	.972	1.058	1.137		1.158	1.166	1.166	.922	.778	.753	.706	.583
C_D	0°	.017		.017	.021	.039	.072	.088	.104	.123		.167	.204	.262	.396	.461	.640	.826	1.000
C_l'	0°	-.005		-.006	-.009	-.014	-.019	-.021	-.026	-.031		-.050	-.068	-.072	-.060	-.058	-.050	-.046	-.045
C_n'	0°	.002		.001	.001	.002	.004	.005	.006	.008		.000	.001	.007	.027	.029	.038	.036	.043
Right aileron up -20° yaw																			
C_l'	25°				.033		.031		.031	.030		.029	.028	.029	-.005	.003	.013		
C_n'	25°				.002		-.003		-.004	-.005		-.008	-.007	-.015	-.002	-.008	-.011		
C_l'	35°				.042		.040		.038	.037		.037	.036	.039	.004	.009	.021		
C_n'	35°				.004		-.001		-.003	-.004		-.006	-.009	-.012	-.029	-.006	-.015		
C_l'	50°				.056		.055		.053	.051		.049	.048	.047	.010	.012	.019		
C_n'	50°				.001		.003		.006	.007		-.001	.001	.005	.025	.031	.032		
C_l'	60°				.061		.061		.060	.058		.056	.054	.043	.015	.011	.014		
C_n'	60°				.012		.005		.002	.001		-.001	-.004	-.007	-.024	-.006	-.010		
Right aileron down 20° yaw																			
C_l'	7°				-.008		-.009		-.006	-.008		-.005	-.005	-.004	-.003	-.002	-.003		
C_n'	7°				.001		.002		.002	.003		.004	.004	.003	.003	.002	.003		
C_l'	15°				-.018		-.016		-.014	-.003		-.008	-.008	-.009	-.006	-.005	-.005		
C_n'	15°				.003		.004		.004	.013		.007	.008	.007	.007	.005	.007		
C_l'	25°				-.024		-.024		-.020	-.005		-.010	-.010	-.010	-.006	-.005	-.004		
C_n'	25°				.006		.007		.009	.018		.012	.012	.011	.010	.008	.009		

TABLE IX

FORCE TESTS. CLARK Y WING TAPERED 5 : 1
WITH TAPERED CHORD SHORT WIDE AILERON (ONE AILERON ONLY)
R.N. = 609,000 Velocity = 80 m.p.h. Yaw = 0°

α		-5°	-4°	-3°	0°	5°	10°	12°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral																	
C_L	0°	-0.011	0.059	0.131	0.333	0.683	1.002		1.218	1.265	1.285	1.273	1.202	1.060	0.823	0.709	0.718	0.667	0.557
C_D	0°	.016	.015	.016	.020	.044	.083		.123	.148	.164	.182	.233	.333	.400	.455	.651	.847	1.002
Right aileron up																			
C_l'	10°				.021		.018						.003			.003	.004		
C_n'	10°				-.001		-.003						-.004			-.004	-.005		
C_l'	20°				.035		.034						.008			.007	.009		
C_n'	20°				.001		-.004						-.008			-.006	-.009		
C_l'	25°				.040		.041		.039	.032		.017	.010	-.010	-.006	.009	.013		
C_n'	25°				.002		-.003		-.005	-.006		-.008	-.011	-.018	-.003	-.008	-.012		
C_l'	30°				.044		.046						.015			.013	.017		
C_n'	30°				.004		-.001						-.012			-.009	-.014		
C_l'	35°				.048		.052		.049	.041		.028	.019	-.002	-.001	.017	.021		
C_n'	35°				.005		.000		-.003	-.004		-.007	-.012	-.019	-.005	-.010	-.016		
C_l'	40°				.051		.058						.022			.018	.025		
C_n'	40°				.007		.002						-.010			-.009	-.016		
C_l'	50°				.060		.067		.066	.060		.045	.031	.003	-.010	.010	.020		
C_n'	50°				.011		.006		.003	.002		-.002	-.008	-.016	-.002	-.007	-.014		
C_l'	60°				.064		.074		.073	.067		.053	.038	.015	-.006	.007	.017		
C_n'	60°				.014		.008		.007	.005		.003	-.004	-.014	-.001	-.006	-.011		
Right aileron down ✓																			
C_l'	7°				-.010		-.007		-.005	-.001		-.001	-.001	-.001	-.005	.005 -.001	.000		
C_n'	7°				.001		.002		.002	.002		.002	.002	.002	.003	.003 .000	.003		
C_l'	8½°				-.012		-.009						-.002			-.001 .003	.000		
C_n'	8½°				.001		.002						.003			.003 .001	.004		
C_l'	10°				-.013		-.009						.016			-.004 .005	-.001		
C_n'	10°				.001		.003						.011			.003 .002	.004		
C_l'	11½°				-.016		-.010						.016			-.008 .004	-.001		
C_n'	11½°				.002		.003						.012			.007 .003	.005		
C_l'	12°				-.015		-.010						.016			-.007 .004	-.002		
C_n'	12°				.002		.003						.012			.003 .006	.005		
C_l'	13°				-.017		-.011						.016			.006 -.006	-.001		
C_n'	13°				.003		.004						.013			.003 .007	.006		
C_l'	14°				-.018		-.012						.016			.004	-.001		
C_n'	14°				.003		.004						.013			.004	.006		
C_l'	15°				-.019		-.013		-.008	.000		-.001	.017	-.003	-.009	.004	-.001		
C_n'	15°				.003		.004		.004	.006		.005	.013	.005	.007	.003	.006		
C_l'	20°				-.024		-.017						.017			.004	-.001		
C_n'	20°				.005		.007						.015			.006	.006		
C_l'	25°				-.024		-.019		-.009	.001		.000 .010	.018	.000	-.010	.004	.000		
C_n'	25°				.006		.006		.006	.010		.017 .009	.017	.009	.011	.007	.009		
C_l'	30°				-.026		-.019						.020			.005	.002		
C_n'	30°				.008		.010						.018			.009	.012		
C_l'	35°				-.029		-.019						.021			.006	.004		
C_n'	35°				.010		.012						.020			.012	.013		

