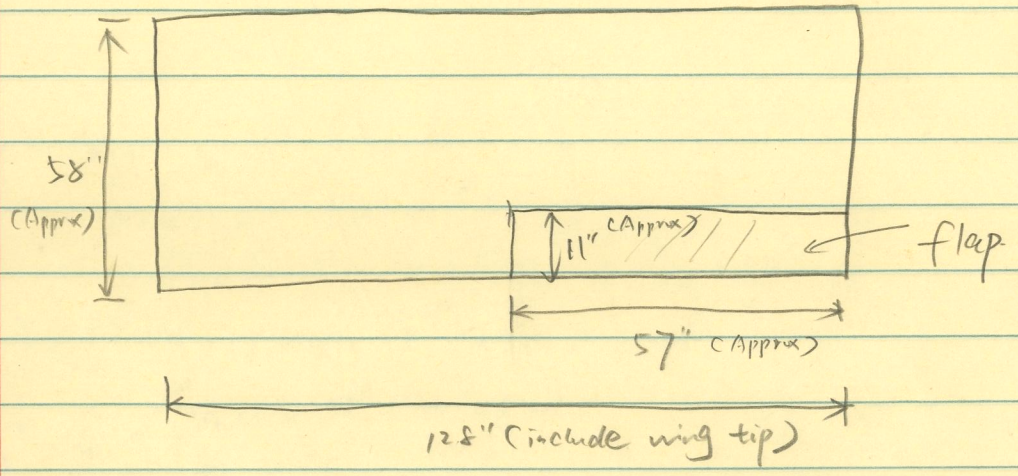
12/14/2011 Flap load calculation. P. 1.

* Wing and flap dimension



Flap force $L_f = C_{Lf} \cdot A_{flap} \cdot \frac{1}{2} \rho V^2$

C_{Lf} – lift coeff. of flap

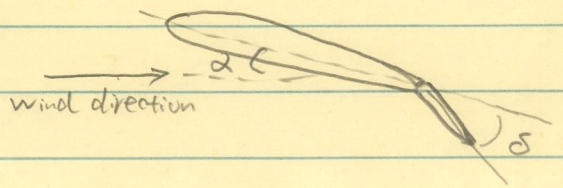
A_{flap} – Area of flap

ρ – density of air

V = speed of airplane

Per study by National Memorial Aeronautical Lab done in 1930.

$$C_{Lf} = n C_L - n_0 \delta$$



$$E = \frac{C_{flap}}{C_{wing}} = \frac{11}{58} = 0.19 \approx 0.2$$

At $E = 0.2$ $\quad n \doteq 0.2$, $\quad n_0 \doteq -2.05$.

Conservatively assuming $C_L = 3$

flap angle $= 40° = 0.7$ rad.

$\Rightarrow C_{Lf} = n C_L - n_0 \delta = 0.2 \times 3 + 2.05 \times 0.7 = 2.04$

Air density $\rho = 0.002377$ slug/ft^3 at sea level.

Assuming flap extension speed $V_{fe} = 100$ mph $= 147$ ft/sec

Flap area $A_{flap} = 11'' \times 57'' = 627$ in$^2 = 4.35$ ft^2

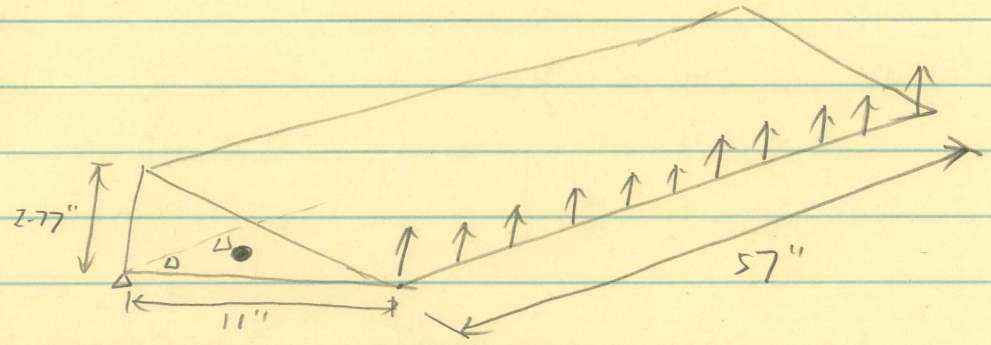
Flap load: $L_f = C_{lf} \cdot A_{flap} \cdot \frac{1}{2} \rho V^2$

