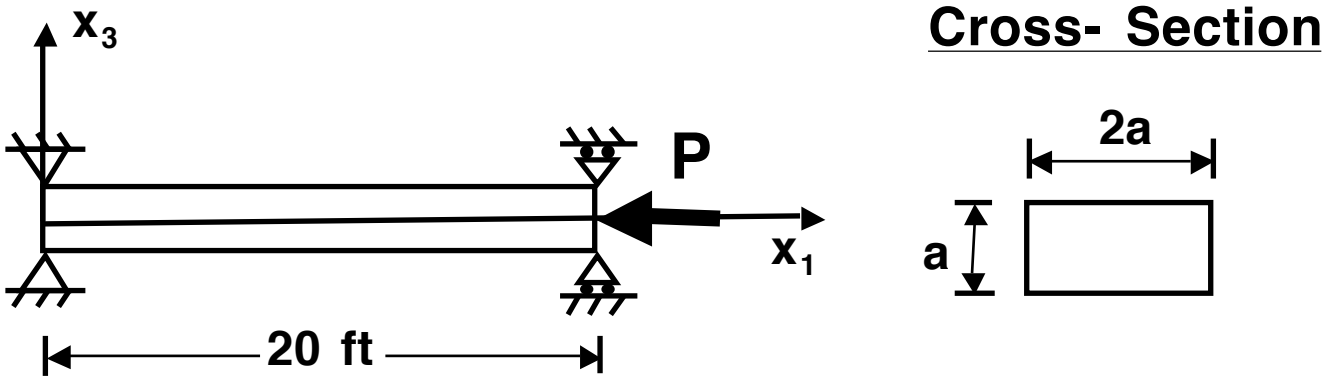
Unified Engineering Problem Set **Lectures: M16, M17**
Week 11 Spring, 2008 **Units: M4.7**

M11.1 ***(10 points)*** A series of 20-foot long columns is to be produced using a titanium alloy with the following material properties: E = 18.5 Msi, σ_{cu} = 150 ksi, σ_{cy} = 98 ksi). These columns will be simply-supported and have rectangular cross-sections with an aspect ratio of width (w) to thickness (t) of 2. The columns will be manufactured with various values of these sizes. A compressive load will be applied at the column end with the roller supports. The supports at each end are attached totally around the cross-section edges. You are asked to determine a design chart showing the maximum load-carrying capability of these products as a function of the cross-section parameter, a, equal to the thickness. Be sure to clearly indicate your reasoning and "important points" on the design chart.

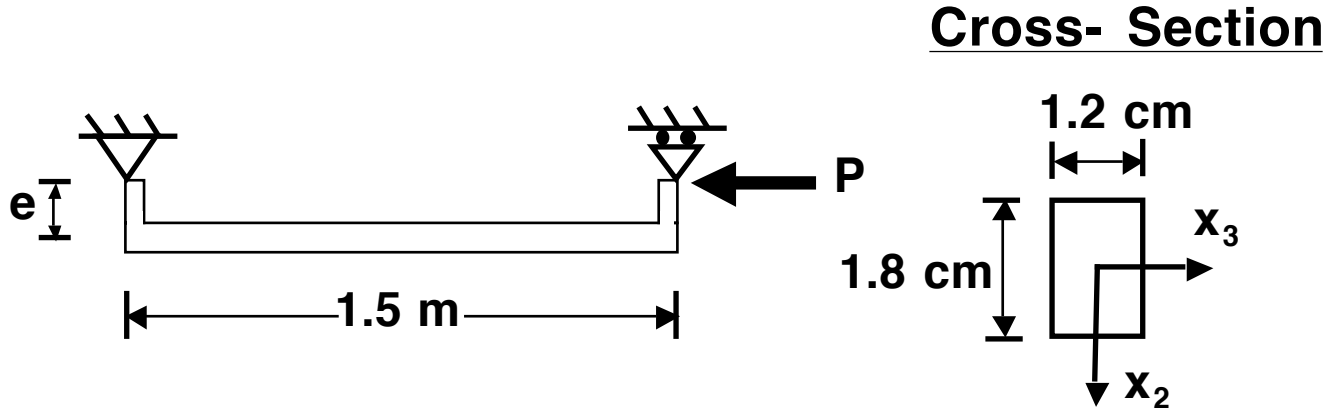


(a) Determine the buckling load for this configuration as a function of the cross-section parameter, a, of the titanium columns.

(b) Determine the squashing load for this configuration as a function of the cross-section parameter, a, of the titanium columns.

(c) Determine and sketch the design chart.

M11.2 ***(10 points)*** An aluminum (E = 70 GPa, ν = 0.3, σ_{cu} = 425 MPa, σ_{cy} = 370 MPa) column is 1.5 meters long and has a rectangular cross-section of 1.8 centimeters by 1.2 centimeters. The column is assumed simply-supported and is used to support a compressive load of magnitude P. Assume that the load is applied off the centerline of the column by an eccentricity of value e. Consider five cases of eccentricity normalized by the total length of the column: 0, 0.01, 0.02, 0.05, 0.1.



(a) For each case, determine the maximum load the column can carry.

(b) For each case, determine a normalized relationship between the applied load and the lateral deflection of the center of the column. Normalize the center deflection of the column by the specimen length and normalize the column load, P, by the critical buckling load, P_{cr}.

(c) Plot the normalized center deflection of the column versus the normalized load for the five cases of eccentricity.