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Note on the Lift and Profile Drag Effects of Split and Slotted Flaps

By
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Notes on the Lift and Profile Drag Effects of Split and Slotted Flaps

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Summary.—The existing data have been analysed and a method has been derived for predicting the lift and profile-drag increments of split and slotted flaps. It is suggested that the probable order of error involved in the method is within the accuracy required for most practical purposes.

It is found that the profile-drag increments of split flaps on wing-body combinations is somewhat lower than on wings alone, whilst the converse is true for slotted flaps. It is suggested that this may be due to wing-body-flap interference effects. Nevertheless, the available data from which these results are derived are scanty and most are comparatively unreliable; further systematic tests are needed before definite conclusions can be drawn.

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1. *Introduction.*—Flaps play an essential part in the take-off and landing of modern aeroplanes; for estimating the performance of an aeroplane it is therefore desirable that a satisfactory method of predicting the effect of the flaps on lift and drag should be available.

The effect of a flap on lift is best represented by the increment in the lift coefficient caused by the flap at some moderate angle of incidence. It is found, fortunately enough, that such increments, unlike increments in maximum lift, are relatively independent of test conditions such as Reynolds number and wind-tunnel turbulence, and they vary only slightly with the incidence chosen. In this note (following Lyon and Pindar[40] (1940)) the incidence chosen is 10 deg. above the no-lift angle, this being in the range of incidences usual at take-off. If the increment in the lift coefficient at a fixed incidence due to a flap is known the change in incidence at a fixed lift coefficient due to the flap can be easily estimated if required, given the lift-curve slope of the wing.

The effect of a flap on profile drag is similarly best represented by the increment in the profile drag coefficient at some moderate angle of incidence As with the lift increment the profile drag increment has been found to be fairly independent of test conditions, and, whilst it varies rather more than the lift increment with incidence, its variation over the range of incidences usual during the take-off run is generally small. The incidence chosen in this note is 6 deg. above the no-lift angle. Given the profile drag increment the induced drag of the flapped wing is required to complete any drag estimate. This can be obtained from the data and charts of Hollingdale[42] (1936), Pearson and Anderson[43] (1939) and Young[45] (1942).

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For this report the available evidence, derived from both wind-tunnel and flight tests, has been analysed to provide as far as possible a satisfactory method of predicting the lift and profile drag increments, as defined above, for split and slotted flaps. It is perhaps as well to state at this stage that much of the evidence examined is such that the probable order of error of the profile-drag data derived is large, and where this is the case some indication is made in the Tables. All data have as far as possible been converted to an aspect ratio of 6 and, except where otherwise stated, results quoted in this report all refer to that aspect ratio. The lift increment at another aspect ratio can be calculated on the assumption that it is proportional to the slope of the lift incidence curve, which is given theoretically as proportional to $A/(2 + A)$. The effect of change of aspect ratio on profile drag increment can be neglected.

2. *Lift Increment.*—2.1. *General.*—The basis of the analysis of the lift increment data is the assumption, for which there is some theoretical justification, that for full-span flaps

$$\Delta C_L' = \lambda_1 (c_f/c') \cdot \lambda_2(\beta) , \quad \ldots \quad (1)$$

where $\Delta C_L'$ is the lift increment expressed in terms of the wing area including any extension due to the operation of the flap, $\lambda_1 (c_f/c')$ is a function of the ratio of the flap chord (c_f) to the extended chord* (c'), and $\lambda_2(\beta)$ is a function of the flap angle (β). The relation between $\Delta C_L'$ and ΔC_L, the lift increment in terms of the unextended area, is given by

$$\Delta C_L' = \Delta C_L \frac{c}{c'} - C_{L_0}\left(1 - \frac{c}{c'}\right), \quad \ldots \quad (2)$$

where C_{L_0} is the lift coefficient of the unflapped wing at the chosen incidence. Where there is no extension of chord, as with split flaps, the two increments are identical.

For part-span flaps it is assumed that

$$\Delta C_L' = \lambda_1 (c_f/c') \cdot \lambda_2(\beta) \cdot \lambda_3(b_f/b) , \quad \ldots \quad (3)$$

where $\lambda_3(b_f/b)$ is a function of the ratio of the flap span (b_f/b) to the wing span (b). The relation between $\Delta C_L'$ and ΔC_L is now

$$\Delta C_L' = \Delta C_L \frac{S}{S'} - C_{L_0}\left(1 - \frac{S}{S'}\right), \quad \ldots \quad (4)$$

where S' is the area of the wing, including any extension due to the flap, and S is the unextended area of the wing.

The procedure has been to analyse the available full-span flap data in order to establish the functions $\lambda_1 (c_f/c')$ and $\lambda_2(\beta)$ and then to establish the function $\lambda_3 (b_f/b)$ from part-span flap data, taking careful note of any possible differences due to interference effects which might arise between flaps on wing-body combinations and flaps on wings alone.

2.2. *Full-span Flaps.*—Glauert[44] (1927) has demonstrated that theoretically

$$\Delta C_L' = a\lambda_1 (c_f/c') \beta, \quad \ldots \quad (5)$$

where a is a function only of the aspect ratio of the wing and is equal to 2π for two-dimensional flow, $\lambda_1 (c_f/c')$ is the function shown in Fig. 1. Tables 1 and 2 summarise the experimental data for the full-span split and slotted flaps that have been analysed The measured values of $\Delta C_L'$ have been divided by the corresponding values of $\lambda_1 (c_f/c')$ and plotted against the flap angle β, and it was found that for given wing thickness ratios (t/c) the resulting points approximated fairly closely to well-defined functions of β. These curves of $\lambda_2(\beta)$ for $t/c = 0{\cdot}12$, $0{\cdot}21$ and $0{\cdot}30$ for split flaps are shown in Fig. 2, the corresponding curves for slotted flaps are shown in Fig. 3 (a) and (b). It was found desirable to distinguish between the N.A.C.A. types of slotted flap and the Handley Page type of slotted flap. In the former the flaps are arranged to follow, as far as

* *See* Lyon and Pindar[40] (1940) for definition of extended chord.

possible, paths which give the optimum lift increment at any given flap angle, in the latter the flap is rotated about a fixed hinge position. As might be expected, the differences between the lift increments of the two types of slotted flap are particularly marked at the smaller flap angles.

The values of λ_1 and λ_2 are given in Tables 1 and 2 as are also the estimated values of $\Delta C_L'$ given by the product of λ_1 and λ_2. The general agreement between the measured and estimated values of $\Delta C_L'$ is a justification of the basic assumption embodied in equation (1), and it follows that the curves of Figs. 1 to 3 provide a fairly reliable method of predicting the lift increments of full-span split and slotted flaps.

2.3. *Part-span Flaps*.—The part-span flap data that have been analysed are summarised in Tables 3 and 4. One can derive theoretically the ratio of the lift increment of a part-span flap to that of a full-span flap on wings of various taper ratios (*see* Hollingdale[42] (1936)), the resulting curves are shown in Fig. 4. An examination of the data suggests that these theoretical curves fit with reasonable accuracy the experimental variation of lift increment with flap span for both flaps on wings alone and flaps on wing-body combinations. The curves have accordingly been taken to define the function $\lambda_3\,(b_f/b)$. The values of λ_1, λ_2 and λ_3 are given in Table 3 and 4, as are also the estimated values of $\Delta C_L'$ (= λ_1, λ_2, λ_3) which can be compared with the measured values. For flaps with cut-out the value of λ_3 has been taken as the difference between the value corresponding to the overall flap span and the value corresponding to the cut-out.* Bearing in mind the order of accuracy of the experimental results the agreement between the measured and estimated values of $\Delta C_L'$ is generally very satisfactory. There appears to be no consistent difference between the results for flaps on wing-body combinations and flaps on wings alone, although for the former results the scatter between the experimental and estimated values is somewhat larger than for the latter results. There is, for example, some evidence that at least for split flaps on mid and high wings the presence of a small cut-out can be ignored and λ_3 can be estimated on the basis of the overall flap span; further evidence on this point is desirable.

3. *Profile-drag Increments*.—3.1. The analysis of the profile-drag increment data has been developed on much the same lines as that described above for the lift increment data. Thus, for full-span flaps it has been assumed that the drag increment can be expressed in the form

$$\Delta C_{D_0} = D_1\,(c_f/c)\,.\,D_2(\beta)\,, \qquad (6)$$

and for part-span flaps

$$\Delta C_{D_0} = D_1\,(c_f/c)\,.\,D_2(\beta)\,.\,D_3\,(b_f/b)\,. \qquad (7)$$

No account has been taken of any extension in chord in this analysis since it has been found that the profile-drag increment is not affected by chord extension in the direct way that the lift increment is affected.

The procedure, as before, has been to analyse the full-span flap data in order to establish the functions D_1 and D_2, and then to establish the function D_3 from part-span data.

3.2. *Full-span Flaps*.—There is no satisfactory theoretical approach to the prediction of the profile drag increments of flaps to provide a start to the analysis as is the case with the lift increments, hence both functions $D_1\,(c_f/c)$ and $D_2(\beta)$ are derived empirically from the available data. The functions obtained for split flaps are shown in Fig. 5a and b and those obtained for slotted flaps are shown in Fig. 6a and b. The values of D_1 and D_2 corresponding to the experimental data analysed are given in Tables 1 and 2, as are also the corresponding estimated values of ΔC_{D_0}. It must be emphasised that the order of accuracy of the experimental results is frequently very low. The general agreement between the experimental and estimated values of ΔC_{D_0} is a justification of the assumption embodied in equation (6).

