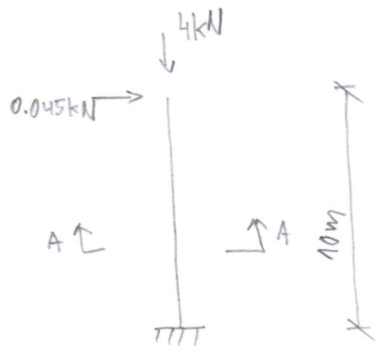
okAgenda

Subject: P-DELTA AND LARGE DISPLACEMENTS FOR CANTILEVER COLUMN
Subtask: (TEST PROBLEM)
Prepared by: ok Date: 8/21/2009
Sheet No. 1 of

GOAL: Illustrate P-Delta and Large Displacements on a simple fixed cantilever model.

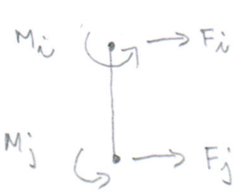
MODEL:



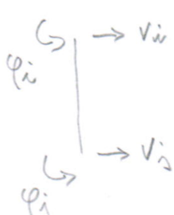
SECTION A-A

ELASTIC AND GEOMETRIC MATRICES:

Edward L. Wilson: Static & Dynamic Analysis of structures, 2004 p. 120-121



FORCES



DISPLACEMENTS

$$K_e = \frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & -6L \\ 6L & 4L^2 & -6L & -2L^2 \\ -12 & -6L & 12 & -6L \\ -6L & -2L^2 & -6L & 4L^2 \end{bmatrix} \qquad K_g = \frac{T}{30L}\begin{bmatrix} 36 & 3L & -36 & 3L \\ 3L & 4L^2 & -3L & -L^2 \\ -36 & -3L & 36 & -3L \\ 3L & -L^2 & -3L & 4L^2 \end{bmatrix}$$

$$\{F\} = \begin{bmatrix} F_i \\ M_i \\ F_j \\ M_j \end{bmatrix}, \quad \{V\} = \begin{bmatrix} v_i \\ \varphi_i \\ v_j \\ \varphi_j \end{bmatrix} \quad \Longrightarrow \quad \{F\} = [k_e + k_g]\{v\}$$

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LINEAR ANALYSIS

solve: $\underbrace{[k_e]_{2\times2}}\begin{Bmatrix} v_i \\ \varphi_i \end{Bmatrix} = \begin{Bmatrix} F_i \\ M_i \end{Bmatrix}$

2x2 submatrix of
full K matrix on page 1

calculate element end forces:

$$\{F\}_{4\times1} = [k_e]_{4\times4}\{v\}_{4\times1}$$

NONLINEAR ANALYSIS WITH P-DELTA EFFECTS

solve: $[k_e + k_g]_{2\times2}\begin{Bmatrix} v_i \\ \varphi_i \end{Bmatrix} = \begin{Bmatrix} F_i \\ M_i \end{Bmatrix}$

calculate element end forces: $\{F\}_{4\times1} = [k_e + k_g]_{4\times4}\{v\}_{4\times1}$

- since k_g changes with applied load, the response should be obtained from maltiple load increments

NONLINEAR ANALYSIS WITH D-DELTA EFFECTS AND LARGE DISPLACEMENTS

- similar to P-Delta analysis, but equilibrium equations are assembled and solved for deformed configuration using updated Lagrangian formulation