AE4132 - Finite Element Analysis
Spring 2021

Homework 3: 1D Bar Elements
Due Friday, March 12th 2021

Problem 1

Consider the variable-geometry bar depicted in Figure 1. The cross-sections are circular with diameters d_1, d_2, and d_3. The bar is made of linear elastic material with Young's modulus $E = 80$ GPa. Using the Finite Element Method, discretize the bar using three elements, and compute the following:

1. Elementary stiffness matrix for each element.

2. Global stiffness matrix and force vector.

3. Displacements at all nodes.

4. Using the results obtained in the point above and the corresponding interpolation scheme, compute strains and stresses over the entire structure. Plot results using matplotlib.
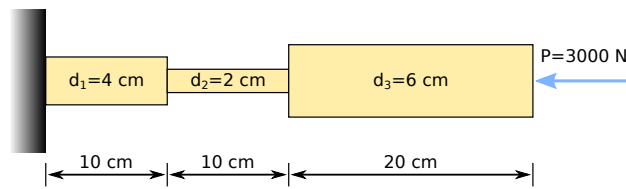

Figure 1: Schematics for problem 1.

Problem 2

Consider the system of bars shown in Figure 2. All bars have identical cross-sectional area $A = 0.1\text{cm}^2$ and Young's modulus $E = 70$ GPa. The system is fixed at the left, and all bars are joined via rigid plates.

1. Determine, using the finite element method, the displacements u_1, u_2, u_3, and u_4.

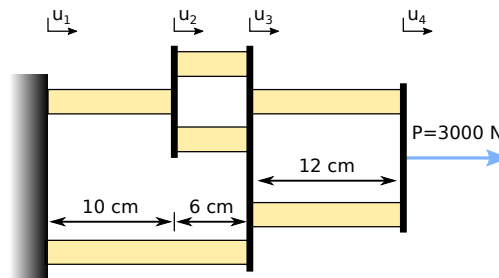2. Determine the same quantities by using equivalent springs. Hint: start with u_4 and work your way backwards to determine the others.

Figure 2: Schematics for problem 2.