* Where a flap is not continued across the body the resulting gap in the flap is considered a cut out.

3.3. *Part-Span Flaps.*—It can be expected that the profile-drag increment of a part-span flap will be roughly proportional to the ratio of flapped wing area to total wing area, and an examination of the available data of part-span flaps on wings alone, admittedly sparse and of poor accuracy, supports this view. In Fig. 7 curves are shown for various wing tapers giving this ratio for varying flap span, and these curves have accordingly been assumed to define the function of $D_3\ (b_f/b)$. The values of the functions D_1, D_2 and D_3 corresponding to the data analysed are given in Tables 3 and 4.

The product $D_1 D_2 D_3$ was found to be in general somewhat pessimistic in predicting $\triangle C_{D_0}$ for split flaps on wing-body combinations and somewhat optimistic for slotted flaps on wing-body combinations. This is illustrated in Fig. 8a and 8b where the values of $\Delta C_{D_0}/D_1 D_3$ are plotted against flap angle for the split and slotted flaps. The full curve in each case is the curve for $D_2(\beta)$ already derived for flaps on wings alone, and it will be seen that in the case of the split flaps the points plotted lie in the main below the full curve and for the slotted flaps the points lie mainly above the full curve. It is dangerous to draw hard and fast conclusions from such little data, particularly in view of the poor accuracy of much of it, nevertheless it is reasonable to suppose that the profile drag increment due to a flap is modified to some extent by the presence of the fuselage, and hence there exists a wing-body-flap interference effect. It is obvious that such an interference effect will be a complicated function of the geometry of the aircraft, and much more data of a systematic nature is required before it can be properly understood. The evidence that we have suggests that with split flaps the interference effect is generally favourable, that is, the profile drag increment of the flap on a wing alone is greater than on a wing-body combination. This is possibly associated with some cleaning up of the flow at the wing-body junction caused by the flap, and, as might be expected, this effect diminishes in importance as the flap span is increased. On the other hand, with slotted flaps the evidence suggests that the interference effect is generally unfavourable. This may be due to the fact that with the operation of slotted flaps a definite break is caused at the wing-body junction and, in addition, it is frequently impossible to bring the flaps well up to the body. Further, a factor which cannot be left out of account is the possibility that either through inaccuracy in manufacture or distortion under load the slot shape may not conform to the design shape; the performance of a slotted flap can be seriously affected by quite small deviations of the slot shape from the optimum.

In Fig. 8a and 8b the dotted lines have been drawn as better mean curves for the plotted points than the full curves. The dotted line in Fig. 8a defines the curve $0 \cdot 85 D_2(\beta)$ for split flaps, whilst that of Fig. 8b defines the curve $1 \cdot 4 D_2(\beta)$ for slotted flaps. It is suggested therefore, that in the absence of further evidence, the profile drag increments on wing-body combinations of split flaps be obtained by means of the formula

$$\Delta C_{D_0} = 0 \cdot 85\ D_1\ D_2\ D_3\ , \qquad (8)$$

and the profile-drag increments of slotted flaps be obtained by means of

$$\Delta C_{D_0} = 1 \cdot 4\ D_1\ .\ D_2\ .\ D_3\ . \qquad (9)$$

Values of ΔC_{D_0} estimated according to these formulae are given in Tables 3 and 4 where they may be compared with the measured values. The need for further tests to provide systematic data particularly for slotted flaps cannot be too strongly emphasised. Nevertheless, it is believed that the above formulae should provide a basis of prediction with a probable error of $\pm$ 20 per cent. This order of accuracy is probably within the order of accuracy of most of the experimental data analysed, and should be good enough for most cases where estimates of flap drag are required.

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TABLE 1

Full-span Split Flaps

Ref. No.	Wing: Section	Wing: t/c	Wing: Taper	Flaps: c_f/c	Flaps: β, deg.	Measured: ΔC_L $(\alpha-\alpha_0=10°)$	Measured: ΔC_{D0} $(\alpha-\alpha_0=6°)$	$\lambda_1\left(\frac{c_f}{c}\right)$ (Fig. 1)	$\lambda_2(\beta)$ (Fig. 2)	Estimated $\Delta C_L = \lambda_1 \lambda_2$	$D_1\left(\frac{c_f}{c}\right)$ (Fig. 5*a*)	$D_2(\beta)$ (Fig. 5*b*)	Estimated $\Delta C_{D0} = D_1 D_2$	Remarks
1	23012	0·12	1 : 1	0·2	15	0·33	0·032	0·55	0·65	0·36	1·00	0·025	0·025	Accuracy of profile drag data very poor.
					30	0·68	0·079	0·55	1·07	0·59	1·00	0·067	0·067	
					45	0·86	0·132	0·55	1·35	0·74	1·00	0·117	0·117	
					60	0·92	0·178	0·55	1·55	0·85	1·00	0·167	0·167	
					75	0·93	0·210	0·55	1·66	0·91	1·00	0·212	0·212	
	23021	0·21	1 : 1	0·2	15	0·40	—	0·55	0·84	0·46	1·00	0·016	0·016	Accuracy of profile drag data very poor.
					30	0·73	0·041	0·55	1·44	0·79	1·00	0·050	0·050	
					45	0·98	0·096	0·55	1·83	1·01	1·00	0·100	0·100	
					60	1·05	0·122	0·55	2·11	1·16	1·00	0·151	0·151	
					75	1·13	0·161	0·55	2·27^{5}	1·25	1·00	0·197	0·197	
2	*CY*	0·12	1 : 1	0·15	15	0·26^{5}	0·027	0·482	0·65	0·31	0·7	0·025	0·018	Accuracy of profile drag data very poor.
					30	0·49^{5}	0·047	0·482	1·07	0·52	0·7	0·067	0·047	
					45	0·63^{5}	0·095	0·482	1·35	0·65	0·7	0·117	0·082	
					60	0·71^{5}	0·127	0·482	1·55	0·75	0·7	0·167	0·110	
				0·25	15	0·32	0·028	0·60	0·65	0·39	1·34	0·025	0·034	
					30	0·61	0·073	0·60	1·07	0·64	1·34	0·067	0·090	
					45	0·78	0·158	0·60	1·35	0·81	1·34	0·117	0·157	
3	*CY*	0·12	5 : 1	0·15	15	0·28^{5}	0·007	0·482	0·65	0·31	0·70	0·025	0·018	Accuracy of profile drag data very poor.
					30	0·50	0·057	0·482	1·07	0·51^{5}	0·70	0·067	0·047	
					45	0·67	0·079	0·482	1·35	0·65	0·70	0·117	0·082	
					60	0·76	0·098	0·482	1·55	0·75	0·70	0·167	0·117	
					75	0·82	0·108	0·482	1·66	0·80	0·70	0·212	0·148	
				0·25	15	0·36	0·046	0·60	0·65	0·39	1·15	0·025	0·029	
					30	0·66	0·085	0·60	1·07	0·64	1·15	0·067	0·077	
					45	0·85	0·113	0·60	1·35	0·81	1·15	0·117	0·135	
					60	0·94	0·164	0·60	1·55	0·93	1·15	0·167	0·192	
4	23012	0·12	1 : 1	0·10	15	0·29	0·010	0·395	0·65	0·26	0·43	0·025	0·011	
					30	0·47	0·031	0·395	1·07	0·42	0·43	0·067	0·029	
					45	0·58	0·054	0·395	1·35	0·53	0·43	0·117	0·050	
					60	0·69	0·074	0·395	1·55	0·61	0·43	0·167	0·072	
					75	0·72	0·096	0·395	1·66	0·66	0·43	0·212	0·091	
					90	0·72	0·106	0·395	1·68	0·66	0·43	0·234	0·100	

TABLE 1 (*contd.*)