TABLE X

FORCE TESTS. CLARK Y WING TAPERED 5 : 1 WITH TAPERED CHORD SHORT WIDE AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = ± 20°

α		-5°	0°	5°	10°	12°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°			
	δ_A	Aileron locked and neutral 20° yaw																		
C_L	0°	-0.098	0.288	0.602	0.887		1.078	1.154		1.174	1.187	1.207	0.928	0.782	0.756	0.692	0.572			
C_D	0°	.016	.020	.039	.072		.106	.127		.167	.211	.259	.399	.461	.635	.825	.982			
C_l'	0°	.006	.011	.013	.018		.028	.037		.042	.068	.076	.032	.063	.052	.048	.046			
C_n'	0°	-.002	-.002	-.003	-.005		-.007	-.007		-.001	-.005	-.009	-.020	-.032	-.033	-.038	-.044			
Aileron locked and neutral -20° yaw																				
C_L	0°	-.013	.282	.569	.868		1.088	1.143		1.162	1.163	1.135	.925	.728	.762	.702	.589			
C_D	0°	.017	.020	.038	.071		.105	.136		.171	.211	.261	.397	.463	.646	.831	.986			
C_l'	0°	-.006	-.008	-.015	-.018		-.027	-.034		-.055	-.071	-.078	-.064	-.059	-.049	-.046	-.044			
C_n'	0°	.002	.001	.002	.004		.006	.008		.001	.001	.007	.029	.031	.032	.037	.043			
Right aileron up -20° yaw																				
C_l'	25°		.037		.036		.038	.035		.034	.035	.026	.007	.001	.009					
C_n'	25°		.003		-.002		-.004	-.006		-.007	-.011	-.015	-.019	-.008	-.013					
C_l'	35°		.049		.049		.048	.049		.048	.047	.040	.006	.008	.016					
C_n'	35°		.007		.001		-.002	-.003		-.007	-.011	-.013	-.030	-.011	-.016					
C_l'	50°		.060		.069		.070	.070		.069	.068	.060	.019	.018	.024					
C_n'	50°		.013		.007		.004	.002		-.001	-.007	-.012	-.025	-.012	-.016					
C_l'	60°		.060		.076		.078	.080		.079	.079	.071	.029	.029	.020					
C_n'	60°		.015		.012		.008	.006		.003	-.002	-.007	-.021	-.011	-.013					
Right aileron down 20° yaw																				
C_l'	7°		-.010		-.008		-.006	-.004		-.003	-.004	-.004	-.003	-.002	-.001					
C_n'	7°		.001		.002		.003	.003		.003	.003	.003	.003	.003	.004					
C_l'	15°		-.017		-.015		-.010	.001		-.004	-.007	-.007	-.004	-.001	-.061					
C_n'	15°		.004		.005		.006	.007		.007	.007	.007	.006	.004	.005					
C_l'	25°		-.024		-.019		-.013	.001		-.006	-.010	-.010	-.005	-.002	-.001					
C_n'	25°		.007		.009		.011	.016		.012	.011	.011	.011	.007	.008					

TABLE XI

FORCE TESTS. CLARK Y WING TAPERED 5 : 1 WITH CONSTANT CHORD MEDIUM AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = 0°

α		-5°	-4°	-3°	0°	5°	10°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral																
C_L	0°	-.007	.063	.132	.741	.688	1.013	1.217	1.280	1.287	1.277	1.210	.957	.771	.710	.718	.668	.553
C_D	0°	.018	.015	.018	.021	.044	.082	.123	.143	.162	.180	.224	.349	.385	.455	.643	.848	1.007
Right aileron up																		
C_l'	10°				.020		.018					.001			.003	.004		
C_n'	10°				-.001		-.003					-.005			-.004	-.005		
C_l'	20°				.035		.035					.007			.007	.010		
C_n'	20°				.001		-.004					-.009			-.007	-.010		
C_l'	25°				.040		.041	.037	.032		.019	.010	-.010	.013	.012	.014		
C_n'	25°				.001		-.004	-.005	-.006		-.008	-.009	-.017	-.003	-.008	-.012		
C_l'	30°				.044		.045					.007			.016	.018		
C_n'	30°				.002		-.002					-.008			-.009	-.014		
C_l'	35°				.048		.050	.043	.036		.019	.008	-.009	.019	.019	.023		
C_n'	35°				.004		-.002	-.004	-.005		-.006	-.008	-.015	-.008	-.009	-.016		
C_l'	40°				.052		.053					.008			.009	.015		
C_n'	40°				.005		.000					-.007			-.005	-.010		
C_l'	50°				.060		.063	.057	.050		.030	.013	-.009	.009	.008	.011		
C_n'	50°				.008		.002	-.001	-.002		-.005	-.007	-.015	-.005	-.005	-.009		
C_l'	60°				.066		.069	.064	.055		.038	.019	-.007	.010&.018	.012	.012		
C_n'	60°				.011		.005	.002	.001		-.002	-.006	-.014	-.004	-.007	-.009		
Right aileron down																		
C_l'	7°				-.013		-.009	-.008	-.005		-.002	.019	.011	.009	.004&-.003	-.002		
C_n'	7°				.001		.002	.002	.003		.003	.012	.005	-.001	.003& .000	.003		
C_l'	8½°				-.014		-.011					.019			-.003	-.002		
C_n'	8½°				.003		.003					.012			.002	.004		
C_l'	10°				-.018		-.013					.018			.002	-.003		
C_n'	10°				.002		.003					.012			.002	.004		
C_l'	11½°				-.019		-.014					.018			.002	-.003		
C_n'	11½°				.002		.004					.013			.002	.005		
C_l'	12°				-.021		-.015					.018			.003	-.003		
C_n'	12°				.003		.004					.013			.003	.006		
C_l'	13°				-.021		-.015					.018			.002	-.003		
C_n'	13°				.003		.004					.013			.003	.006		
C_l'	14°				-.022		-.016					.019			.001	-.004		
C_n'	14°				.002		.004					.014			.003	.006		
C_l'	15°				-.023		-.018	-.016	-.009		-.004	-.019	.009&.013	.007	.000& .015	-.004		
C_n'	15°				.003		.005	.005	.006		.006	.014	.009	.003	.004	.007		
C_l'	20°				-.026		-.023					.019			.001	-.004		
C_n'	20°				.005		.007					.016			.008	.009		
C_l'	25°				-.033		-.027	-.020	-.010		.023	.019	.016&.008	.014&.010	.001	-.004		
C_n'	25°				.006		.009	.009	.010		.021	.018	.011	.003&.007	.008	.011		
C_l'	30°				-.033		-.028					.019			.000	-.004		
C_n'	30°				.007		.010					.019			.009	.013		
C_l'	35°				-.035		-.028					.017			-.001	-.004		
C_n'	35°				.008		.012					.021			.011	.014		

