

U3 Position of engine c.g. = $\begin{pmatrix} 5 \\ -1 \\ -1 \end{pmatrix}$ m
 (given)

Weight of engine = $\begin{pmatrix} 0 \\ 0 \\ -50 \end{pmatrix}$ KN
 (given)

a) Moment about origin $\underline{M} = \underline{r} \times \underline{F} = \begin{pmatrix} 5 \\ -1 \\ -1 \end{pmatrix} \times \begin{pmatrix} 0 \\ 0 \\ -50 \end{pmatrix}$

$\underline{M} = \begin{pmatrix} +50 \\ +250 \\ 0 \end{pmatrix}$ KNm $\hat{=}$

b) line OT $\Rightarrow \underline{t} = \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix}$ unit vector $\hat{\underline{t}} = \frac{1}{\sqrt{1100}} \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix}$
 (given)

use scalar product to project \underline{M} onto $\hat{\underline{t}}$

$\underline{M}_t = (\underline{M} \cdot \hat{\underline{t}}) \hat{\underline{t}} = \frac{1}{\sqrt{1100}} (50 \times 30 + (250 \times (-14)) + 0) \left[\frac{1}{\sqrt{1100}} \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix} \right]$
 $(1500 + (-3500)) = -2000$

$= -\frac{2000}{\sqrt{1100}} \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix} = \begin{pmatrix} -54.5 \\ +25.5 \\ -3.6 \end{pmatrix}$ KNm $\hat{=}$

This causes twisting of the wing about its axis.

$$c) \quad \underline{M}_\perp = \underline{M} - M_{\text{parallel}}$$

$$\begin{pmatrix} 50 \\ 250 \\ 0 \end{pmatrix} - \begin{pmatrix} -54.5 \\ 25.5 \\ -3.6 \end{pmatrix} = \begin{pmatrix} 104.5 \\ 224.5 \\ +3.6 \end{pmatrix} \text{ kNm} \quad \Leftarrow$$

check

$$\begin{pmatrix} 104.5 \\ 224.5 \\ 3.6 \end{pmatrix} \cdot \begin{pmatrix} 30 \\ -14 \\ 2 \end{pmatrix} = 0 \quad \Leftarrow$$

(d) This component of the moment causes bending of the wing about its axis. \Leftarrow

d) See answers to parts (b) and (c).