Exercise 1

A simple beam with a square cross-section (side a, length L) is put under a complex load (fig. 1). The beam is characterised by the following values: $E = 16\,\text{GPa}$, $a = 2\,\text{cm}$, $L = 30\,\text{cm}$ and $F = 100\,\text{N}$.

We define $z = 0$ at the top of the beam and $x = 0$ at the clamped end. Using the principle of superposition and the tables of the formulary, calculate the deflection $\omega(x)$. What is the deflection in $x = L$?

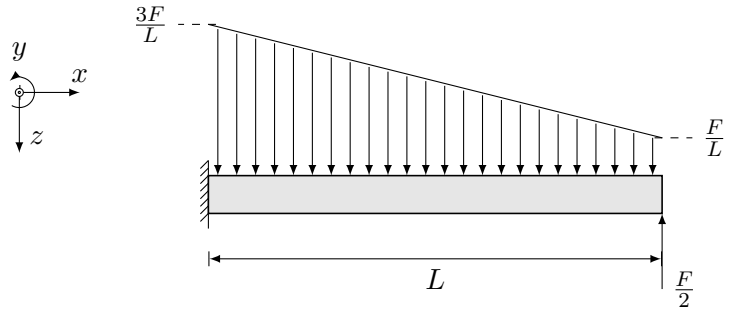

Figure 1: Schematic of the loaded bar and its cross-section.

Exercise 2

A steel bar having a square cross section ($50\,\text{mm} \times 50\,\text{mm}$) and length $L = 2\,\text{m}$ is compressed by axial loads that have a resultant $P = 60\,\text{kN}$ acting at the midpoint of one side of the cross section (see fig. 2).
Assuming that the modulus of elasticity E is equal to 210 GPa and that the ends of the bar are pinned, calculate the maximum deflection δ and the maximum bending moment M_{max}.

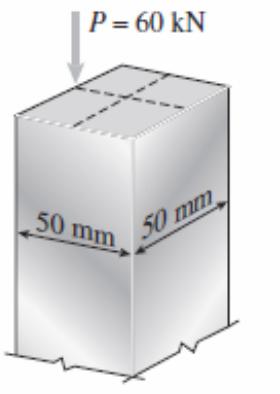

Figure 2: Square cross section bar and load P

Exercise 3

The truss ABC (fig. 3) supports a vertical load W at joint B. Each member is a slender circular steel pipe ($E = 200\,\text{GPa}$) with outside diameter 100 mm and wall thickness 6 mm. The distance between supports is 7 m. Joint B is restrained against displacement perpendicular to the plane of the truss. Determine the critical value W_{cr} of the load.

Hint: Second moment of area for the pipe of outer and inner diameter d_o and d_i respectively, is $I = \frac{\pi}{64}(d_o^4 - d_i^4)$.

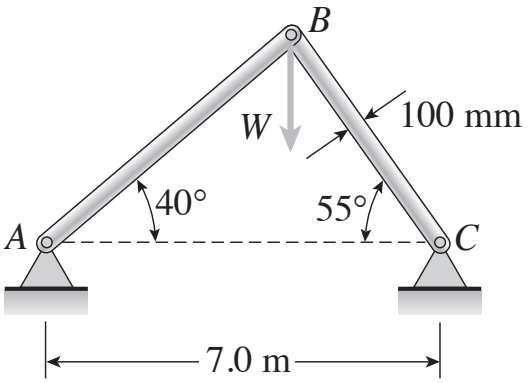

Figure 3: Truss structure under load