TABLE XII

FORCE TESTS. CLARK Y WING TAPERED 5 : 1 WITH CONSTANT CHORD MEDIUM AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = ± 20°

α		-5°	-4°	-3°	0°	5°	10°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral 20° yaw																
C_L	0°	0.000			0.306	0.613	0.902	1.090	1.156		1.183	1.197	1.204	0.930	0.781	0.754	0.700	0.576
C_D	0°	.016			.019	.039	.072	.105	.126		.166	.212	.263	.397	.458	.638	.821	.980
C_l'	0°	.006			.010	.014	.018	.024	.030		.046	.064	.096	.054	.063	.050	.047	.040
C_n'	0°	-.002			-.001	-.002	-.004	-.007	-.007		-.001	-.003	-.006	-.026	-.032	-.033	-.038	-.044
Aileron locked and neutral -20° yaw																		
C_L	0°	-.005			.292	.601	.888	1.076	1.154		1.171	1.187	1.175	.938	.786	.760	.700	.583
C_D	0°	.016			.019	.033	.072	.104	.123		.168	.206	.271	.402	.466	.646	.833	.997
C_l'	0°	-.005			-.006	-.012	-.017	-.026	-.031		-.051	-.072	-.071	-.039	-.060	-.049	-.047	-.045
C_n'	0°	.002			.001	.002	.004	.006	.007		.001	.000	.006	.011	.030	.031	.036	.043
Right aileron up -20° yaw																		
C_l'	25°				.032		.035	.036	.033		.031	.031	.028	.005	.003	.012		
C_n'	25°				.001		-.003	-.005	-.006		-.007	-.009	-.012	-.009	-.006	-.012		
C_l'	35°				.042		.044	.044	.042		.041	.042	.038	-.006	.007	.020		
C_n'	35°				.004		-.001	-.003	-.004		-.006	-.009	-.013	-.027	-.007	-.018		
C_l'	50°				.053		.057	.058	.054		.054	.053	.048	-.002	.008	.028		
C_n'	50°				.009		.002	-.001	-.002		-.004	-.007	-.011	-.024	-.006	-.013		
C_l'	60°				.057		.063	.064	.061		.061	.061	.058	.003	.011	.021		
C_n'	60°				.013		.006	.002	.012		-.001	-.004	-.007	-.022	-.006	-.009		
Right aileron down 20° yaw																		
C_l'	7°				-.012		-.008	-.009	.000		-.004	-.004	-.005	-.002	-.011 &-.004	-.001		
C_n'	7°				.001		.002	.002	.008		.004	.003	.003	.003	.004	.003		
C_l'	15°				-.021		-.016	-.017	-.008		-.007	-.009	-.009	-.004	-.008 &-.008	-.003		
C_n'	15°				.003		.005	.006	.012		.008	.007	.007	.010	.008 & .006	.007		
C_l'	25°				-.027		-.024	-.010	-.006		-.009	-.011	-.012	-.006	-.004	-.002		
C_n'	25°				.006		.009	.016	.017		.014	.013	.011	.010	.008	.010		

TABLE XIII

FORCE TESTS. CLARK Y WING TAPERED 5 : 1 WITH CONSTANT CHORD SHORT WIDE AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = 0°