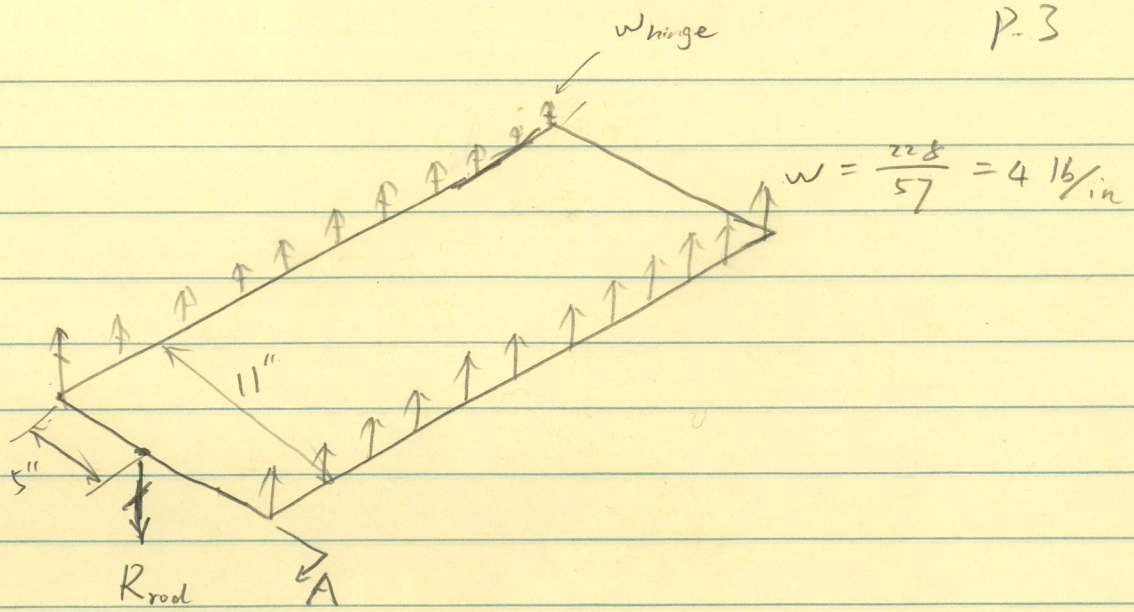
$= 2.04 \times 4.35 \times 0.002377 \times 147^2/2 = \underline{\underline{228 \text{ lbs}}}$.

Now we need to figure out the shear force on the inboard rib rivets. (A)

Assumptions:

— 228 lbs is applied at the trailing edge of the flap (below)



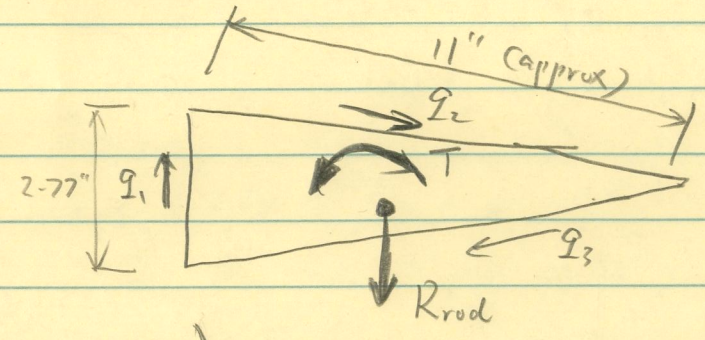


Total moment about hinge line due to flap force

$M = 228 \times 11 = 2508\ in\text{-}lb$

$R_{rod} = 2508/5 = 502\ lbs$

At section A (inboard rib section). FBD shown below



$q_1 = q_{1R} + q_{1T}$

q_{1R} – shear flow due to R_{rod} assuming R_{rod} is taken entirely by member 1

q_{1T} – shear flow due to Torque T.

$q_{1T} = q_2 = q_3 = q_T$, shear flow due to Torque T

$$q = T/2A$$

Area of ~~cr~~section A: $A \doteq 11 \times 2.77/2 = 15.24\ in^2$

$$q = 250/(2 \times 15.24) = 82.3\ lb/in$$

per drawing the rivet spacing at inboard rib is about 1.27"

Shear force at rivet: $P_{shear} = 82.3 \times 1.27 = 105\ lbs$

shear allowable of MK-319-BS rivet.

$P_{all}|_{shear} = 258\ lbs$

$P_{all}|_{tension} = 292\ lbs.$

$$MS = \frac{258}{105} - 1 = 1.45$$

Countersunk allowables

shear Allowable of AN426AD3 for 0.025" sheet = 113 lbs

Tension " " " " 0.036" " = 130 lbs

AN426AD3 shear strength = 207 lbs

tension " =