Ref. No.	Wing: Section	Wing: $\frac{t}{c}$	Wing: Taper	Flaps: c_f/c	Flaps: β, deg.	Measured: ΔC_L $(\alpha-\alpha_0=10°)$	Measured: ΔC_{D0} $(\alpha-\alpha_0=6°)$	$\lambda_1\left(\frac{c_f}{c}\right)$ (Fig. 1)	$\lambda_2(\beta)$ (Fig. 2)	Estimated $\Delta C_L = \lambda_1 \lambda_2$	$D_1\left(\frac{c_f}{c}\right)$ (Fig. 5*a*)	$D_2(\beta)$ (Fig. 5*b*)	Estimated $\Delta C_{D0} = D_1 D_2$	Remarks
4	23012	0·12	1 : 1	0·2	10	0·23	0·012	0·55	0·45	0·25	1·00	0·014	0·014	
					20	0·44	0·035	0·55	0·76	0·42	1·00	0·038	0·038	
					30	0·60	0·066	0·55	1·07	0·59	1·00	0·067	0·067	
					45	0·74	0·119	0·55	1·35	0·74	1·00	0·117	0·117	
					60	0·98	0·166	0·55	1·55	0·85	1·00	0·167	0·167	
					75	0·99	0·205	0·55	1·66	0·91	1·00	0·212	0·212	
				0·3	15	0·48	0·041	0·65	0·65	0·42	1·64	0·025	0·041	
					30	0·76	0·114	0·65	1·07	0·70	1·64	0·067	0·110	
					45	0·97	0·194	0·65	1·35	0·88	1·64	0·117	0·192	
					60	1·12	0·280	0·65	1·55	1·01	1·64	0·167	0·274	
					75	1·14	0·342	0·65	1·66	1·08	1·64	0·212	0·349	
				0·4	15	0·52	0·059	0·74	0·65	0·48	2·17	0·025	0·054	
					30	0·87	0·156	0·74	1·07	0·79	2·17	0·067	0·146	
					45	1·11	0·279	0·74	1·35	1·00	2·17	0·117	0·255	
					60	1·23	0·399	0·74	1·55	1·15	2·17	0·167	0·363	
4	23021	0·21	1 : 1	0·1	15	0·33	0·007	0·395	0·84	0·33	0·43	0·016	0·007	
					30	0·51	0·018	0·395	1·44	0·57	0·43	0·050	0·021^{5}	
					45	0·74	0·039	0·395	1·83	0·72	0·43	0·100	0·043	
					60	0·82	0·060	0·395	2·11	0·83	0·43	0·151	0·065	
					75	0·89	0·079	0·395	2·27^{5}	0·90	0·43	0·197	0·085	
					90	0·97	0·091	0·395	2·33	0·92	0·43	0·223	0·096	
				0·2	15	0·49	0·017	0·55	0·84	0·46	1·00	0·016	0·016	
					30	0·79	0·055	0·55	1·44	0·79	1·00	0·050	0·050	
					45	1·04	0·104	0·55	1·83	1·01	1·00	0·100	0·100	
					60	1·19	0·154	0·55	2·11	1·16	1·00	0·151	0·151	
					75	1·29	0·199	0·55	2·27^{5}	1·25	1·00	0·197	0·197	
					90	1·31	0·233	0·55	2·33	1·28	1·00	0·223	0·223	
				0·3	15	0·66	0·028	0·65	0·84	0·55	1·59	0·016	0·025^{5}	
					30	1·01	0·089	0·65	1·44	0·94	1·59	0·050	0·080	
					45	1·30	0·162	0·65	1·83	1·19	1·59	0·100	0·159	
					60	1·49	0·232	0·65	2·11	1·39	1·59	0·151	0·240	
					75	1·58	0·324	0·65	2·27^{5}	1·48	1·59	0·197	0·314	
				0·4	15	0·74	0·041	0·74	0·84	0·62	2·09	0·016	0·033^{5}	
					30	1·18	0·117	0·74	1·44	1·07	2·09	0·050	0·105	
					45	1·49	0·233	0·74	1·88	1·35	2·09	0·100	0·209	
					60	1·69	0·360	0·74	2·11	1·56	2·09	0·151	0·316	

TABLE 1 (*contd.*)

Ref. No.	Wing: Section	Wing: $\frac{t}{c}$	Wing: Taper	Flaps: c_f/c	Flaps: β, deg.	Measured: ΔC_L $(\alpha-\alpha_0=10°)$	Measured: ΔC_{D0} $(\alpha_0-\alpha=6°)$	$\lambda_1\left(\frac{c_f}{c}\right)$ (Fig. 1)	$\lambda_2(\beta)$ (Fig. 2)	Estimated $\Delta C_L = \lambda_1 \lambda_2$	$D_1\left(\frac{c_f}{c}\right)$ (Fig. 5*a*)	$D_2(\beta)$ (Fig. 5*b*)	Estimated $\Delta C_{D0} = D_1 D_2$	Remarks
4	23030	0·30	1 : 1	0·1	15	0·35	0·007	0·395	1·00	0·39^5	0·43	0·011	0·005	
					30	0·65	0·011	0·395	1·74	0·69	0·43	0·037	0·016	
					45	0·89	0·027	0·395	2·27^5	0·40	0·43	0·075	0·032	
					60	1·07	0·046	0·395	2·63	1·04	0·43	0·122	0·052	
					75	1·12	0·063	0·395	2·84	1·12	0·43	0·166	0·071	
					90	1·15	0·071	0·395	2·91	1·15	0·43	0·200	0·086	
					105	1·14	0·079	0·395	2·85	1·13	0·43	0·198	0·085	
				0·2	15	0·52	0·010	0·55	1·00	0·55	1·00	0·011	0·011	
					30	0·93	0·034	0·55	1·74	0·96	1·00	0·037	0·037	
					45	1·27	0·078	0·55	2·27^5	1·25	1·00	0·075	0·075	
					60	1·47	0·120	0·55	2·63	1·45	1·00	0·122	0·122	
					75	1·57	0·164	0·55	2·84	1·56	1·00	0·166	0·166	
					90	1·62	0·200	0·55	2·91	1·60	1·00	0·200	0·200	
				0·3	15	0·66	0·016	0·65	1·00	0·65	1·72	0·011	0·019	
					30	1·14	0·066	0·65	1·74	1·14	1·72	0·037	0·064	
					45	1·49	0·132	0·65	2·27^5	1·48	1·72	0·075	0·130	
					60	1·71	0·208	0·65	2·63	1·71	1·72	0·122	0·210	
					75	1·85	0·294	0·65	2·84	1·85	1·72	0·166	0·286	
					90	1·89	0·379	0·65	2·91	1·89	1·72	0·200	0·344	
				0·4	15	0·77	0·028	0·74	1·00	0·74	2·44	0·011	0·027	
					30	1·31	0·102	0·74	1·74	1·29	2·44	0·037	0·090	
					45	1·70	0·191	0·74	2·27^5	1·68	2·44	0·075	0·183	
					60	1·93	0·285	0·74	2·63	1·95	2·44	0·122	0·298	
					75	2·10	0·422	0·74	2·84	2·10	2·44	0·166	0·405	
5	23012	0·12	1 : 1	0·2	5	0·14	0·003	0·55	0·25	0·14	1·00	0·006	0·006	
					10	0·25^5	0·010	0·55	0·45	0·25	1·00	0·014	0·014	
					15	0·36	0·019	0·55	0·65	0·36	1·00	0·025	0·025	
					20	0·45	0·034	0·55	0·76	0·42	1·00	0·038	0·038	
					30	0·64^5	0·066	0·55	1·07	0·59	1·00	0·067	0·067	
					45	0·81	0 115	0 55	1·35	0·74	1·00	0·117	0·117	
					60	0·91	0·159	0·55	1·55	0·85	1·00	0·167	0·167	
					75	0·91	0·197	0·55	1·66	0·91	1·00	0·212	0·212	
					90	0·91	0·223	0·55	1·68	0·92	1·00	0·234	0·234	

TABLE 1 (*contd.*)

Ref. No.	Wing: Section	Wing: $\frac{t}{c}$	Wing: Taper	Flaps: c_f/c	Flaps: β deg.	Measured: ΔC_L $(\alpha-\alpha_0=10°)$	Measured: ΔC_{D0} $(\alpha-\alpha_0=6°)$	$\lambda_1\left(\frac{c_f}{c'}\right)$ (Fig. 1)	$\lambda_2(\beta)$ (Fig. 2)	Estimated ΔC_L $=\lambda_1\lambda_2$	$D_1\left(\frac{c_f}{c}\right)$ (Fig. 5*a*)	$D_2(\beta)$ (Fig. 5*b*)	Estimated ΔC_{D0} $=D_1 D_2$	Remarks
6	RAF 48	0·15	1 : 1	0·1	90	0·64	—	0·395	1·87	0·74	0·43	0·230	0·099	
6	CY	0·12	1 : 1	0·1	90	0·78	—	0·395	1·68	0·66	0·43	0·234	0·100	
7	RAF 69	0·21	1 : 1	0·15	90	0·885	0·150	0·482	2·33	1·12	0·70	0·223	0·156	
	RAF 89	0·25	1 : 1	0·15	90	1·025	0·137	0·482	2·60	1·25	0·70	0·215	0·150	
8	RAF 44	0·15	1 : 1	0·1	67	0·77	0·087	0·395	1·82	0·72	0·43	0·183	0·079	
					97	0·74	0·110	0·395	1·90	0·75	0·43	0·228	0·098	
				0·2	67	0·98	0·179	0·55	1·02	1·00	1·00	0·183	0·183	
					97	0·90	0·227	0·55	1·90	1·05	1·00	0·228	0·228	
9	CY	0·12	1 : 1	0·2	15	0·34	0·028	0·55	0·65	0·36	1·00	0·025	0·025	Accuracy of profile drag data poor.
					30	0·58	0·069	0·55	1·07	0·59	1·00	0·067	0·067	
					45	$0{\cdot}77^{5}$	0·117	0·55	1·35	0·74	1·00	0·117	0·117	
					60	0·83	0·171	0·55	1·55	0·85	1·00	0·167	0·167	
					75	$0{\cdot}87^{5}$	0·199	0·55	1·66	0·91	1·00	0·212	0·212	
				0·3	15	0·41	0·033	0·65	0·65	0·42	1·64	0·025	0·041	
					30	0·69	0·115	0·65	1·07	0·69	1·64	0·067	0·110	
					45	0·87	0·185	0·65	1·35	0·88	1·64	0·117	0·192	
					60	0·96	0·266	0·65	1·55	1·01	1·64	0·167	0·274	
				0·4	15	0·45	0·043	0·74	0·65	0·48	2·17	0·025	0·054	
					30	0·77	0·126	0·74	1·07	0·79	2·17	0·067	0·145	
					45	0·96	0·227	0·74	1·35	1·00	2·17	0·117	0·254	
					60	1·02	0·334	0·74	1·55	1·14	2·17	0·167	0·362	

TABLE 2A

Full-span Slotted Flaps, NACA Type. (Optimum flap path)

