

NORMAL FORCE ON FLAPS AND CONTROLS

1. NOTATION AND UNITS

		SI	British
C_{Nf}	normal load coefficient of flap, <i>i.e.</i> load on flap per unit span in direction normal to flap chord in its deflected position divided by $\frac{1}{2}\rho V^2 c_f$	m	ft
c	aerofoil chord	m	ft
c_f	flap or control chord, <i>i.e.</i> for split flaps and plain controls distance from hinge line to trailing edge, for slotted and Fowler flaps projection of flap in closed position on wing chord	m	ft
V	velocity relative to undisturbed air	m/s	ft/s
δ_f	deflection of flap from closed position	degree	degree
ρ	density of undisturbed air	kg/m ³	slug/ft ³

2. NOTES

The normal load coefficient, C_{Nf} , is plotted against flap deflection, δ_f , for three types of flap (Figures 2 to 4) and the slope of the normal load coefficient with control deflection, $dC_{Nf}/d\delta_f$, for plain controls is plotted against the ratio control chord/wing chord, c_f/c (Figure 1).

This Item is intended as a guide to the estimation of air loads on flaps and controls, mainly for use in stress calculations. The greatest force on flaps generally occurs at the maximum permissible speed with flaps fully extended, corresponding to small angles of incidence of the aerofoil, where C_{Nf} is substantially independent of aerofoil incidence (Figures 2 to 4). On the other hand, the greatest force on control surfaces may occur during manoeuvres at high speed with small deflections, when the maximum permissible control deflection is generally limited to those angles for which C_{Nf} varies linearly with control deflection. For this case, therefore, the rate of increase of normal load coefficient with control deflection within the linear range is plotted against c_f/c (Figure 1).

There are several parameters, such as aerofoil shape and Reynolds number, the effects of which on C_{Nf} cannot be estimated from the information available. The values given for split and Fowler flaps should be regarded as averages, from which deviations of 0.1 may easily occur. The majority of tests were carried out on aerofoils with thickness/chord ratios between 0.09 and 0.12. For a given flap deflection, C_{Nf} increased with increase in aerofoil thickness/chord ratio for split flaps; for plain flaps, no definite trend of C_{Nf} with aerofoil thickness/chord ratio has been established.

Slotted flaps are especially sensitive to changes in the shape of the slot, and there can be variations of up to 0.3 in C_{Nf} due to this effect alone. The variation in the maximum value of C_{Nf} due to slot shape, however, is much smaller.

For split flaps having their trailing edges ahead of, or behind, the trailing edge of the aerofoil the value of C_{Nf} is generally somewhat different. Sufficient evidence is not available to give more than a tentative estimate; a reduction of C_{Nf} of about 5 per cent for a shift forward or rearward of $0.1c$ is indicated.

3. DERIVATION

General

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Split Flaps

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HARRIS, T.A. Pressure distribution over a rectangular airfoil with a partial-span split flap. NACA Rep. 571, 1936.
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Plain Flaps

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10. AMES, M.B.
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Slotted Flaps

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12. SEIFERTH, R. Kraftmessungen und Druckverteilungsmessungen an zwei Flügeln mit Klappe und Düsenpalt. *Jahrbuch der Deutschen Luftfahrtforschung*, 1941.