UNIVERSITY OF CALIFORNIA, BERKELEY
Fall Semester 2019

Dept. of Civil and Environmental Engineering
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CE 220 - Structural Analysis

Homework Set 9 (due 11/6/2019)

1. Problem (5 points)

The truss structure in Fig. 1 is subjected to two load cases: (a) a horizontal force of 50 units with a concurrent vertical force of 30 units as shown, and (b) a thermal loading consisting of a temperature change of 100 degrees that affects all elements. The axial stiffness of elements a and b is EA=10,000 units, the axial stiffness of element c is EA=20,000 units. The coefficient of thermal expansion α is equal to $2 \cdot 10^{-5}$ per unit of temperature change.

You are asked to answer the following questions for each load case separately after selecting the basic force of element b as redundant:

1. Set up the particular and the homogeneous solution of the equilibrium equations.
2. Determine the fictitious release deformation in element b due to the particular and the homogeneous static solution.
3. Determine the value of the redundant basic force.
4. Determine the basic forces in all elements.
5. Determine the translations at the free dofs.
6. What happens to the answers in (4) and (5), if the axial stiffness of all elements is doubled?

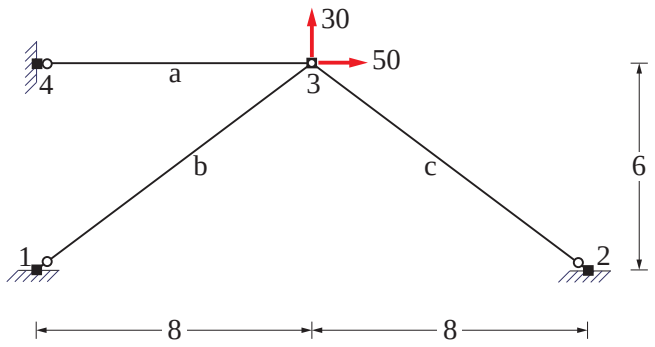

Figure 1: Simple truss

2. Problem (5 points)

The truss in Fig. 2 is subjected to two load cases: (a) a horizontal force of 50 units with a concurrent vertical force of 30 units, as shown, and (b) a thermal loading consisting of a *temperature increase* of 100 degrees affecting only element c. The coefficient of thermal expansion α is equal to $2 \cdot 10^{-5}$ per unit of temperature change. The axial stiffness of elements a and b is EA=10,000 units, the axial stiffness of elements c and d is EA=20,000 units.

You are asked to answer the following questions for each load case separately with the displacement method of analysis:

1. Determine the translations at the free dofs of the structural model.
2. Determine the basic forces in all truss elements.

You are also asked to determine the support reactions for the thermal load case and check global equilibrium.

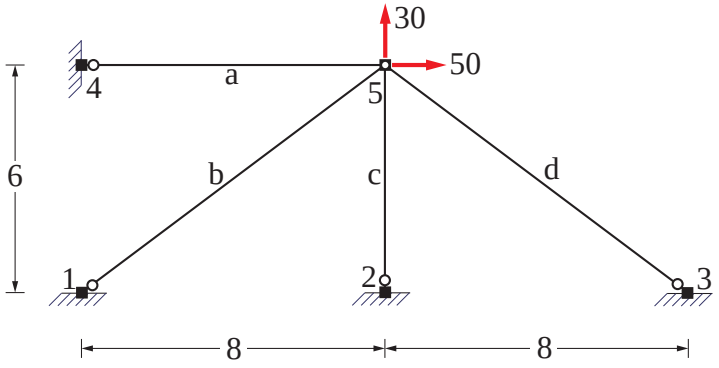

Figure 2: Plane truss under nodal forces and thermal effects

3. Problem (5 points)

The continuous beam over three spans in Fig. 3 and Fig. 4 is subjected to two load cases: (a) a uniform load of 10 units in elements a and b, as Fig. 3(a) shows, and (b) a thermal curvature $\kappa_0 = 1 \cdot 10^{-3}$ in elements b and c, as Fig. 3(b) shows.
The flexural stiffness $EI_a = EI_b$ of elements a and b is 200,000 units, while the flexural stiffness EI_c of element c is 300,000 units.

You are asked to answer the following questions for both load cases:

1. Determine the free dof displacements with the displacement method of analysis.
2. Use the element force-deformation relations to determine the basic forces $\boldsymbol{Q}$ and draw the bending moment diagram $M(x)$.
3. Draw the deformed shape of the continuous beam under the given loading.

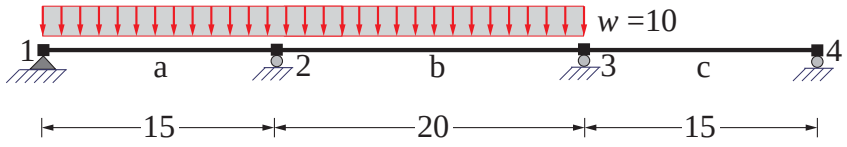

Figure 3: Continuous beam under uniform loading

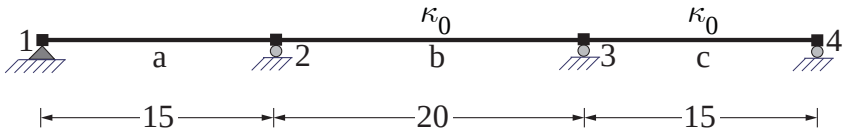

Figure 4: Continuous beam under thermal loading