Ref. No.	Wing: Section	Wing: t/c	Wing: Taper	Flaps: c_f/c	Flaps: c_f/c'	Flaps: β deg.	Measured: ΔC_L ($\alpha-\alpha_0=10°$)	Measured: $\Delta C_L'$	Measured: ΔC_{D0} ($\alpha-\alpha_0=6°$)	$\lambda_1\left(\frac{c_f}{c'}\right)$ (Fig. 1)	λ_2 (β) Fig. 3	Estimated $\Delta C_L' = \lambda_1 \lambda_2$	$D_1\left(\frac{c_f}{c}\right)$ Fig. 6(*a*)	D_2 (β) Fig. 6(*b*)	Estimated $\Delta C_{D0} = D_1 D_2$	Remarks
10	23012	0·12	1 : 1	0·10	0·098	20	0·42	0·40	0·004	0·39	1·15	0·45	0·45	0·007	0·003	
					0·097	40	0·66	0·62	0·018	0·38^{5}	1·70	0·65	0·45	0·039	0·018	
					0·097	50	0·75	0·71	0·024	0·38^{5}	1·78	0·69	0·45	0·059	0·026^{5}	
				0·257	0·252	10	0·40	0·38	0·003	0·60	0·66	0·40	1·41	0·003^{5}	0·003^{5}	
					0·246	20	0·73	0·67	0·007	0.60	1·15	0·69	1·41	0·007	0·010	
					0·243	30	1·02	0·93	0·021	0·59^{5}	1·50	0·90	1·41	0·020	0·028	
					0·240	40	1·17	1·04	0·053	0·59	1·70	1·01	1·41	0·039	0·055	
					0·236	50	1·16	1·00	0·079	0·58^{5}	1·78	1·04	1·41	0·059	0·083	
					0·236	60	1·16	1·00	0·103	0·58^{5}	1·76	1·03	1·41	0·075	0·106	
11	23012	0·12	1 : 1	0·400	0·381	10	0·53	0·47	0·006	0·72^{5}	0·66	0·48	3·18	0·002^{5}	0·008	
					0·370	20	0·99	0·86	0·013	0·71	1·15	0·82	3·18	0·007	0·022	
					0·364	30	1·38	1·19	0·022	0·71	1·50	1·06	3·18	0·020	0·064	
					0·357	40	1·28^{5}	1·07	0·115	0·70	1·70	1·19	3·18	0·039	0·124	
					0·357	50	1·34	1·12	0·191	0·70	1·78	1·25	3·18	0·059	0·185	
12	23021	0·21	1 : 1	0·257	0·252	10	0·44	0·41^{5}	0·008	0·60	0·66	0·40	1·41	0·003^{5}	0·005	
					0·246	20	0·83	0·76^{5}	0·014	0·60	1·15	0·69	1·41	0·011	0·015	
					0·243	30	0·98	0·89	0·035	0·59^{5}	1·41	0·84	1·41	0·024	0·034	
					0·237	40	1·13	0·99	0·066	0·58^{5}	1·55	0·91	1·41	0·040	0·056	
					0·236	50	1·19	1·04	0·101	0·58^{5}	1·63	0·95	1·41	0·054	0·076	
					0·236	60	1·26^{5}	1·10	0·119	0·58^{5}	1·67^{5}	0·98	1·41	0·069	0·097	
13	23021	0·21	1 : 1	0·400	0·388	10	0·54	0·50^{5}	0·008	0·73	0·66	0·48	2·70	0·003^{5}	0·009	
					0·373	20	0·92	0·81	0·023	0·72	1·15	0·83	2·70	0·011	0·030	
					0·370	30	0·97	0·83	0·082	0·71	1·41	1·00	2·70	0·024	0·065	
					0·363	40	1·14	0·97	0·110	0·71	1:55	1·10	2·70	0·040	0·108	
					0·363	50	1·28	1·09	—	0·71	1·63	1·15	2·70	0·054	0·146	
14	23030	0·30	1 : 1	0·257	0·242	20	0·87	0·78	0·014	0·59^{5}	1·30	0·77	1·41	0·011	0·015	
					0·239	30	1·07	0·94^{5}	0·041	0·59	1·52	0·90	1·41	0·026	0·037	
					0·236	40	1·10^{5}	0·95^{5}	0·062	0·58^{5}	1·63	0·95	1·41	0·047	0·066	
					0·232	50	1·17	0·98	0·074	0·58	1·68	0·97	1·41	0·069	0·097	
					0·229	60	1·20	0·99	0·094	0·58	1·69	0·98	1·41	0·089	0·125	
				0·400	0·388	10	0·61	0·57	0·016	0·73	0·80	0·58	2·70	0·003^{5}	0·009	
					0·374	20	1·02	0·90^{5}	0·028	0·72	1·30	0·94	2·70	0·011	0·030	
					0·370	30	1·17	1·02	0·062	0·71	1·52	1·08	2·70	0·026	0·070	
					0·354	40	1·18	0·96	0·104	0·70	1·63	1·14	2·70	0·047	0·127	

TABLE 2B

Full-span Slotted Flaps. H.P. Type, Fixed Hinge

Ref. No.	Wing: Section	Wing: $\frac{t}{c}$	Wing: Taper	Flaps: C/c	Flaps: C_f/c'	Flaps: β deg.	Measured: ΔC_L $(\alpha-\alpha_0=10°)$	Measured: $\Delta C_L'$	Measured: ΔC_{D0} $(\alpha-\alpha_0=6°)$	$\lambda_1\left(\frac{c_f}{c'}\right)$ (Fig. 1)	$\lambda 2$ (β) Fig. 3	Estimated $\Delta C_L'$ $=\lambda_1\lambda_2$	$D\left(\frac{c_f}{c}\right)$ Fig. 6(*a*)	D_2 (β) Fig. 6(*b*)	Estimated ΔC_{D0} $=D_1 D_2$	Remarks
8	RAF 44	0·15	1 : 1	0·2	0·194	40	0·92	0·87	0·030	0·54	1·40	0·76	1·00	0·039	0·039	
					0·190	60	0·84	0·76	0·072	0·53^5	1·58	0·85	1·00	0·073	0·073	
15	H.P. 51	0·16	1 : 1	0·2	0·198	10	0·30	0·29	0·004	0·54^5	0·47	0·26	1·00	0·003	0·003	
					0·197	20	0·54	0·52	0·015	0·54^5	0·87	0·47	1·00	0·009	0·009	
					0·195	30	0·72	0·69	0·030	0·54	1·20	0·65	1·00	0·023	0·023	
					0·194	40	0·82	0·78	0·050	0·54	1·42	0·77	1·00	0·039	0·039	
					0·193	50	0·84^5	0·78	0·073	0·54	1·57	0·85	1·00	0·057	0·057	
					0·191	60	0·78	0·71^5	0·099	0·53^5	1·60	0·86	1·00	0·073	0·073	
16	H.P. 51	0·16	1 : 1	0·3	0·292	45	0·80	0·760	—	0·64^5	1·50	0·97	1·76	0·048	0·085	
17	23021	0·21	1 : 1	0·15	0·147	40	0·58^5	0·55	0·029	0·48	1·32	0·63	0·72	0·040	0·029	
					0·145	60	0·76	0·70	0·052	0·48	1·63	0·78	0·72	0·069	0·050	
18	23021	0·21	1 : 1	0·15	0·147	30	0·55	0·53	0·016	0·48	1·07	0·51	0·72	0·024	0·017	
					0·146	40	0·64	0·60^5	0·026	0·48	1·32	0·63	0·72	0·040	0·029	
					0·144	60	0·86	0·80	0·047	0·47^5	1·65	0·77	0·72	0·069	0·050	
					0·143	70	0·88	0·81	0·062	0·47^5	1·67	0·78	0·72	0·084	0·060	
					0·142	80	0·88	0·79	0·071	0·47	1·67	0·74	0·72	0·099	0·071	
19	23012	0·12	1 : 1	0·257	0·254	10	0·32	0·31	0·003	0·61	0·54	0·33	1·41	0·002^5	0·003^5	
					0·252	20	0·59	0·57	0·010	0·60^5	1·00	0·60^5	1·41	0·007	0·010	
					0·249	30	0·88	0·83^5	0·019	0·60	1·37	0·83	1·41	0·020	0·028	
					0·247	40	1·09	1·02	0·056	0·60	1·58	0·95	1·41	0·039	0·055	
					0·245	50	1·01	0·92	0·098	0·59^5	1·61	0·96	1·41	0·059	0·083	
					0·242	60	0·97^5	0·88	0·114	0·59^5	1·57	0·93	1·41	0·075	1·106	