α		-5°	-4°	-3°	0°	5°	10°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral																
C_L	0°	-0.005	0.065	0.133	0.340	0.689	1.013	1.216	1.285	1.290	1.265	1.165	1.115	0.847	0.756	0.730	0.670	0.555
C_D	0°	.017	.016	.016	.021	.046	.084	.123	.147	.163	.195	.255	.319	.390	.488	.651	.848	1.012
Right aileron up																		
C_l'	10°				.020		.017					-.018			.012	.004		
C_n'	10°				-.001		-.003					-.011			-.006	-.005		
C_l'	20°				.034		.034					-.013			.018	.009		
C_n'	20°				.001		-.003					-.015			-.009	-.009		
C_l'	25°				.040		.042	.040	.032		.020	-.005	-.003	.008	.017	.013		
C_n'	25°				.003		-.002	-.004	-.006		-.010	-.015	-.016	-.013	-.010	-.012		
C_l'	30°				.044		.047					-.006			.021	.017		
C_n'	30°				.004		-.001					-.018			-.012	-.015		
C_l'	35°				.048		.055	.051	.043		.031	.001	.006	.015	.023	.022		
C_n'	35°				.006		.001	-.002	-.004		-.009	-.017	-.016	-.015	-.012	-.016		
C_l'	40°				.052		.059					.002			.027	.026		
C_n'	40°				.006		.002					-.016			-.013	-.017		
C_l'	50°				.060		.069	.069	.063		.049	.014	.003	.030	.024	.022		
C_n'	50°				.012		.005	.003	.001		-.004	-.014	-.014	-.012	-.010	-.014		
C_l'	60°				.068		.073	.075	.069		.056	.022	.006	.015	.024	.015		
C_n'	60°				.014		.009	.006	.005		.000	-.010	-.014	-.008	-.008	-.012		
Right Aileron down																		
C_l'	7°				-.011		-.007	-.006	-.005		-.003	-.001	.000	.004	.006 &.014	-.001		
C_n'	7°				.001		.002	.008	.008		.001	.003	.004	-.002	-.003 &.000	.003		
C_l'	8½°				-.013		-.009					-.004			.013 &.006	-.013		
C_n'	8½°				.002		.003					.005			-.001 &+.001	.004		
C_l'	10°				-.015		-.012					-.005			.012 & 005	-.002		
C_n'	10°				.002		.004					.005			.000	.006		
C_l'	11½°				-.016		-.013					-.004			.012 &.005	-.001		
C_n'	11½°				.003		.004					.006			.000 &.002	.006		
C_l'	12°				-.017		-.013					-.004			.012	-.002		
C_n'	12°				.003		.004					.006			.000	.006		
C_l'	13°				-.019		-.014					-.004			.012	-.002		
C_n'	13°				.003		.005					.006			.000	.006		
C_l'	14°				-.020		-.015					-.003			.012	-.002		
C_n'	14°				.003		.005					.007			.001	.007		
C_l'	15°				-.021		-.017	-.012	-.006		.014	-.004	-.003	-.004	.012	-.002		
C_n'	15°				.003		.005	.006	.005		.013	.006	.005	.000	.001	.007		
C_l'	20°				-.024		-.019					-.003			.011	-.002		
C_n'	20°				.005		.008					.009			.003	.009		
C_l'	25°				-.028		-.020	-.012	.011		.015	-.005	-.004	-.003	.011	-.001		
C_n'	25°				.007		.009	.009	.017		.017	.009	.009	.004	.008	.011		
C_l'	30°				-.030		-.020					-.002			.012	.000		
C_n'	30°				.008		.010					.013			.008	.014		
C_l'	35°				-.032		-.021					-.001			.012	.001		
C_n'	35°				.010		.012					.014			.009	.015		

TABLE XIV

FORCE TESTS. CLARK Y WING TAPERED 5 : 1 WITH CONSTANT CHORD SHORT WIDE AILERON (ONE AILERON ONLY)

R.N. = 609,000 Velocity = 80 m.p.h. Yaw = ± 20°

α		-5°	-4°	-3°	0°	5°	10°	14°	16°	17°	18°	20°	22°	25°	30°	40°	50°	60°
	δ_A	Aileron locked and neutral 20° yaw																
C_L	0°	0.000			0.303	0.605	0.888	1.088	1.147		1.173	1.195	1.208	0.925	0.825	0.755	0.696	0.579
C_D	0°	.015			.019	.038	.071	.107	.135		.169	.210	.259	.397	.470	.638	.818	.987
C_l'	0°	.006 .009			.010	.013	.017	.023	.031		.044	.043	.083	.053	.053	.051	.047	.045
C_n'	0°	-.002			-.001	-.002	-.004	-.006	-.003		-.003	-.011	-.008	-.027	-.028	-.033	-.038	-.044
		Aileron locked and neutral -20° yaw																
C_L	0°	-.003			.292	.591	.880	1.060	1.138		1.165	1.170	1.155	1.028	.788	.762	.702	.583
C_D	0°	.018			.021	.040	.072	.105	.128		.169	.208	.267	.366	.463	.643	.838	.992
C_l'	0°	-.006 -.003			-.008	-.014	-.018	-.026	-.032		-.052	-.090	-.075 -.042	-.045	-.053	-.050	-.048	-.045
C_n'	0°	.001			.000	.000	.002	.005	.007		-.002	-.007	.008 .015	.012	.028	.032	.037	.043
		Right aileron up -20° yaw																
C_l'	25°				.035		.034	.034	.031		.051	.030	.023 -.010	.000	.002	.010		
C_n'	25°				.004		-.001	-.002	-.005		-.007	-.010	-.015 -.023	-.010	-.009	-.012		
C_l'	35°				.046		.049	.048	.047		.044	.045	.039 .006	-.010	.009	.016		
C_n'	35°				.008		.001	-.001	-.004		-.008	-.011	-.017 -.024	-.021	-.012	-.016		
C_l'	50°				.059		.066	.069	.066		.068	.066	.061 .028	.007	.030	.024		
C_n'	50°				.015		.008	.004	.001		-.001	-.006	-.013 -.020	-.018	-.015	-.018		
C_l'	60°				.065		.074	.076	.075		.076	.075	.068 .035	.015	.039	.029		
C_n'	60°				.019		.012	.009	.005		.003	-.002	-.011 -.019	-.015	-.013	-.014		
		Right aileron down 20° yaw																
C_l'	7°				-.007		-.007	-.008	.002		-.002	-.004	-.005	-.006	.018	-.003		
C_n'	7°				.001		.002	.003	.004		.004	.004	.003	.003	-.005	.004		
C_l'	15°				-.018		-.015	-.006	-.005		-.006	-.008	-.008	-.006	-.015	-.002		
C_n'	15°				.004		.006	.011	.008		.008	.007	.007	.006	-.002	.007		
C_l'	25°				-.025		-.021	-.007	-.004		-.007	-.010	-.011	-.008	.009	-.001		
C_n'	25°				.007		.010	.016	.013		.013	.012	.012	.011	.005	.010		

TABLE XV

ROTATION TESTS. CLARK Y WING TAPERED 5 : 1

C_λ is given for forced rotation at $\frac{p'b}{2V} = 0.05$ $\left\{\begin{matrix}(+) \text{ aiding rotation} \\ (-) \text{ damping rotation}\end{matrix}\right.$

R.N. = 609,000 Velocity = 80 m.p.h.

