1.054/1.541 Mechanics and Design of Concrete Structures (3-0-9)

Homework #3

Assigned: Thursday, March 18, 2004 **Due:** Thursday, April 1, 2004

Biaxial Column Interaction

Introduction

To demonstrate the adequacy of a given column section subjected to a given biaxial loading using the approximate contour method and the theoretical method. A square cross section is as shown in Fig. 1 with the following information:

Concrete

Uniaxial compressive strength: $f_c^{'} = 5000$ psi;

Maximum concrete strain: $\varepsilon_{cu} = 0.003$;

Steel

Yield stress: $f_y = 60$ ksi;

Yield strain: $\varepsilon_{sy} = 0.002$.

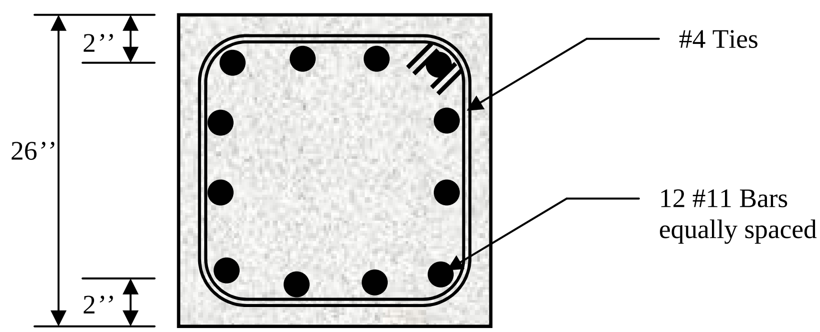

Figure 1. Configuration of the reinforced concrete column section

Questions

1. (Uniaxial Column Interaction Diagram)

For the cross section shown in Fig. 1, construct the axial load-moment interaction diagram. As a minimum calculation, establish the points corresponding to

(a) pure axial load ($P_o^{'}$),

(b) balanced loads ($P_b^{'}$, $M_b^{'}$), and

(c) pure moment ($M_o^{'}$).

You may assume straight lines between these points. Also, plot the axial load ultimate curvature diagram.

2. (Biaxial Column Interaction)

For the same column cross section, assume that the neutral axis is originated at 45 degree to the principal axes, and has a depth equal to 12 inches. At the extreme compression fiber, the compression strain is equal to 0.003. Accomplish the following tasks:

(a) Calculate the axial load and bending moment acting on the section,

(b) Plot the load contour (P vs. M_x vs. M_y) using the Bresler load contour method with α = 1.5, and the uniaxial interaction diagram from part 1.

(c) Show the loading points on the load contour and comment on the adequacy of the section for the loading considered.

- **Note:** Bresler's Load Contour Method

The general nondimensional equaiton for the load contour at constant may be expressed in the form

$$\left(\frac{M_{nx}}{M_{ox}}\right)^{\alpha_1} + \left(\frac{M_{ny}}{M_{oy}}\right)^{\alpha_2} = 1 \qquad (1)$$

where $M_{nx} = P_n e_y$; $M_{ny} = P_n e_x$;

$M_{ox} = M_{nx}$ capacity at axial load P_n when $M_{ny} = 0$ or $(e_x = 0)$;

$M_{oy} = M_{ny}$ capacity at axial load P_n when $M_{nx} = 0$ or $(e_y = 0)$.

Bresler (1960) suggests that it is acceptable to take $\alpha_1 = \alpha_2 = \alpha$; then

$$\left(\frac{M_{nx}}{M_{ox}}\right)^{\alpha} + \left(\frac{M_{ny}}{M_{oy}}\right)^{\alpha} = 1 \qquad (2)$$

which is shown graphically in Fig. 2.

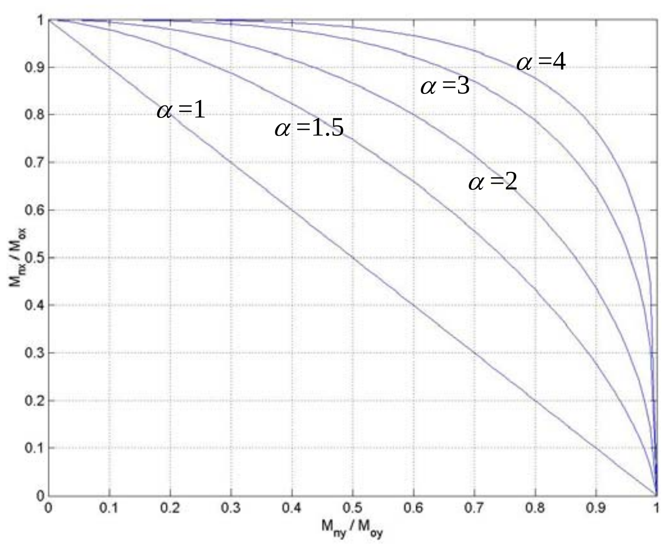

Figure 2. Interaction curves for Eq. (2)