TABLE 3A

Part-span Split Flaps on Wings Alone

Ref. No.	Wing: Section	Wing: t/c	Wing: Taper	Flaps: Span/2b (net)	Flaps: c_f/c	Flaps: β deg.	ΔC_L ($\alpha-\alpha_0=10°$)	ΔC_{D0} ($\alpha-\alpha_0=6°$)	$\lambda_1\left(\frac{c_f}{c}\right)$ Fig. 1	$\lambda_2(\beta)$ Fig. 2	$\lambda_3\left(\frac{b_f}{b}\right)$ Fig. 4	Estimated $\Delta C_L = \lambda_1 \lambda_2 \lambda_3$	$D_1\left(\frac{c_f}{c}\right)$ Fig. 6(a)	$D_2\,\beta$ Fig. 5(b)	$D_3\left(\frac{b_f}{b}\right)$ Fig. 7	Estimated ΔC_{D0} $D_1 D_2 D_3$	Remarks
20	CY	0·12	1 : 1	0·2	0·2	60	0·22	0·025^5	0·55	1·55	0·23	0·20	1·00	0·167	0·2	0·033	Accuracy of profile drag data very poor.
				0·4			0·41	0·059	0·55	1·55	0·45	0·38	1·00	0·167	0·4	0·067	
				0·6			0·60	0·100^5	0·55	1·55	0·67	0·57	1·00	0·167	0·6	0·100	
				0·8			0·78	0·129^5	0·55	1·55	0·86	0·73	1·00	0·167	0·8	0·134	
				1·00			0·92	0·176	0·55	1·55	1·00	0·85	1·00	0·167	1·0	0·167	
21	CY	0·12	5·1	0·2	0·15	60	0·20^5	0·033	0·48	1·55	0·28	0·21	0·7	0·167	0·31	0·036	Accuracy of profile drag data extremely poor
				0·4			0·40	0·063	0·48	1·55	0·54	0·40	0·7	0·167	0·56	0·065	
				0·6			0·59	0·082	0·48	1·55	0·74	0·55	0·7	0·167	0·76	0·089	
				0·8			0·71	0·090	0·48	1·55	0·91	0·68	0·7	0·167	0·91	0·106	
				1·00			0·79	0·110	0·48	1·55	1·00	0·74	0·7	0·167	1·00	0·117	
22	CY	0·12	5 : 3	0·59	0·15	60	0·59	0·062	0·48	1·55	0·68	0·51	0·7	0·167	0·65	0·076	Accuracy of profile data extremely poor.
				0·70			0·67	0·069	0·48	1·55	0·75^5	0·56	0·7	0·167	0·72	0·084	
				1·00			0·86	0·104	0·48	1·55	0·92	0·69	0·7	0·167	0·89	0·104	
	CY	0·12	5 : 1	0·5	0·15	60	0·53	0·061	0·48	1·55	0·68	0·51	0·7	0·167	0·69	0·080	
				0·7			0·68	0·072	0·48	1·55	0·81	0·60	0·7	0·167	0·81	0·094	
				1·00			0·80	0·085	0·48	1·55	0·91	0·68	0·7	0·167	0·91	0·106	

TABLE 3B

Part-span Split Flaps on Wing-body Combinations (Model)

Ref. No.	Wing: Section	Wing: t/c	Wing: Taper	Flaps: Net Span/b	Flaps: Cut out/b	Flaps: c_f/c	Flaps: β deg.	ΔC_L ($\alpha-\alpha_0=10°$)	ΔC_{D0} ($\alpha-\alpha_0=6°$)	$\lambda_1\left(\frac{c_f}{c'}\right)$ Fig. 1	$\lambda_2(\beta)$ Fig. 2	$\lambda_3(b_f/b)$ Fig. 4	Estimated $\Delta C_L = \lambda_1 \lambda_2 \lambda_3$	$D_1\left(\frac{c_f}{c}\right)$ Fig. 5(a)	$D_2(\beta)$ Fig. 5(b)	$D_3(b_f/b)$ Fig. 7	Estimated $\Delta C_{D0} = 0·85\, D_1 D_2 D_3$	Remarks
23		0·16	2 : 1	0·6	0	0·15	60	0·56	0·078	0·48	1·80	0·70	0·61	0·70	0·16	0·68	0·065	Low wing, A = 5·92.
				0·525	0·075			0·52	0·068	0·48	1·80	0·60	0·52	0·70	0·16	0·60	0·058	
				0·456	0·144			0·48	0·056	0·48	1·80	0·51	0·44	0·70	0·16	0·50	0·048	
				0·383	0·217			0·41	0·047	0·48	1·80	0·43	0·39	0·70	0·16	0·42	0·040	
24	0012	0·12	1 : 1	0·9	0·1	0·2	60	0·84	0·146	0·55	1·55	0·89	0·76	1·00	0·167	0·9	0·128	High Wing.
				0·8	0·2			0·76	0·131	0·55	1·55	0·77	0·66	1·00	0·167	0·8	0·114	
				0·4	0·1			0·34	0·038	0·55	1·55	0·45	0·38^5	1·00	0·167	0·4	0·056	
				0·2	0·2			0·28	0·021^5	0·55	1·55	0·22	0·19	1·00	0·167	0·2	0·029	
				0·9	0·1	0·2	60	0·79	0·147	0·55	1·55	0·89	0·75^5	1·00	0·167	0·9	0·128	Semi-high wing.
				0·9	0·1	0·2	60	0·79	0·149	0·55	1·55	0·89	0·75^5	1·00	0·167	0·9	0·128	Mid wing.
				1·00	0	0·2	60	0·78	0·156	0·55	1·55	1·00	0·85	1·00	0·117	1·00	0·143	Low wing.

TABLE 3B (*contd.*)

Ref. No.	Wing: Secton	Wing: t/c	Wing: Taper	Flaps: Net Span/b	Flaps: Cut out/b	Flaps: c_f/c	Flaps: β deg.	ΔC_L ($\alpha-\alpha_0$ =10°)	ΔC_{D0} ($\alpha-\alpha_0$ =6°)	$\lambda_1\left(\frac{c_f}{c}\right)$ Fig. 1	$\lambda_2(\beta)$ Fig. 2	$\lambda_3(b_f/b)$ Fig. 4	Estimated ΔC_L $=\lambda_1\lambda_2\lambda_3$	$D_1\left(\frac{c_f}{c}\right)$ Fig. 5(*a*)	$D_2(\beta)$ Fig. 5(*b*)	$D_3(b_f/b)$ Fig. 7	Estimated ΔC_{D0} $=0·85$ $D_1D_2D_3$	Remarks
25	23012	0·12	1 : 1	0·48	0·12	0·2	60	0·66	0·078	0·55	1·55	0·53	0·45^5	1·00	0·167	0·48	0·068	High wing
				0·48	0·12	0·2	60	0·63	0·082	0·55	1·55	0·53	0·45^5	1·00	0·167	0·48	0·068	Mid wing
				0·60	0	0·2	60	0·70	0·080	0·55	1·55	0·67	0·57	1·00	0·167	0·60	0·085	Low wing
	23012	0·12	3 : 1	0·48	0·12	0·2	60	0·64	0·071	0·55	1·55	0·56	0·48	1·00	0·167	0·55	0·079	High wing
				0·48	0·12	0·2	60	0·60	0·076	0·55	1·55	0·56	0·48	1·00	0·167	0·55	0·079	Mid wing
				0·60	0	0·2	60	0·69	0·087	0·55	1·55	0·72	0·62	1·00	0·167	0·72	0·102	Low wing } Accuracy of profile drag data very poor
26	Thin		1 : 1	0·53	0·07	0·083	90	0·37	0·043	0·36	1·68	0·59	0·36	0·35	0·234	0·53	0·037	High wing.
				0·83	0·07	0·083	90	0·51	0·012	0·36	1·68	0·86	0·52	0·35	0·234	0·83	0·058	

TABLE 3C

Part-span Split Flaps on Wing-body Combinations (Full Scale)

Ref. No.	Secton	t/c	Taper	Net Span/b	Cut out/b	c_f/c	β deg.	ΔC_L	ΔC_{D0}	λ_1	λ_2	λ_3	Estimated ΔC_L	D_1	D_2	D_3	Estimated ΔC_{D0}	Remarks
27		0·15	1·3 : 1	0·40^5	0·08	0·2	45	0·40^5	0·03	0·55	1·55	0·46	0·39	1·00	0·13	0·43	0·048	Low wing $A = 6·45$
28	CYH	0·12	1·56 : 1	0·42^5	—	0·11	90	0·37^5	0·029	0·42	1·68	0·50	0·35	0·49	0·234	0·47	0·046	Low wing $A = 6·4$
29		0·16	1·8 : 1	0·58	—	0·15	80	0·61	0·058*	0·48	1·90	0·67	0·64	0·70	0·218	0·64	0·083	Low wing $A = 6·7$ *ΔC_{D0} measured at $\alpha - \alpha_0 = 10°$
30		0·16	2·9 : 1	0·58	—	0·15	90	0·54*	0·094*	0·48	1·95	0·70	0·65	0·70	0·230	0·69	0·089	Low wing $A = 6·7$ *ΔC_{D0} & ΔC_L measured at $\alpha - \alpha_0 = 11°$
31		0·17	2·9 : 1	0·62	—	0·10	70	0·63*	0·050*	0·40	1·90	0·74	0·56	0·43	0·187	0·73	0·059	Low wing. $A = 8·23$ *ΔC_{D0} measured at $\alpha - \alpha_0 = 7°$
32	2212	0·12	1 : 1	0·82^5	0·09	0·10	20	0·23	0·003	0·40	0·81	0·85	0·27	0·43	0·038	0·82^5	0·012	High wing. Tests done in full scale tunnel. Accuracy of profile-drag data very poor.
							40	0·31	0·039	0·40	1·27	0·85	0·43	0·43	0·100	0·82^5	0·030	
							60	0·51	0·060	0·40	1·55	0·85	0·53	0·43	0·167	0·82^5	0·051	
33	N.22	0·12^5	1 : 1	0·9	0·10	0·2	20	0·30	0·024	0·55	0·81	0·89	0·40	1·00	0·039	0·9	0·030	High wing. Tests done in full scale tunnel. Accuracy of profile-drag data very poor. $A = 5·45$
							40	0·50	0·080	0·55	1·27	0·89	0·63	1·00	0·100	0·9	0·077	
							59	0·66	0·128	0·55	1·53	0·89	0·75	1·00	0·165	0·9	0·126	
	RAF 28	0·17	2 : 1	0·54	0·075	0·154	20	0·18^5	0·008	0·49	0·97	0·61	0·29	0·72	0·03	0·59	0·011	Unpublished. Blenheim, mid wing. $A = 6·7 : 1$
							40	0·37	0·024	0·49	1·55	0·61	0·46	0·72	0·09	0·59	0·032	