	α	0°	10°	14°	15°	16°	18°	19°	20°	21°	22°	24°	25°	27°	30°	40°	
Ailerons neutral Yaw = 0°																	
(+) Rotation (clockwise)	C_λ	-0.022	-0.016	0.001	0.020	0.027	0.038	0.041	0.014	0.012	0.006		0.004		0.001	-0.002	
(-) Rotation (counterclockwise)	C_λ	-.016	-.012	-.002	.003	.031	.035	.035	.036	.016	.011		.012		.000	.002	
Ailerons neutral Yaw = -20°																	
(+) Rotation (clockwise)	C_λ	-.020	-.015	-.014		-.017		-.008	-.010	-.009	-.008	-0.010		-0.017	-.027	-.030	
(-) Rotation (counterclockwise)	C_λ	-.011	-.010	.001		.011		.028	.034	.042	.021	.020		.028	.027	.024	

TABLE XVI

CRITERIONS SHOWING RELATIVE MERITS OF AILERONS
(Assumed Right Aileron Up and Left Aileron Down)

Subject	Criterion		Plain ailerons 25 per cent c by 40 per cent b/2 (assumed standard size). Medium, rectangular wing.				Plain ailerons 40 per cent c by 30 per cent b/2. Short wide, rectangular wing.				Tapered chord medium ailerons 5:3 tapered wing				Tapered chord short wide ailerons 5:3 tapered wing			
			Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°	Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°	Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°	Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°
Wing area or minimum speed	Maximum C_L	$\delta_A = 0^\circ$	1.370	1.370	1.370	1.370	1.258	1.258	1.258	1.258	1.275	1.275	1.275	1.275	1.282	1.282	1.282	1.282
Speed range	Max C_L/Min C_D		79.4	79.4	79.4	79.4	78.5	78.5	78.5	78.5	80.7	80.7	80.7	80.7	81.7	81.7	81.7	81.7
Rate of climb	L/D at C_L=0.70		15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7
Lateral controllability	RC	$\alpha = 0^\circ$	.204	.202	.214	.196	.226	.234	.228	.202	.218	.218	.219	.202	.217	.208	.228	.202
	RC	$\alpha = 10^\circ$	.076	.074	.074	.072	.078	.084	.083	.076	.076	.074	.078	.072	.075	.072	.081	.079
	RC	$\alpha = 20^\circ$	.038	.051	.055	.054	.046	.058	[g].073	[h].074	.020	.034	.037	.039	.031	.038	.049	.066
	RC	$\alpha = 30^\circ$	.017	.005	.002	.008	.019	.025	.028	.022	.039	.046	.027	.018	.030	.037	.034	.027
Lateral control with sideslip	Maximum α at which ailerons will balance C_l' due to 20° yaw		20°	20°	21°	22°	19°	20°	22°	25°	19°	19°	20°	20°	18°	19°	21°	22°
Yawing moments due to ailerons: (+) favorable (-) unfavorable	C_n	$\alpha = 0^\circ$	-.007	.003 [b]-.003	.010 [b]-.002	.016	-.007	.005 [b]-.002	.016 [a]-.001	.021	-.005	.001 [b]-.003	.008 [b]-.002	.013 [a]-.001	-.005	.003 [a]-.003	.013 [b]-.002	.018 [a]-.001
	C_n	$\alpha = 10^\circ$	-.004	.004 [b]-.002	.013 [b]-.001	.018	-.007	.006 [b]-.005	.020 [a]-.002	.028	-.005	.004 [a]-.002	.012 [a]-.001	.017 [a]-.001	-.004	.005 [a]-.003	.018 [b]-.002	.025 [c]-.002
	C_n	$\alpha = 20^\circ$	-.010	[b]-.007	.008 [b]-.006	.013 [a]-.003	-.010	.001 [b]-.008	.019 [b]-.007	.029 [a]-.003	-.013	[c]-.010	.003 [d]-.009	.006 [b]-.006	-.011	[b]-.009	.010 [b]-.008	.021 [b]-.003
	C_n	$\alpha = 30^\circ$	-.008	-.008	[b]-.007	.002 [b]-.004	-.012	[d]-.009	.003 [c]-.005	.009 [c]-.002	-.006	.001 [c]-.004	.008 [c]-.004	[f].002 [b]-.002	-.010	.008 [e]-.006	.002 [e]-.005	.005 [a]-.001
Lateral stability ($\delta_A = 0^\circ$)	α for initial instability in rolling		18°	18°	18°	18°	18°	18°	18°	18°	15°	15°	15°	15°	15°	15°	15°	15°
	α for initial instability at $\frac{p'b}{2V}$ = 0.05	Yaw = 0°	17°	17°	17°	17°	17°	17°	17°	17°	14°	14°	14°	14°	14°	14°	14°	14°
		Yaw = 20°	11°	11°	11°	11°	12°	12°	12°	12°	11°	11°	11°	11°	11°	11°	11°	11°
	Maximum unstable C_λ	Yaw = 0°	.048	.048	.048	.048	.022	.022	.022	.022	.045	.045	.045	.045	.045	.045	.045	.045
		Yaw = 20°	.093	.093	.093	.093	.085	.085	.085	.085	.084	.084	.084	.084	.084	.084	.084	.084
Control force required	CF	$\alpha = 0^\circ$	.017	.019	.028	.041	.030	.032	.052	.079	.012	.013	.020	.029	.022	.023	.038	.069
	CF	$\alpha = 10^\circ$	.006	.005	.005	.010	.010	.007	.007	.014	.004	.004	.005	.006	.007	.005	.005	.009

Footnotes are given at end of table.

