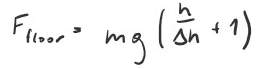


For two feet



$$\begin{aligned} m &= 120 \text{ kg} \\ h &= 7 \text{ m} \\ \Delta h &= 0,15 \text{ m} \\ E &= 17 \text{ GPa} \\ D_o &= 0,025 \text{ m} \\ D_i &= 0,013 \text{ m} \end{aligned}$$

$$\varepsilon_1 = \frac{\sigma_1}{E} = \frac{2mg \left(\frac{h}{2h} + 1 \right)}{\pi (D_o^2 - D_i^2) E} = 4,608 \cdot 10^{-3} = \underline{0,4608\%} < 1,6\% \rightarrow \text{no fracture}$$

The diagram illustrates the decomposition of a rigid body into a particle and a massless rod. On the left, a rectangular rigid body of length L is shown. A green curved arrow indicates a counter-clockwise angular acceleration α . A red arrow at the bottom left represents the floor reaction force F_{floor} at an angle θ to the vertical. On the right, the equivalent system is shown: a particle with forces R_x (horizontal) and R_y (vertical) at the top, and a massless rod of length L with a moment $M(y)$ and a floor reaction force F_{floor} at the bottom at an angle θ .

$$M(y) = \frac{F_{\text{door}}}{2} \sin \theta (y-L)$$

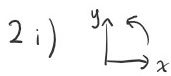
$$\sigma_2(y) = \frac{M(y)}{I} x + \frac{F_{\text{floor}}}{2A} \cos \theta$$

$$\begin{aligned} \max y: & \quad y = 0 \\ \Rightarrow M(\sigma) = & \quad -\frac{F_{\text{floor}}}{2} \sin \theta L \\ \max x: & \quad x \in \left[-\frac{D_0}{2}, \frac{D_0}{2}\right] \end{aligned}$$

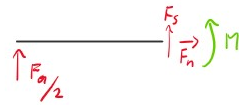
$$\sigma_{2\max} = \frac{F_{\text{floor}}}{2A} \cos \theta \pm \frac{F_{\text{floor}}}{2I} \sin \theta L \left(\frac{D_o}{2} \right)$$

$$= \frac{F_{\text{load}}}{2} \left(\frac{\cos \theta}{A} + \frac{\sin \theta \cdot L D_o}{2I} \right) = \begin{cases} \underline{46 \text{ Pa}} \\ -3,96 \text{ Pa} \end{cases}$$

$$\epsilon_{2max} = \frac{F_{t\text{load}}}{2E} \left(\frac{\cos\theta}{A} \pm \frac{\sin\theta \cdot L D_o}{2I} \right) = \begin{cases} 0,2367 = \underline{23,67\%} > 1,6\% \rightarrow \text{fracture} \\ -0,2287 \end{cases}$$

2 i) 

$$0 < x < \frac{L}{2}$$



$$\frac{L}{2} < x < L$$



$$\sum M = 0$$

$$M_1(x) = \frac{F_A}{2} x$$

$$M_2(x) = \frac{F_A}{2} (L - x)$$

max:

$$M\left(\frac{L}{2}\right) = \frac{L F_A}{4}$$

ii)

$$\sigma_{\max} = \frac{M_{\max} y}{I} = \frac{M_{\max} d_o}{2I} = \left(\frac{M_{\max} = \frac{L F_A}{4}}{I = \frac{\pi}{64} (d_o^4 - d_i^4)} \right) = \frac{8 L F_A d_o}{\pi (d_o^4 - d_i^4)}$$

offset from neutral axis

$$\sigma_{\max} = \varepsilon_{\max} E$$

$$\Rightarrow \varepsilon_{\max} E = \frac{8 L F_A d_o}{\pi (d_o^4 - d_i^4)}$$

$$F_A = \frac{\varepsilon_{\max} E \pi (d_o^4 - d_i^4)}{8 L d_o} = \underline{\underline{15,85 \text{ N}}}$$

$$\begin{aligned} L &= 0,05 \text{ m} \\ d_o &= 0,004 \text{ m} \\ d_i &= 0,0038 \text{ m} \\ E &= 8,56 \text{ Pa} \\ \varepsilon_{\max} &= 0,02 \end{aligned}$$

iii)

$$I_x = \frac{\pi}{4} a b^3 \quad \text{— bending happens along the } x\text{-axis}$$

$$I = I_o - I_i = \frac{\pi}{4} \frac{d_1}{2} \left(\frac{d_2}{2}\right)^3 - \frac{\pi}{4} \left(\frac{d_1}{2} - w\right) \left(\frac{d_2}{2} - w\right)^3 = \frac{\pi}{4} \left(\frac{d_1 d_2^3}{16} - \left(\frac{d_1}{2} - w\right) \left(\frac{d_2}{2} - w\right)^3\right)$$

$$\Rightarrow \sigma_{\max} = \frac{L F_A d_2}{2\pi \left(\frac{d_1 d_2^3}{16} - \left(\frac{d_1}{2} - w\right) \left(\frac{d_2}{2} - w\right)^3\right)} \quad \text{— offset from neutral axis}$$

$$\Rightarrow F_{\theta 1} = \frac{2 \varepsilon_{\max} E \pi \left(\frac{d_1 d_2^3}{16} - \left(\frac{d_1}{2} - w\right) \left(\frac{d_2}{2} - w\right)^3\right)}{L d_2} = \underline{\underline{25,33 \text{ N}}}$$

$$\begin{aligned} d_1 &= 0,0048 \text{ m} \\ d_2 &= 0,0032 \text{ m} \\ w &= 0,0002 \text{ m} \end{aligned}$$