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## In-class Exercise Week #5: Iterative Techniques and Corotational Transformation

### Exercise #1:

Consider the following column:

$$A = 1.27 \cdot 10^4 mm^2, I = 3.66 \cdot 10^7 mm^2, E = 200{,}000 MPa$$

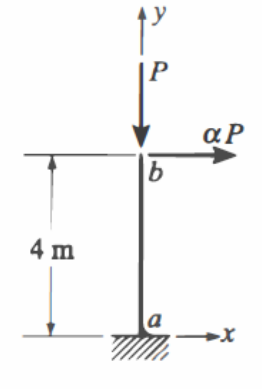


Figure 1. Column under axial and lateral loading

Analyze the behavior of the system for the following cases:

1. $\alpha = 0$ (determine the critical load)

Using load control and nonlinear geometry (with the corotational formulation), determine the secondary equilibrium path (Force-displacement relationship) of the structure when:

2. $\alpha = 0.05$
3. $\alpha = 0.05$ and P directed upward

Hint: for 2d elastic beam elements, the element stiffness matrix in the basic reference system $\hat{\mathbf{k}}$ is given by:

$$\hat{\mathbf{k}} = \begin{bmatrix} \frac{EA}{L} & 0 & 0 \\ 0 & \frac{4EI}{L} & \frac{2EI}{L} \\ 0 & \frac{2EI}{L} & \frac{4EI}{L} \end{bmatrix}$$

**Exercise #2:**

Consider the following frame:

- Members ab and bc: $A = 2.50 \cdot 10^4 mm^2, I = 6.36 \cdot 10^8 mm^2, E = 200{,}000 MPa$
- Members bd and ce: $A = 1.76 \cdot 10^4 mm^2, I = 8.61 \cdot 10^8 mm^2, E = 200{,}000 MPa$

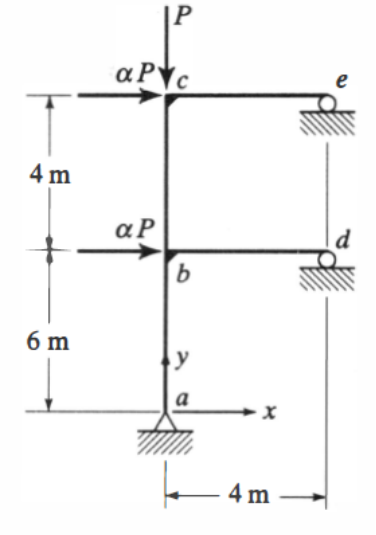


Figure 2. Planar frame under axial and lateral loading

Analyze the behavior of the system for the following cases:

1. $\alpha = 0$ (determine the critical load)

Using load control and nonlinear geometry (with the corotational formulation), determine the secondary equilibrium path (Force-displacement relationship) of the structure when:

2. $\alpha = 0.01$