TABLE XVI (Continued)

CRITERIONS SHOWING RELATIVE MERITS OF AILERONS
(Assumed Right Aileron Up and Left Aileron Down)

Subject	Criterion		Tapered chord medium ailerons 5:1 tapered wing				Tapered chord short wide ailerons 5:1 tapered wing				Constant chord medium ailerons 5:1 tapered wing				Constant chord short wide ailerons 5:1 tapered wing			
			Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°	Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°	Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°	Standard 25° up 25° dn	Differential No. 1 35° up 15° dn	Differential No. 2 50° up 7° dn	Up-only 60°
Wing area or minimum speed	Maximum C_L	$\delta_A = 0^\circ$	1.288	1.288	1.288	1.288	1.285	1.285	1.285	1.285	1.287	1.287	1.287	1.287	1.290	1.290	1.290	1.290
Speed range	Max C_L/Min C_D		82.5	82.5	82.5	82.5	84.6	84.6	84.6	84.6	85.2	85.2	85.2	85.2	81.7	81.7	81.7	81.7
Rate of climb	L/D at C_L=0.70		14.9	14.9	14.9	14.9	15.4	15.4	15.4	15.4	15.5	15.5	15.5	15.5	15.0	15.0	15.0	15.0
Lateral controllability	RC	$\alpha = 0^\circ$	.284	.302	.297	.278	.288	.300	.315	.288	.304	.315	.318	.291	.302	.302	.312	.290
	RC	$\alpha = 10^\circ$	.095	.095	.099	.093	.092	.096	.111	.107	.096	.101	.104	.100	.094	.105	.110	.104
	RC	$\alpha = 20^\circ$	.005	.001	.015	.018	.003	.013	.043	.046	.001	{-.004 {-.001	0	.024	.011	.017	.026	.030
	RC	$\alpha = 30^\circ$	.033	.044	.026	.018	.026	.037	.014 .030	.020	.037	.048	.026	.030	.006	.033	{.039 {.027	.049
Lateral control with sideslip	Maximum α at which ailerons will balance C_l' due to 20° yaw		17°	17°	19°	19°	17°	18°	21°	23°	17°	18°	19°	20°	17°	19°	20°	22°
Yawing moments due to ailerons: (+) favorable (-) unfavorable	C_n	$\alpha = 0^\circ$	-.003	0 ^{c}-.002	.007 ^{b}-.002	.010 ^{a}-.001	^{c}-.004	.003 ^{b}-.002	.010 ^{a}-.002	.014 ^{a}-.001	-.004	.001 ^{b}-.003	.009 ^{b}-.002	.011 ^{a}-.001	-.004	.002 ^{a}-.002	.011 ^{c}-.002	.014 ^{a}-.005
	C_n	$\alpha = 10^\circ$	.002	.005	.012	.016	0 -.001	.007 ^{a}-.001	.017 ^{a}-.001	.022	-.001	.006 ^{b}-.001	.013	.016	^{c}-.001	.008 ^{a}-.001	.017	.021
	C_n	$\alpha = 20^\circ$	-.026	^{e}-.024	^{e}-.022	^{c}-.003	-.029	^{e}-.024	.002 ^{e}-.024	.010 ^{e}-.006	-.028	-.025	^{d}-.025	.001 ^{b}-.006	^{c}-.026	^{e}-.023	^{e}-.025	^{e}-.019
	C_n	$\alpha = 30^\circ$	-.007	^{c}-.005	^{c}-.004	^{e}.001 -.002	-.011	^{e}-.006	^{e}-.007	.001 ^{c}-.002	^{c}-.006	^{c}-.006	^{c}-.006	^{e}.001 ^{b}-.003	^{c}-.008	^{c}-.007	^{e}-.006	.005
Lateral stability ($\delta_A = 0^\circ$)	α for initial instability in rolling		15°	15°	15°	15°	15°	15°	15°	15°	15°	15°	15°	15°	15°	15°	15°	15°
	α for initial instability at $\frac{p'b}{2V} = 0.05$	Yaw = 0°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°
		Yaw = 20°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°	14°
	Maximum unstable C_λ	Yaw = 0°	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040
		Yaw = 20°	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042	.042
Control force required	CF	$\alpha = 0^\circ$	.008	.009	.013	.020	.015	.016	.025	.039	.007	.007	.012	.018	.013	.014	.023	.035
	CF	$\alpha = 10^\circ$	.002	.002	.002	.004	.004	.003	.003	.006	.002	.002	.002	.004	.004	.003	.003	.005

a to f, Where the maximum yawing moment occurred below maximum deflection, the letters indicate the deflection of the up aileron as follows: $^{a} = 10^\circ$, $b = 15^\circ$, $c = 20^\circ$, $d = 25^\circ$, $e = 30^\circ$, $f = 35^\circ$:

g, RC has a minimum value of 0.066 at $\alpha = 17^\circ$ and a maximum of 0.079 at $\alpha = 22^\circ$. h, RC = 0.064 at $\alpha = 17^\circ$ and 0.094 at $\alpha = 22^\circ$.

