

ESDU Flaps 02.01.07

CONVERSION FACTOR FOR PROFILE DRAG INCREMENT FOR PART-SPAN FLAPS

1. NOTATION AND UNITS

		SI	British
A	aspect ratio, b^2/S		
b	wing span	m	ft
$b_{f1}, b_{f2} \dots$	distances between corresponding ends of flaps as shown in sketch on Figure 1	m	ft
c	wing local chord	m	ft
c_r	wing root chord	m	ft
c_t	wing tip chord	m	ft
S	wing area	m ²	ft ²
ΔC_{D0}	profile drag increment corresponding to full-span flaps		
λ	taper ratio, c_t/c_r		
$\mu \Delta C_{D0}$	profile drag increment corresponding to part-span flaps		
μ	overall conversion factor, $\mu_1 - \mu_2 + \mu_3 - \mu_4 + \dots etc.$		
μ_n	conversion factor corresponding to flaps of overall span b_{fn}		

2. NOTES

The conversion factor, μ_n , for deriving the drag increment of part-span flaps of all types from that of full-span flaps, is plotted in Figure 1 against b_{fn}/b , the ratio of flap span to wing span. It is assumed that the flap chord to wing chord ratio is constant along the span. Where only a central cut-out exists the overall conversion factor is the difference between the conversion factor for unbroken flap span, b_{fn} , and the conversion factor for a flap of span equal to that of the gap. More generally, where additional cut-outs exist the overall conversion factor, μ , is equal to $\mu_1 - \mu_2 + \mu_3 - \mu_4 + \dots$. The data were obtained from Derivation 1 in which μ_n is defined as the ratio of the wing area between the extremities of the flaps of span b_{fn} to the wing area S .

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3. DERIVATION

1. YOUNG, A.D. Note on the lift and profile drag effects of split and slotted flaps.
HUFTON, P.A. RAE Rep. BA 1707 (ARC Rep. 5472), 1941.

4. EXAMPLE

Find the conversion factor and value of the profile drag increment for the flap arrangement shown in the sketch on Figure 1.

Flap data:

Split flaps of chord $0.2c$ at a flap angle of 60° .

$$b_{f1} = 12.2 \text{ m}, b_{f2} = 7.32 \text{ m}, b_{f3} = 5.79 \text{ m}, b_{f4} = 1.52 \text{ m}.$$

Wing data:

$$b = 19.8 \text{ m}, \text{ wing section maximum thickness} = 0.18c, A = 6.0, \lambda = 0.5.$$

Then $b_{f1}/b = 0.616$, and from Figure 1 $\mu_1 = 0.70$,
 $b_{f2}/b = 0.370$, and from Figure 1 $\mu_2 = 0.45$,
 $b_{f3}/b = 0.292$, and from Figure 1 $\mu_3 = 0.36$,
 $b_{f4}/b = 0.077$, and from Figure 1 $\mu_4 = 0.10$.

$$\text{Hence } \mu = \mu_1 - \mu_2 + \mu_3 - \mu_4 = 0.51.$$

From Item No. 74010, ΔC_{D0} due to full-span split flaps = 0.159.

$$\begin{aligned} \text{Therefore } \mu \Delta C_{D0} &= 0.51 \times 0.159 \\ &= 0.081. \end{aligned}$$