Lecture: Inertial load and load factor

A mass (body) experiences an inertial load proportional to it's acceleration and opposite to the direction of acceleration

⟶ D'Alembert's Principle.

$$\left.\begin{aligned} \sum F_x + m a_x &= 0 \\ \sum F_y + m a_y &= 0 \end{aligned}\right] \text{ Eqn. of dynamic equilbm.}$$

Load factor The load factor (in a particular direction) is the total force. (acting in that dirc.) less the gravitational and inertial force (forces associated with mass) divided by weight.

$$\sum F_y - mg - ma_y = 0 \qquad \text{Eqn. of dynamic equilbm.}$$

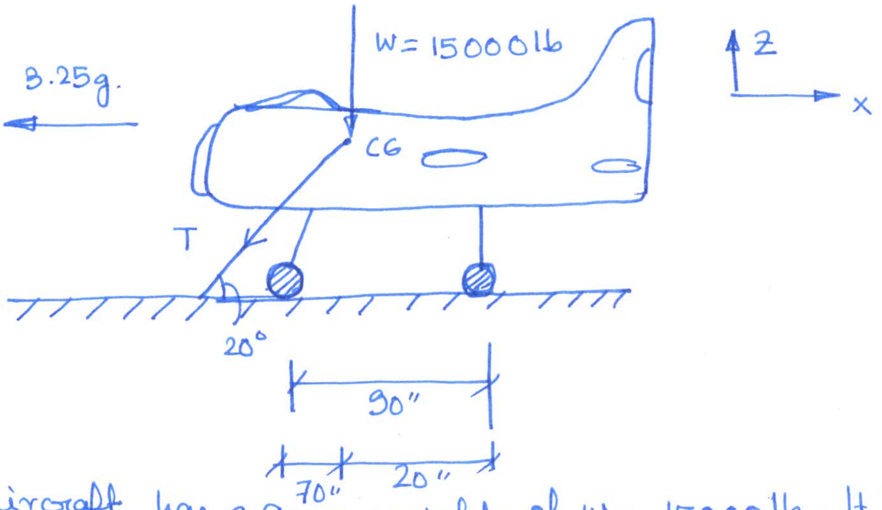
(total force not containing wt & inertial force)

$$\Rightarrow \quad \sum F_y = m(g + a_y)$$

Load factor in y-dirc (n_y) $= \dfrac{\sum F_y}{W}$ /w.

$$= \frac{m(g+a_y)}{W} = \frac{W}{W}\left(1+\frac{a_y}{g}\right) = 1 + \frac{a_y}{g}.$$

Example



The aircraft has a gross weight of W = 15000 lb. It is being launched from an aircraft carrier. The tension T is the cable acts through the airplane c.G. and is sufficient to the give the airplane a forward acceleration 3.25g.

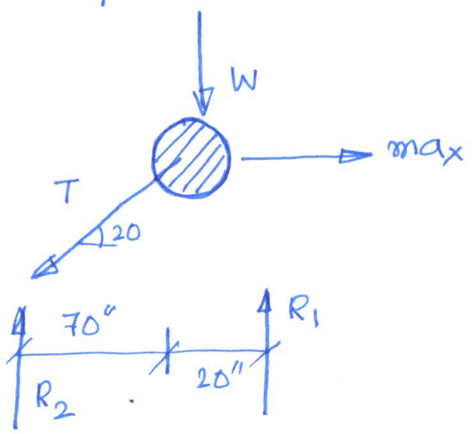
Find:

(a) tension in the cable

(b) Reaction loads on the landing gear R_1 & R_2

(c) Load factor n_x and n_z

FBD



Eqns. of dynamic equilm

$$-T\cos 20 + ma_x = 0 \qquad (1)$$

$$\Rightarrow T\cos 20 = \frac{W}{g}\cdot a_x = 15000 \times 3.25$$

$$\Rightarrow \underline{T = 51879 \text{ lb}}$$

$$R_1 + R_2 - T\cos 70 - W = 0 \qquad (2)$$

and $$70R_2 = 20R_1 \qquad (3)$$

$$\Rightarrow R_1 = 25467 \text{ lb}$$
$$R_2 = 7276 \text{ lb}$$

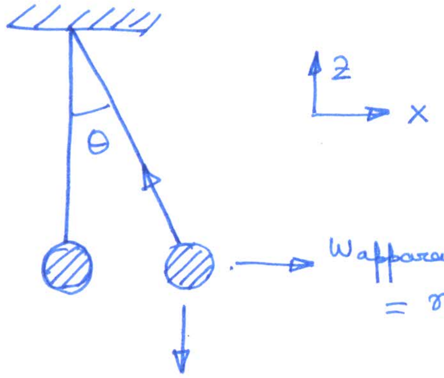
Load factors

$$n_x = \frac{-T\cos 20}{W} = -\frac{W}{g}\cdot\frac{3.25g}{W} = -3.25$$

$$n_z = \frac{R_1 + R_2 - T\cos 70}{W} = \frac{W}{W} = 1$$

Procedure for computing apparent wt using load factors:

An airplane is maneuvering so that following load factors are computed $n_x = -1.5$ and $n_z = 2$. An item weighing 10 lb is suspended from a wire. If the load factors remain constant for a long enough time, find the tension in the wire



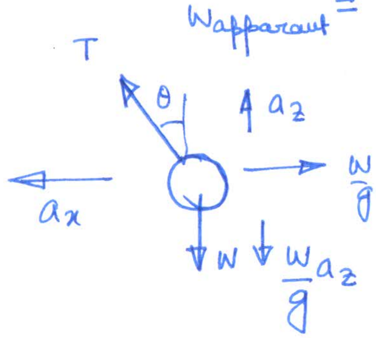
$W_{apparent} = n_x \cdot W = 15\text{ lb}$

$W_{apparent} = n_z \cdot W = 20\text{ lb}$

$\therefore\ T = \sqrt{15^2 + 20^2} = 25\text{ lb}.$

$\theta = \tan^{-1}\dfrac{15}{20} = 37.87^\circ$

FBD



$\dfrac{W\left(1+\frac{a_z}{g}\right)}{W} \mathbin{/\!/} n_z = \dfrac{T\cos\theta}{W} \Rightarrow T\cos\theta = 2 \times W = 20\text{ lb}$

$\dfrac{-W a_x}{W g} \mathbin{/\!/} n_x = \dfrac{-T\sin\theta}{W} \Rightarrow T\sin\theta = 15\text{ lb}$