TABLE 4A

Part-Span Slotted Flaps on Wings Alone

Ref. No.	Wing: Section	Wing: $\frac{t}{c}$	Wing: Taper	Flaps: Net Span/b	Flaps: Cut out/b	Flaps: c_f/c	Flaps: C_f/c'	Flaps: s'/s	Flaps: β deg.	ΔC_L $\alpha-\alpha_0 = 10°$	$\Delta C_L'$	ΔC_{D0} $\alpha-\alpha_0 = 6°$	$\lambda_1\left(\frac{c_f}{c'}\right)$ Fig. 1	λ_2 (β) Fig. 3	$\lambda_3(b_f/b)$ Fig. 4	Estimated $\Delta C_L'$ $=\lambda_1 \lambda_2 \lambda_3$	$D_1 c_f/c)$ Fig. 6 (a)	D_2 (β) Fig. 6 (b)	$D_3(b_f/b)$ Fig. 7	Estimated ΔC_{D0} $= D_1 D_2 D_3$	Remarks
34	23012	0·12	1 : 1	0·2		0·256	0·240	1·01	40	0·23	0·22	0·012	0·59	1·70	0·23	0·23	1·40	0·39	0·2	0·011	N.A.C.A. Type. Accuracy of profile-drag data extremely poor.
				0·4				1·02^5		0·48	0·45	0·036	0·59	1·70	0·45	0·45	1·40	0·39	0·4	0·022	
				0·6				1·04		0·72	0·66	0·044	0·59	1·70	0·67	0·67	1·40	0·39	0·6	0·033	
				0·8				1·05		0·93	0·82	0·050	0·59	1·70	0·86	0·86	1·40	0·39	0·8	0·044	
				1·0				1·06^5		1·17	1·02	0·052	0·59	1·70	1·00	1·00	1·40	0·39	1·00	0·055	
	23012	0·12	5 : 1	0·2		0·256	0·240	1·020	40	0·28	0·26	0·028^5	0·59	1·70	0·28	0·28	1·40	0·39	0·31	0·017	
				0·4				1·03^5		0·64	0·58	0·038^5	0·59	1·70	0·54	0·54	1·40	0·39	0·58	0·032	
				0·6				1·05		0·90	0·80	0·039	0·59	1·70	0·74	0·74	1·40	0·39	0·78	0·043	
				0·8				1·06		1·09	0·96	0·033	0·59	1·70	0·91	0·91	1·40	0·39	0·91	0·050	
				1·0				1·06^5		1·22	1·06	0·037	0·59	1·70	1·00	1·00	1·40	0·39	1·00	0·055	

TABLE 4B

Part-span Slotted Flaps on Wing-Body Combinations (Model)

Ref. No.	Wing			Flaps						ΔC_L $\alpha-\alpha_0 = 10°$	$\Delta C_L'$	ΔC_{D0} $\alpha-\alpha_0 = 6°$	$\lambda_1\left(\frac{c_f}{c'}\right)$ Fig. 1	λ_2 (β) Fig. 3	$\lambda_3(b_f/b)$ Fig. 4	Estimated $\Delta C_L'$ $=\lambda_1 \lambda_2 \lambda_3$	D_1/c_f Fig. 7 (*a*)	D_2 (β) Fig. 7 (*b*)	$D_3(b_f/b)$ Fig. 8	Estimated ΔC_{D0} $= 1{\cdot}4$ $D_1 D_2 D_3$	Remarks
	Section	$\frac{t}{c}$	Taper	Net Span/b	Cut out $\frac{}{b}$	c_f/c	c_f/c'	s'/s	β deg.												
35		0·16	2 : 1	0·46	0·144	0·2	0·196	1·01	20	0·24	0·23	0·014	0·54	0·9	0·53	0·26	1·00	0·008	0·51	0·006	Low wing. A =5·93 H.P. Type.
							0·192	1·02	40	0·44^{5}	0·42	0·037	0·54	1·45	0·53	0·41^{5}	1·00	0·040	0·51	0·028	
							0·188	1·03	60	0·44	0·40^{5}	0·060	0·53	1·60	0·53	0·45	1·00	0·073	0·51	0·052	
							0·184	1·04^{5}	75	0·28	0·24	0·084	0·53	1·45	0·53	0·41	1·00	0·095	0·51	0·068	
							0·180	1·05^{5}	90	0·23^{5}	0·18	0·095	0·52	1·10	0·53	0·31	1·00	0·110	0·51	0·078	
36	N.A.C.A. 24 Series	0·16	2·51:1	0·474	0·115	0·25	0·245	1·01	20	0·53^{5}	0·52	0·003^{5}	0·60	0·9	0·55	0·30	1·36	0·008	0·53	0·008	Low wing. A =7·22 H.P. type.
							0·240	1·02	40	0·84^{5}	0·82	0·038^{5}	0·59	1·45	0·55	0·47	1·36	0·040	0·53	0·040	
							0·237	1·03	50	0·84^{5}	0·80	0·041	0·59	1·55	0·55	0·50	1·36	0·057	0·53	0·057	
37		0·16	1·76:1	0·51	0·09	0·256	0·243	1·03	45	0·68	0·64	0·030	0·60	1·50	0·58	0·52	1·40	0·048	0·55	0·052	High wing. A = 7·82 (S/24/37) H.P. type.

TABLE 4C

Part-span Slotted Flaps on Wing-body Combinations (Full scale)

		0·17	3·7:1	0·42	0·08^{5}	0·23	0·225	1·01	20	0·22	0·20^{5}	0·009	0·57^{5}	0·87	0·51	0·25^{5}	1·21	0·008^{5}	0·51	0·007	Mid wing. A = 6·5 H.P. type (Hampden)
							0·220	1·02^{5}	40	0·38^{5}	0·36	0·034	0·57	1·40	0·51	0·41	1·21	0·040	0·51	0·036	
							0·215	1·04^{5}	60	0·38^{5}	0·34	0·048	0·56	1·60	0·51	0·46	1·21	0·072	0·51	0·062	
38		0·15	2·5:1	0·37	0·195	0·274	0·267	1·02	36	0·47^{5} (both rows)		0·028* (both rows)	0·62	1·35	0·42	0·35	1·55	0·032	0·41	0·028	Slotted Flaps; Low wing *ΔC_{D0} Measured at $\alpha - \alpha_. = 10\frac{1}{2}°$
				0·37		0·204	0·200	1·00^{5}	14½				0·55	0·70	0·29	0·11	1·03	0·005	0·23	0·001	Slotted ailerons
39	N.A.C.A. 22 Series	0·15	2·7:1	0·275	0·225	0·225	0·216	1·01	40	0·28^{5}	0·27^{5}	0·016	0·56	1·45	0·33	0·27	1·17	0·039	0·31	0·018	Slotted Flaps; Low wing.
				0·435		0·25	0·245	1·00^{5}	23	0·26	0·25	0·020	0·60	1·05	0·35	0·22	1·36	0·013	0·36	0·008	Slotted ailerons

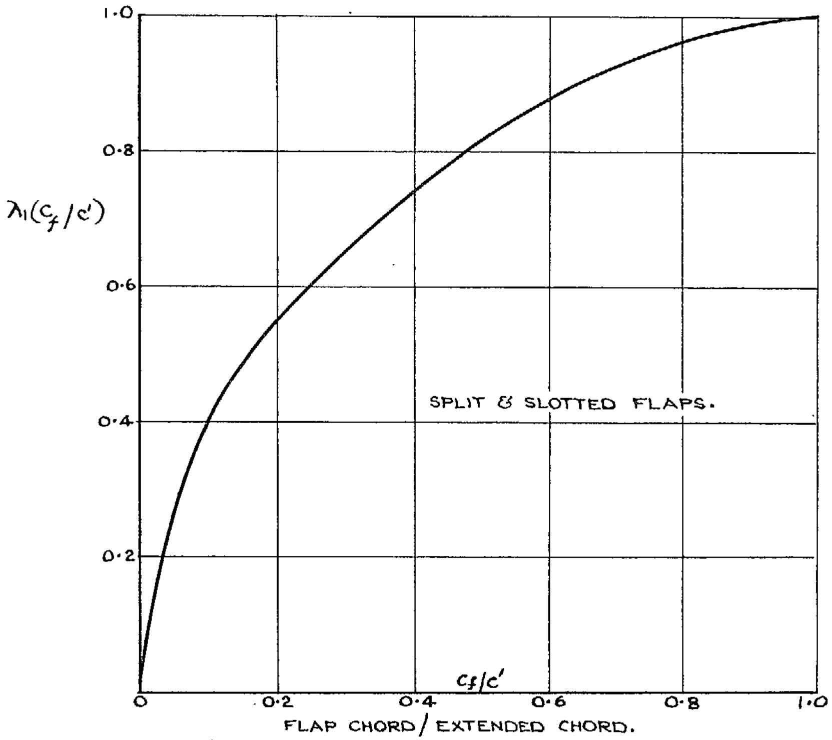

FIG. 1.

