

10

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Complete identification

Problem number

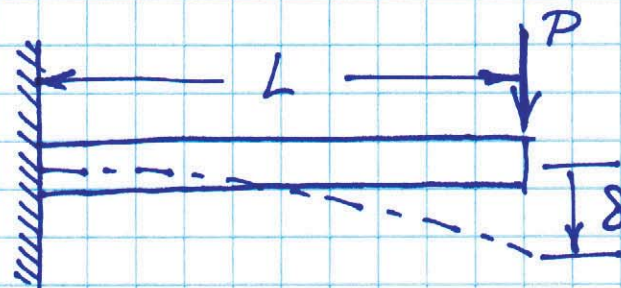
Complete problem statement

Prob. 1.23. A 200-mm-long cantilever beam of circular cross section is subjected to a transverse force of 100 N at its free end. What minimum diameter d is required if the deflection δ at the free end is not to exceed 10 mm? The beam is made of copper ($E = 130$ GPa).

Solution:

Clear beginning of solution

Explanatory figure(s) (even if not given with problem)



Explanation of work in short English phrases

The deflection δ is given by

$$\delta = \frac{PL^3}{3EI} \quad \text{where} \quad I = \frac{\pi}{64} d^4.$$

Therefore

$$\delta = \frac{PL^3 \cdot 64}{3E\pi d^4} = \frac{64PL^3}{3\pi E d^4} \quad (1)$$

Solving for d yields

$$d = \sqrt[4]{\frac{64PL^3}{3\pi E \delta}} \quad (2)$$

For the given information,

$$d = \sqrt[4]{\frac{64(100)(0.200)^3}{3\pi(130 \times 10^9)(0.010)}} = 8.04 \times 10^{-3} \text{ m}$$

No more than 3 significant figures

$$= \boxed{8.04 \text{ mm}}$$

Final answer

Correct units

Ans.

This is a minimum value, since if d were smaller than this, δ in (1) would be larger than 10 mm.

Discussion