Mechanics of Materials

Lecture 8 - Axial Load

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schedule

- 8 Sep - Exam 1 (online, no recitation this day)
- 10 Sep - Axial Load
- 15 Sep - Torsion, Homework 3 Due
- 17 Sep - Torsion

outline

- force method
- thermal stress

force method

- One way to solve statically indeterminate problems is using the principle of superposition
- We choose one redundant support and remove it
- We then add it back as a force separately (without the other forces in the problem)

force method

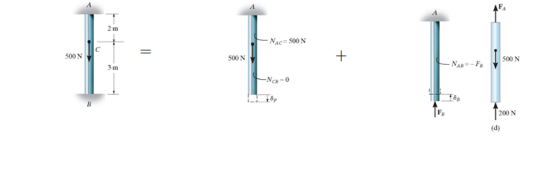


Figure 1: An illustration of the force method, we have the same statically indeterminate problem as before, a 5 m long, vertically-oriented bar is fixed at both ends, with a 500 N downward load applied 2 m from the top. We set this equivalent to a a bar with the same load, but no support on the bottom end. We then add a force which will provide enough displacement to cancel out the displacement

force method

- We connect the two problems by requiring that the displacement in both frames adds to 0 to meet the support requirements
- This is referred to as the equation of compatibility

procedure

- Choose one support as redundant, write the equation of compatibility
- Express the external load and redundant displacements in terms of load-displacement relationship
- Draw free body diagrams and use the equations of equilibrium to solve

example 4.9

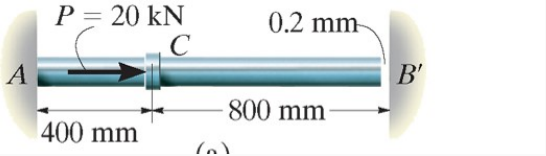


Figure 2: A 1200 mm long horizontal rod is fixed at its left end and has a fixed support 0.2 mm away from its right end. A 20 kN load is applied to the right 400 mm away from its left end.

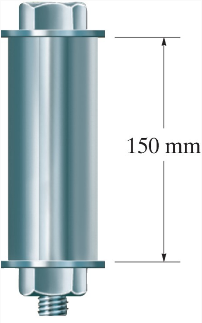
The steel rod shown has a diameter of 10 mm. Determine the reactions at A and B'.

- A change in temperature cases a material to either expand or contract
- For most materials this is linear and can be described using the coefficient of linear expansion

$$\delta_T = \alpha \Delta T L$$

- When a body is free to expand, the deformation can be readily calculated using
- If it is not free to expand, however, thermal stresses develop
- We can use the force method described previously to find the thermal stresses developed

example 4.12



An aluminum tube with cross-section of 600 mm2 is used as a sleeve for a steel bolt with cross-sectional area of 400 mm2. When T=15 degrees Celsius there is negligible force and a snug fit, find the force in the bolt and sleeve when T=80 degrees Celsius.