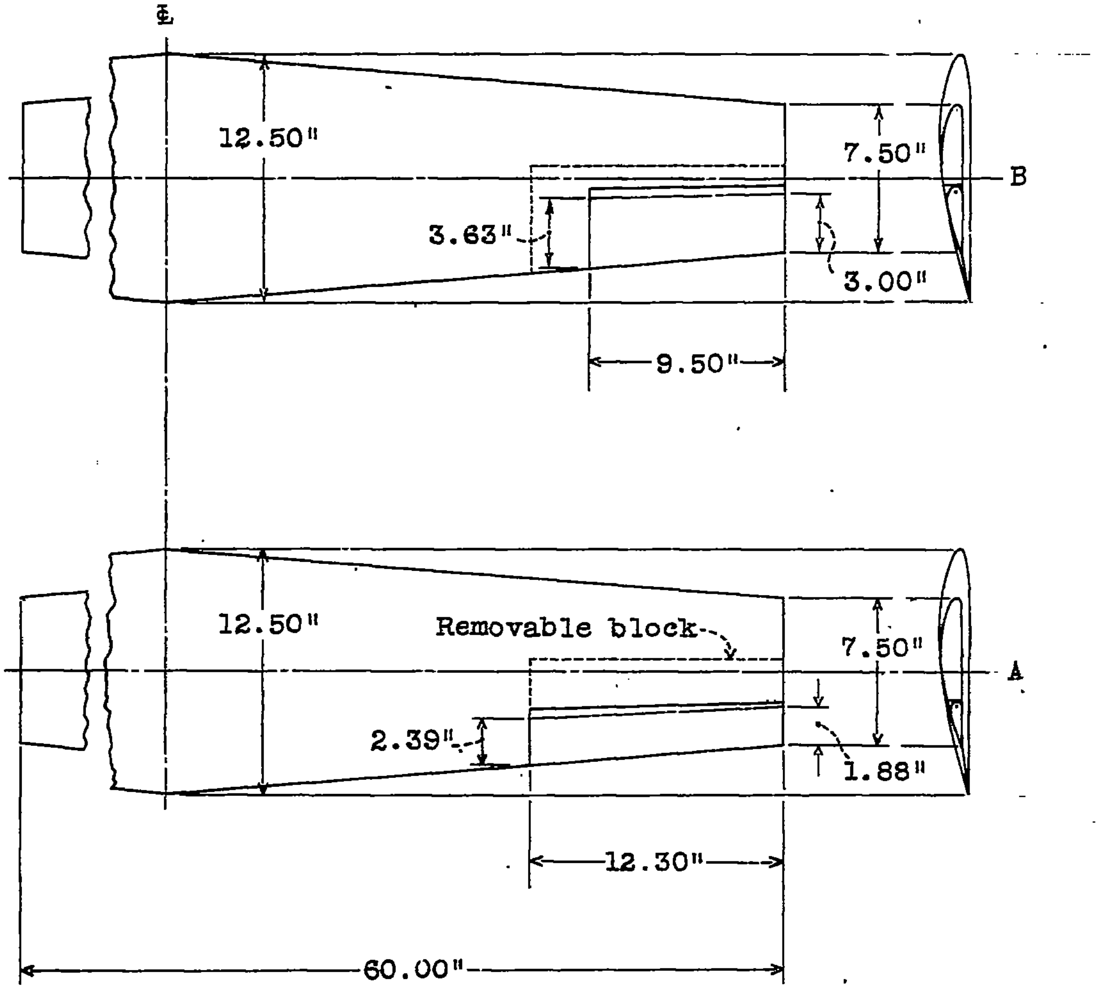


Figure 1. -Clark Y wing with 5:3 taper and plain ailerons.

