

Homework #5 (ASEN5022, Spring 2005)

Due at Start of Class on Tuesday, 08 March

5.1 Vibrations of Beam Bending with Uncertain Boundary Conditions

Vibration experiments were conducted on a beam in a laboratory setting and yielded the following results:

- The measured first mode was: $\beta L = 3.75$.
- The peak amplitude of its mode shape occurred at the beam span $x = 0.54L$, measured from the left end.

Determine the boundary spring constants by modifying Matlab code provided.

Hint: The first modes of classical boundary cases are given by:

$$\text{Simply supported at both ends: } \beta L = \pi$$

$$\text{One end fixed and the other free (cantilevered beam): } \beta L = 1.875$$

$$\text{Both ends fixed: } \beta L = 4.730$$

$$\text{One end fixed and other end simply supported: } \beta L = 3.937$$

5.2 FEM Modeling of Vibration of Bars

Consider a bar whose ends are constrained by springs and masses shown below as discussed in the class. For your convenience, you may utilize the non-dimensional parameters given by

$$\kappa_{01} = k_{01}L/EA, \quad \kappa_{02} = k_{02}L/EA, \quad \kappa_{L1} = k_{L1}L/EA, \quad \kappa_{L2} = k_{L2}L/EA$$
$$\mu_0 = M_0/\rho L, \quad \mu_L = M_L/\rho L$$

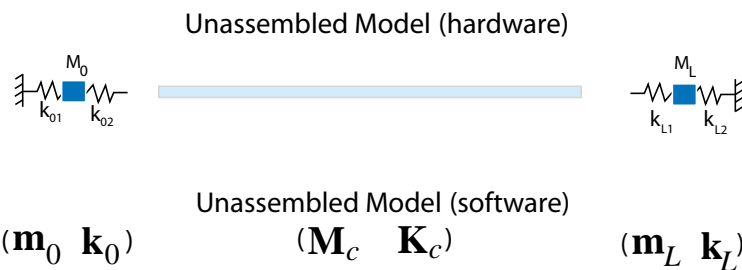


Figure for Problem 5.2

- 5.2.1 Perform an FEM vibration analysis by gradually increasing the number of bar elements for the case of *free-free bar*. This condition can be realized in your FEM code by setting all of the end masses and springs to be zero. Determine the number elements needed to obtain the FEM computed two lowest frequencies to be within 0.1 % of the continuum results.
- 5.2.2 Repeat Problem 5.2.1 with your choice of *soft support conditions* by selecting appropriate end masses and springs.
- 5.2.3 Repeat Problem 5.2.1 with your choice of *hard support conditions* by selecting appropriate end masses and springs.

Discuss your FEM analysis results as compared to the analytical results (the continuum solution). What have you learned?