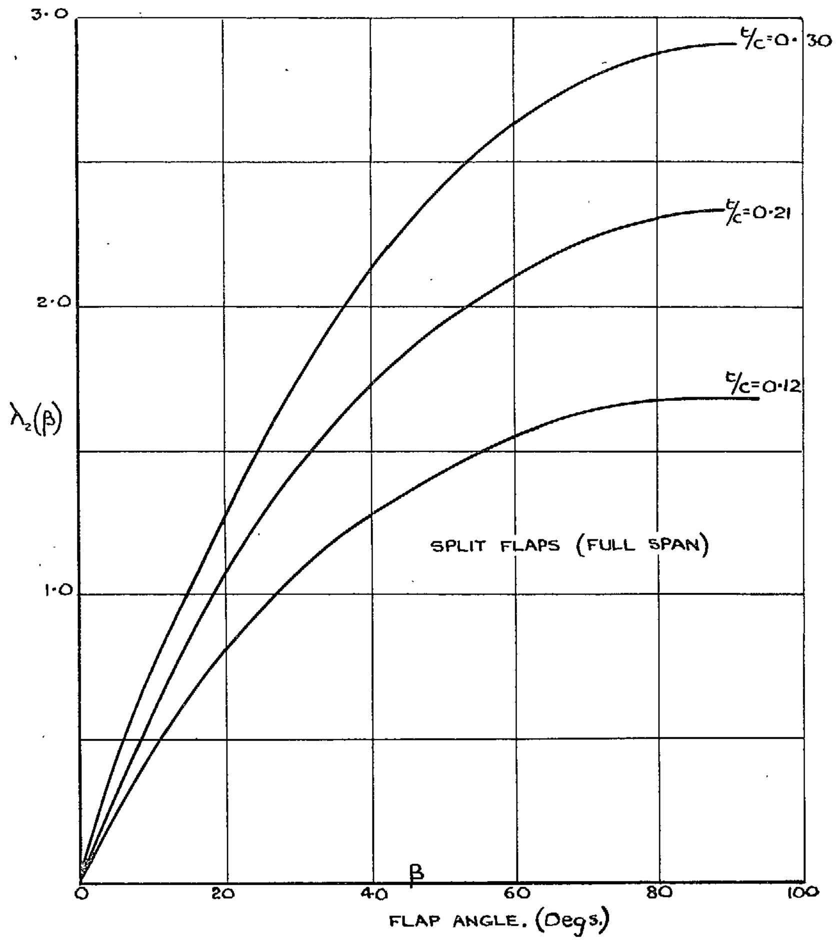

FIG. 2. Lift Increment for Full-Span Split Flaps.
($\Delta C_L' = \lambda_1 (c_f/c'). \quad \lambda_2(\beta)$).

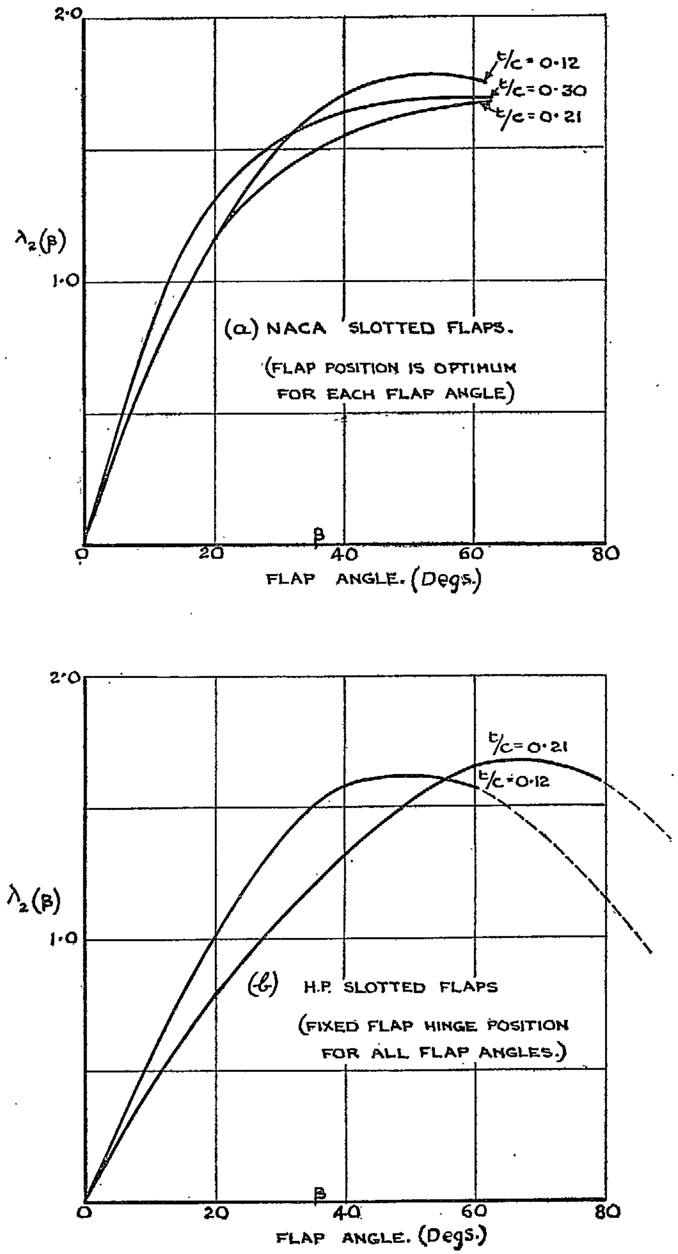

FIG. 3. Lift Increment for Full-span Slotted Flaps.
$(\Delta C_L' = \lambda_1 (c_f/c') . \ \lambda_2 (\beta))$.

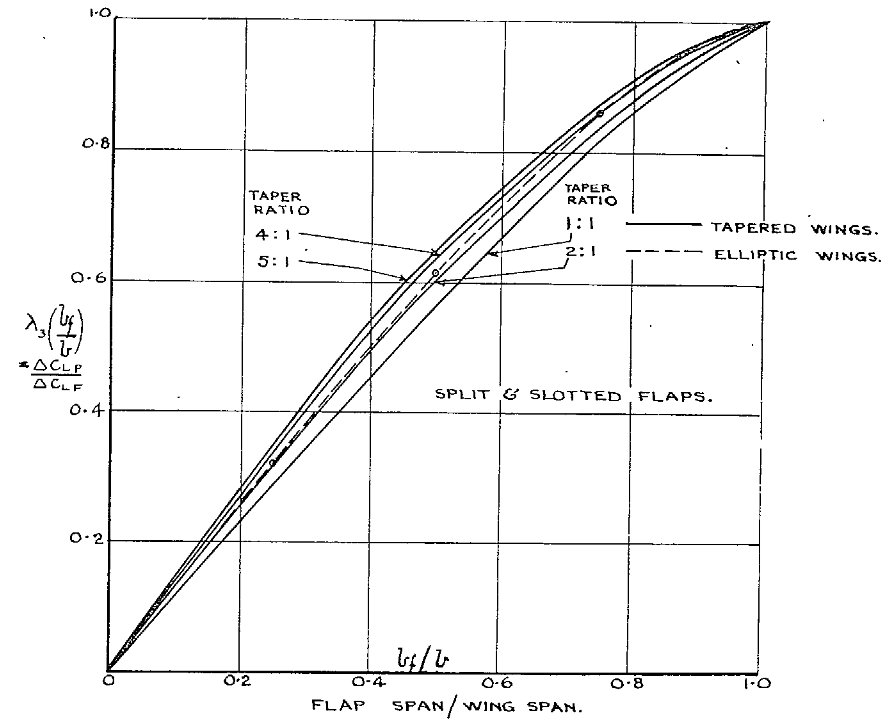

FIG. 4. Theoretical Ratio of Lift Increment of Part-span Flap to Lift Increment of Full-span Flap for Varying Flap Span and Various Wing Tapers.
$(\Delta C_L' = \lambda_1 (c_f/c') . \ \lambda_2 (\beta) . \ \lambda_3 (b_f/b))$

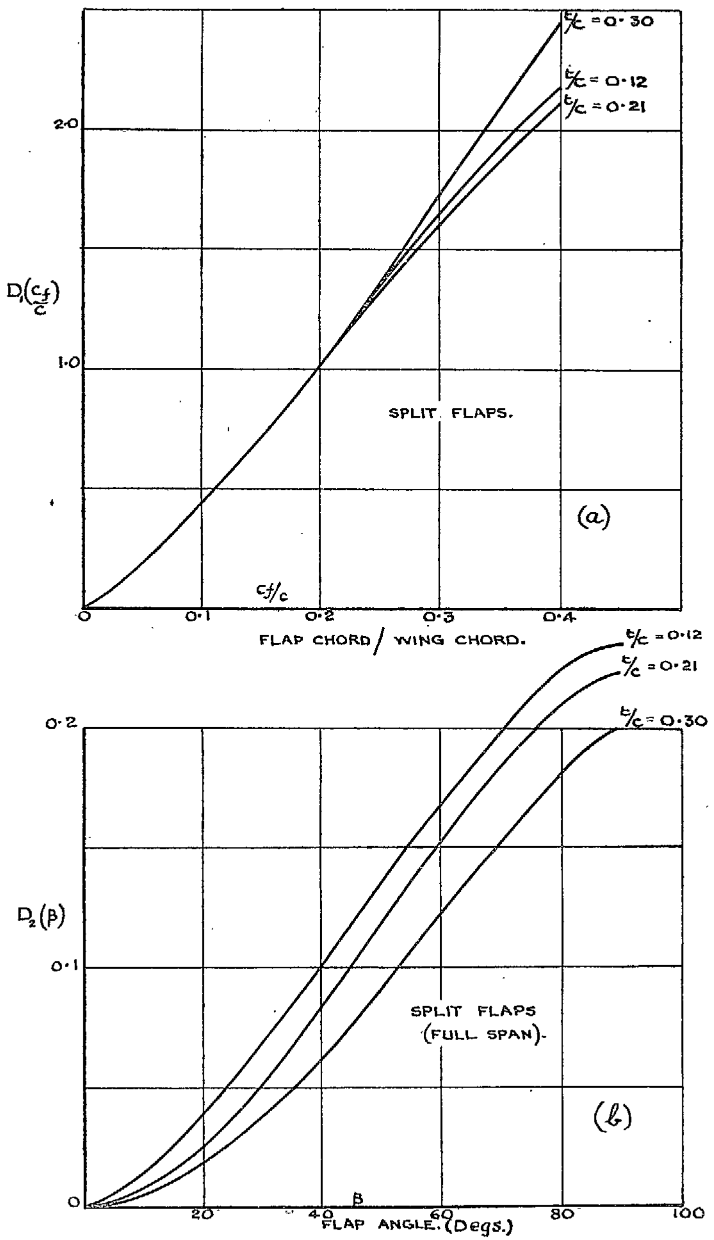

FIG. 5. Charts for Determining Drag Increment Due to Split Flaps. Full Span.
($\Delta C_{D0} = D_1 . (c_f/c)$. $D_2 (\beta)$).