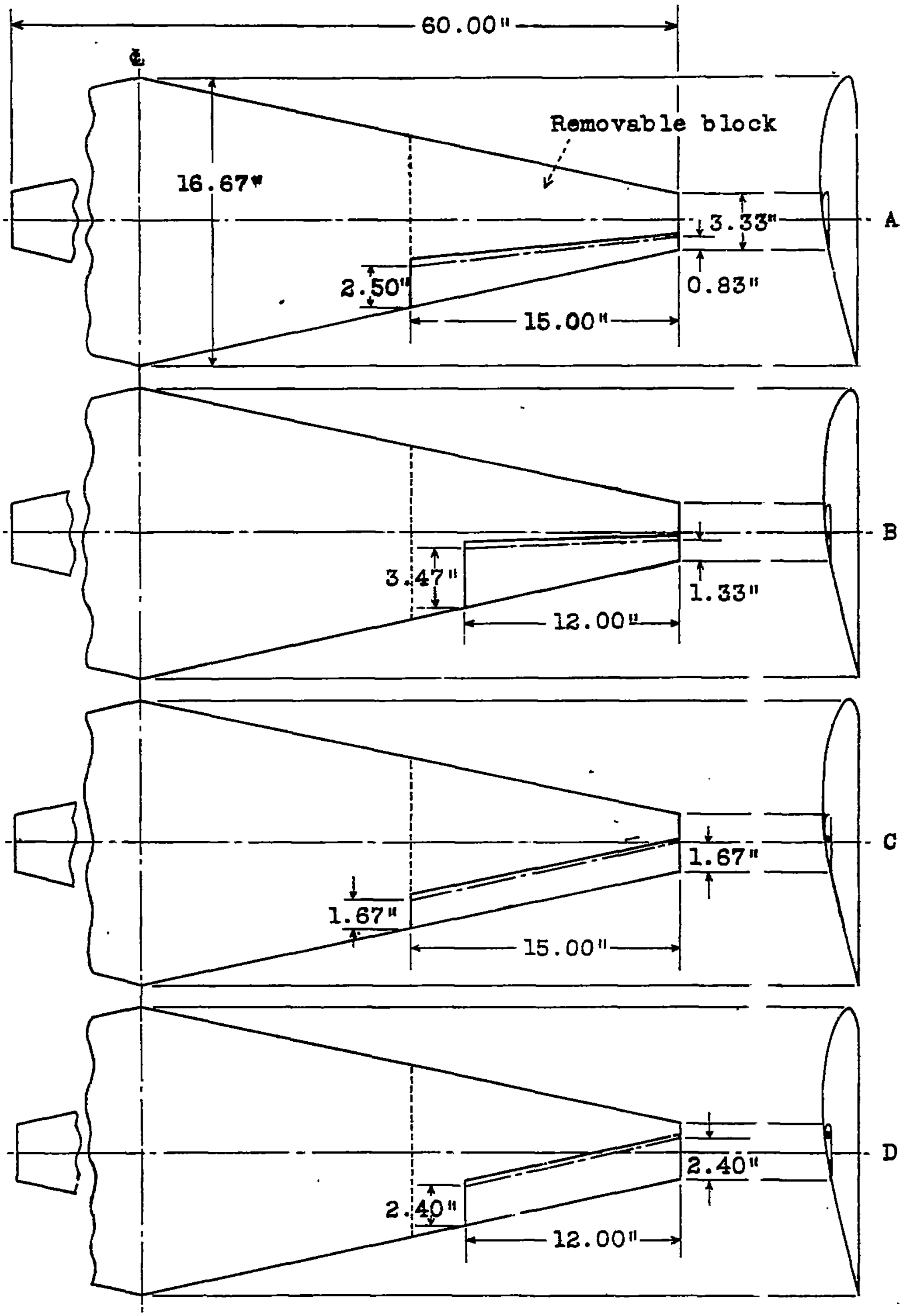
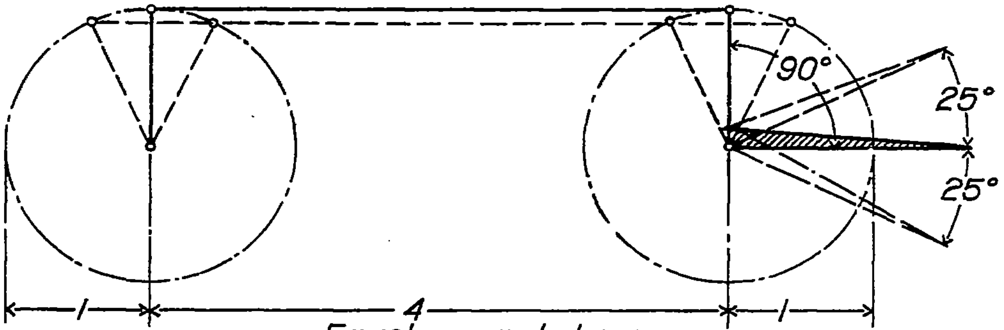
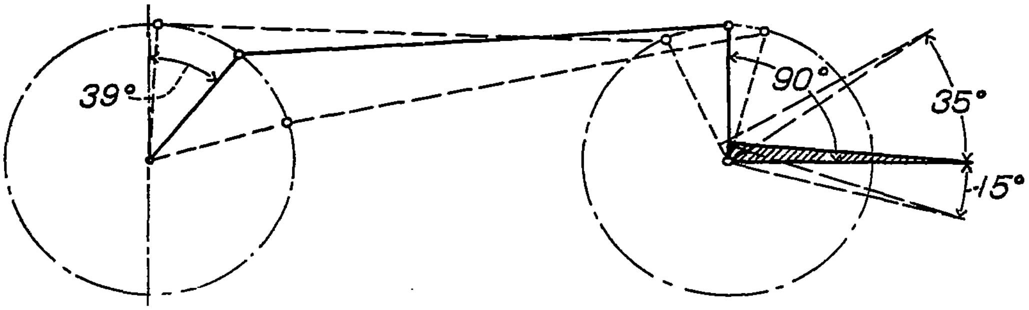


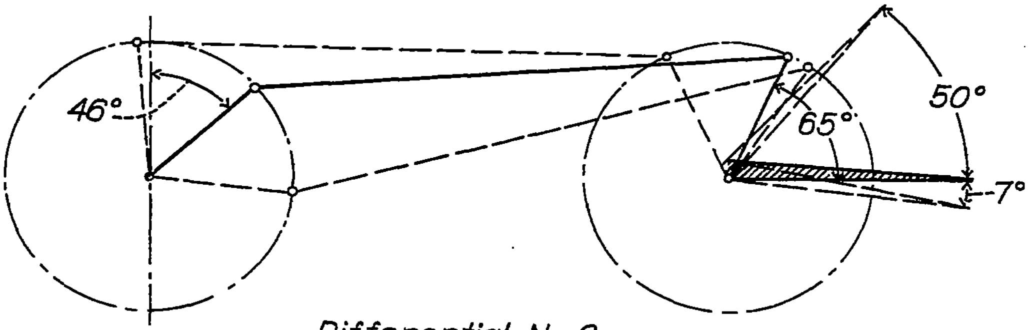
Figure 2. Clark Y wing with 5:1 taper and plain ailerons.



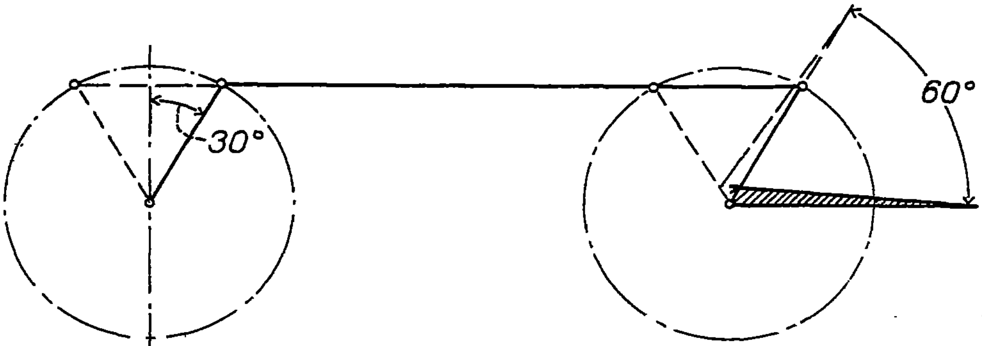
Equal up-and-down



Differential No.1



Differential No.2



Up-only

Figure 3.-Aileron linkage systems-assumed maximum deflections.