UNIVERSITY OF CALIFORNIA, BERKELEY
Fall Semester 2019

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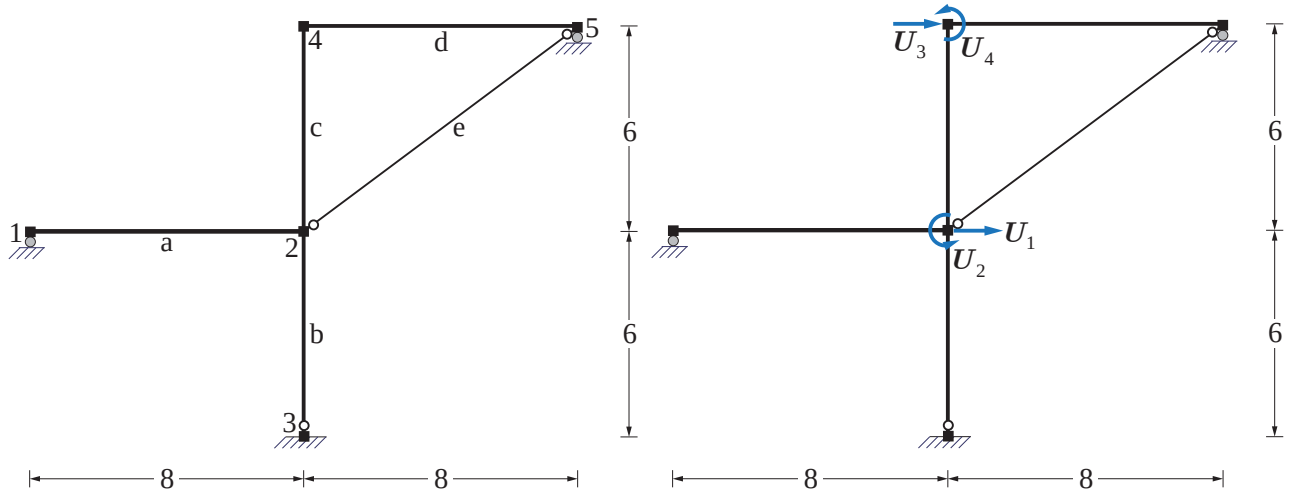
CE 220 - Structural Analysis

Homework Set 10 (due 11/13/2019)

1. Problem (3 points)

The two story braced frame in Fig. 1(a) has four independent free degrees-of-freedom under the assumption that the elements a through d are inextensible. Fig. 1(b) shows the independent free dofs of the structural model.

You are asked to determine symbolically the stiffness coefficients K_{11}, K_{31}, K_{22} and K_{34}. Use subscripts for each element flexural stiffness EI or axial stiffness EA, as appropriate, *in order to identify the contribution of each element to the stiffness coefficients of interest*.



(a) Geometry (b) Free dofs

Figure 1: Determination of stiffness coefficients for two story braced frame

2. Problem (10 points)

The braced frame in Fig. 2 consists of inextensible frame elements a, b, and c with flexural stiffness EI of 100,000 units. The brace element d has axial stiffness EA of 30,000 units. The braced frame is subjected to a uniformly distributed load w of 5 units in element c, as the figure shows.

You are asked to answer the following questions with the displacement method of analysis, even though the force method of analysis requires the solution of only two compatibility conditions for the two redundant basic forces $\boldsymbol{Q}_x$:

1. Determine the four independent free global dof displacement values $\boldsymbol{U}_f$.
2. Use the slope-deflection equations to determine the basic forces $\boldsymbol{Q}$.
3. Draw the bending moment diagram.
4. Determine the support reactions and check global equilibrium.
5. Draw the deformed shape of the structural model.

For the case that the brace element d is prestressed with an initial tensile force of 10 units you are asked to answer the following questions *with a separate analysis*:

1. Determine the four free global dof displacement values.
2. Use the slope-deflection equations to determine the basic forces $\boldsymbol{Q}$.
3. Draw the bending moment diagram.

