

Ex 27.3 Steel, silk & gravity

The ultimate strength of steel is $500 \times 10^6 \text{ Pa.} = P_{\text{steel}}$

Spider silk is about $2000 \times 10^6 \text{ Pa.} = P_{\text{silk}}$

How thick would they need to be to hold Earth in orbit?

$$F_g = G \frac{M_E M_S}{r_{ES}^2} = 3.5 \times 10^{22} \text{ Newtons.}$$

For steel:

$$P_{\text{steel}} \times \text{Area} = 3.5 \times 10^{22}$$

$$\left. \begin{aligned} \text{Area} &= 7e13 \\ \frac{\pi D^2}{4} &= 7e13 \end{aligned} \right\} \Rightarrow \text{diameter} = 9.1 \times 10^3 \text{ km}$$

This is about $\boxed{\frac{3}{4} \text{ Earth's diameter}}$!

For spider silk:

$$P_{\text{silk}} \times \text{Area} = 3.5e22$$

$$\text{dia} = 4.72 \times 10^3 \text{ km}$$

This is a little under $\boxed{\frac{1}{2} \text{ Earth's diameter}}$