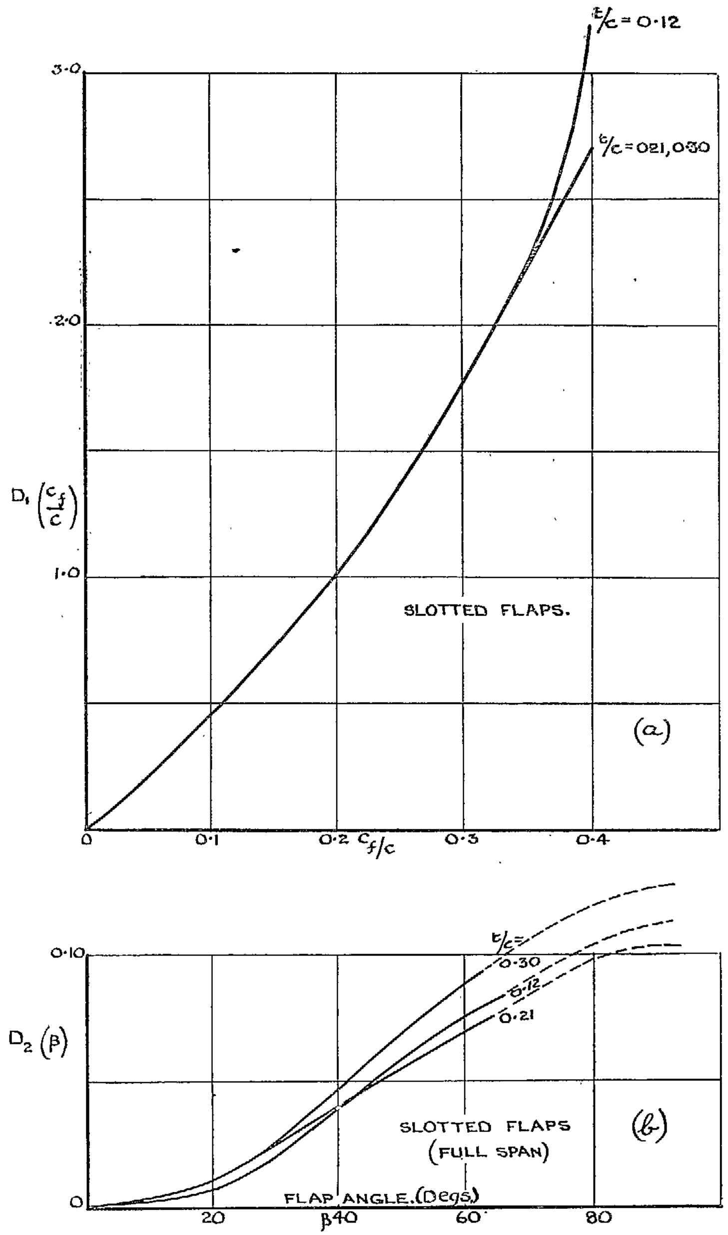

FIG. 6. Charts for Determining Drag Increment Due to Slotted Flaps. Full Span.
($\Delta C_{D0} = D_1 . (c_f/c)$. $D_2 (\beta)$)

(93079) Wt. 13/806 K 5 2/51 Hw.

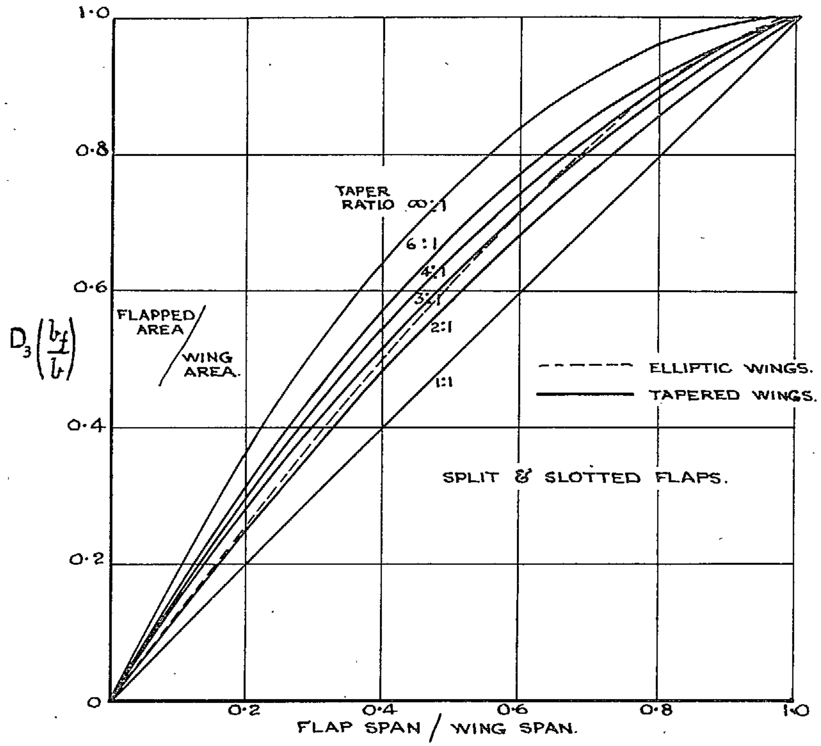

FIG. 7. Ratio of Flapped Area to Wing Area for Various Flap Spans and Wing Tapers.

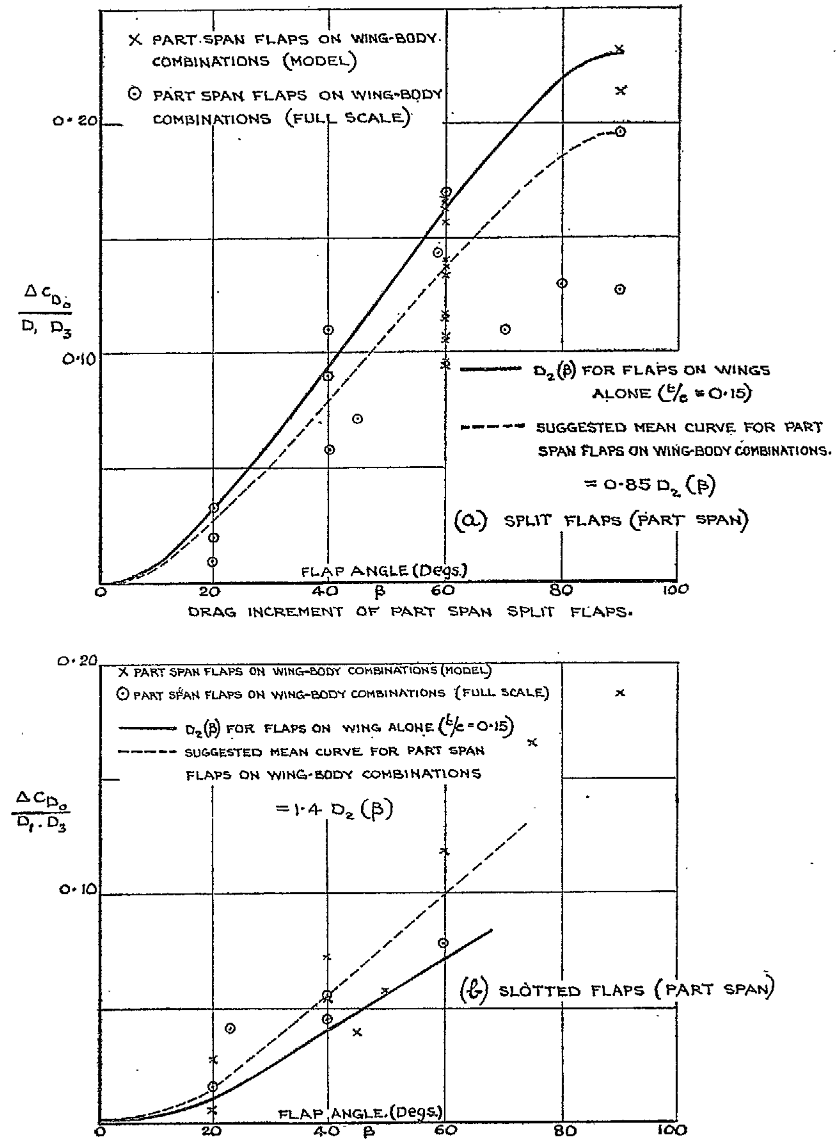

FIG. 8. Drag Increment of Part-span Slotted Flaps.

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