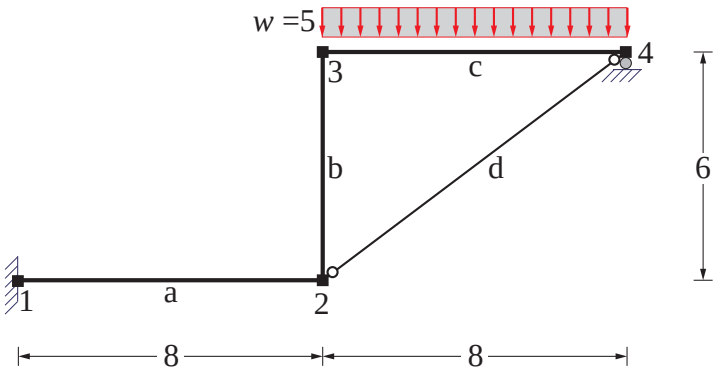


Figure 2: Braced frame under uniformly distributed load and brace prestressing

3. Problem (7 points)

The cable-stayed propped cantilever in Fig. 3 is subjected to a downward vertical force of 20 units at node 2. Elements a, b and c are assumed to be inextensible with flexural stiffness EI=50,000 units. The truss element d has axial stiffness EA= 20,000 units. The structural model has 4 non-trivial independent free dofs, as shown in Fig. 4.

You are asked to answer the following questions regarding the response of the cable-stayed propped cantilever under the downward vertical force of 20 units at node 2:

1. Set up *symbolically* the coefficients of the structure stiffness matrix $\mathbf{K}_f$.
2. *Confirm* that the displacement values for the independent free dofs are

$$\boldsymbol{U}_f = \begin{pmatrix} -2.494 & -14.149 & 0.6236 & 12.143 \end{pmatrix}^T \cdot 10^{-3}$$

3. Determine the basic forces of primary interest in elements a-d.
4. Draw the bending moment diagram.
5. Draw the deformed shape of the structure.

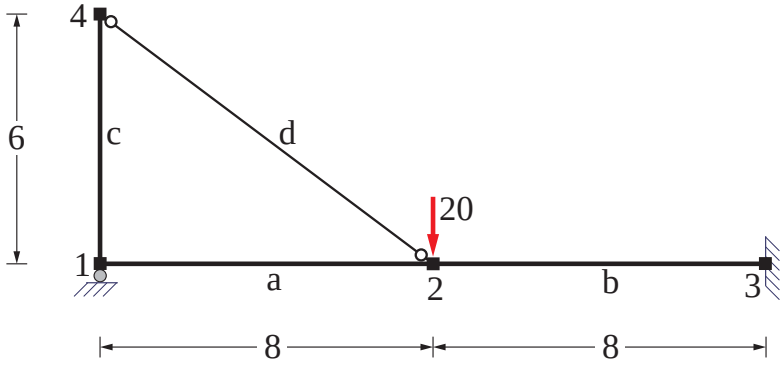


Figure 3: Cable-stayed propped cantilever

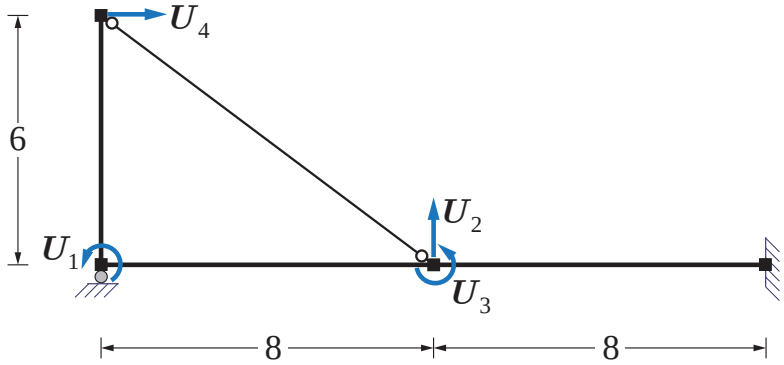


Figure 4: Non-trivial independent free dofs of cable-stayed propped cantilever