Yonsei University

Department of Civil and
Environmental Engrg.

Mid-term Exam

Behavior of Concrete Members

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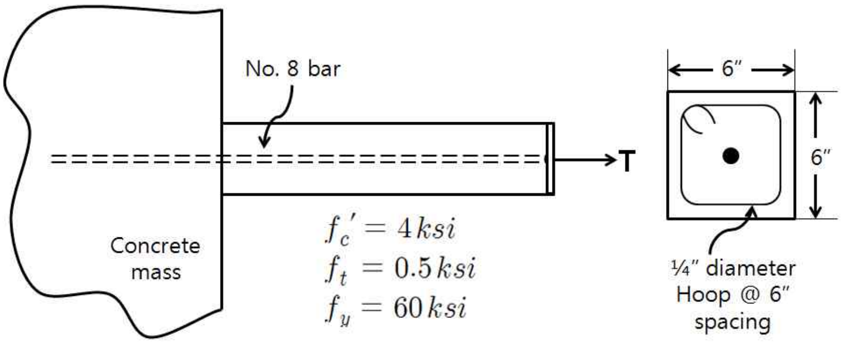
Concrete Structural Engrg. Lab

Due: 2023. 5. 2

Problem 1 [50 points]

A tension member has a square cross section of 6 by 6 inches, and is reinforced with a single No. 8 bar. The member was cast as shown with a straight anchorage into a large mass of concrete.



Side View **Cross Section**

(a) Estimate the average crack width at the midlength of the member for a load of 30 kips.

(b) Estimate the displacement at the loaded end relative to the concrete mass for a load of 30 kips.

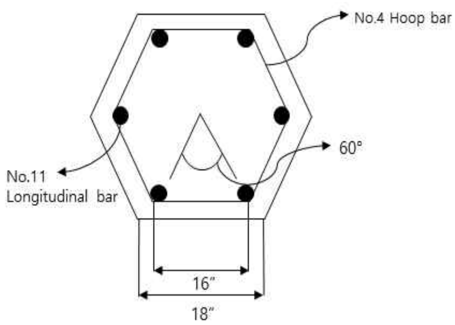
(c) Estimate the length of embedment required into the concrete mass using the ASCE-ACI Comm. 408 recommendations. Assume the bar will be loaded to yield.

(d) Assume that the member is very long, and has a lap splice at midlength. Assume the bar is loaded to yield. Use the ASCE-ACI Comm. 408 recommendations to calculate the required splice length.

Problem 2 [50 points]

A RC compression member has a hexagonal cross section as shown.

f_{ck}=5,000 psi and f_y=60 ksi. Concrete has lightweight aggregate.



(a) Compute the maximum spacing of No. 4 hoops such that the member will exhibit ductility following initial spalling.

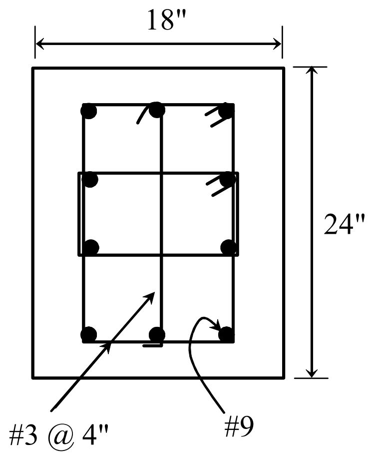
(b) Derive the spacing of hoops required to ensure the longitudinal bars can yield.

Problem 3 [50 points]

(a) For the column cross section shown below, calculate the peak stress capacity of the confined core. Cylinders test at 4000 psi.

(b) Describe expected post-spalling behavior under axial load of a ten-foot long column with the cross section shown. Minimal calculation, if any.

Assume 3" Cover to tie.



$f'_c = 4$ ksi

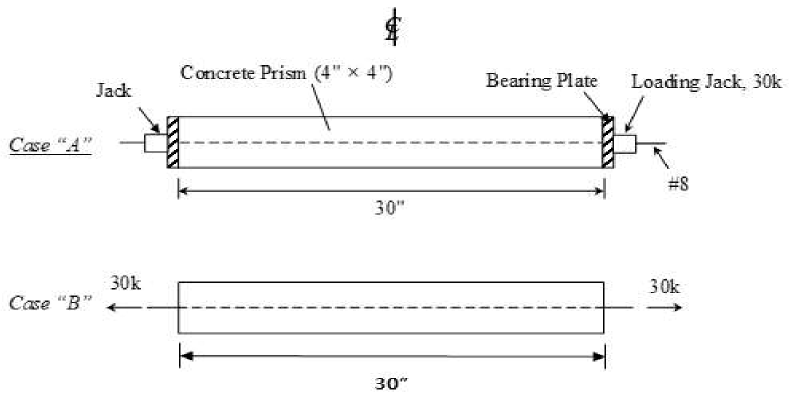
$f_y = 60$ ksi

Problem 4 [50 points]

Shown below are two concrete prism with embedded #8 longitudinal bar bonded to the concrete. f'_c=4,000 psi, f_y=60,000psi

(a) Two jacks pull the #8 bar, reacting against bearing plates that are epoxied to the prism. Calculate the bar slip from concrete at one end when tension of 30 kips is applied. Case "A"

(b) The bars are pulled with same 30 kip force, with no reaction on concrete. Calculate the slip from concrete at one end. Case "B"



$$\bar{a} = \frac{f_t\, A_c}{\pi\, d_b h} \times 1.5$$

$$f_c = 2\frac{\epsilon}{\epsilon_o}\left(1-\frac{1}{2}\,\frac{\epsilon}{\epsilon_o}\right)f'_c$$

$$\sigma_a = (\sigma_1 + \sigma_2 + \sigma_3)/3$$

$$\sigma = \left[\frac{\sum X_i^2 - (\sum X_i)^{2/n}}{(n-1)}\right]^{1/2}$$

$$\ell_s = \frac{1860}{\sqrt{f'_c}} d_b \geqq 20 d_b$$

$$\rho_0 = 0.85\beta_1 \frac{f'_c}{f_y}\,\frac{87000}{87000+f_y}$$

$$\tau_{a} = \frac{1}{\sqrt{15}}\left[(\sigma_1-\sigma_2)^2 + (\sigma_2-\sigma_3)^2 + (\sigma_3-\sigma_1)^2\right]^{1/2}$$

$$f_{cr} = f'_c + t\sigma$$

$$\rho_s = 0.45\left(\frac{A_g}{A_c} - 1\right)\frac{f'_c}{f_y}$$

$$A_{sh} \geqq 0.09\, sh f'_c / f_y$$

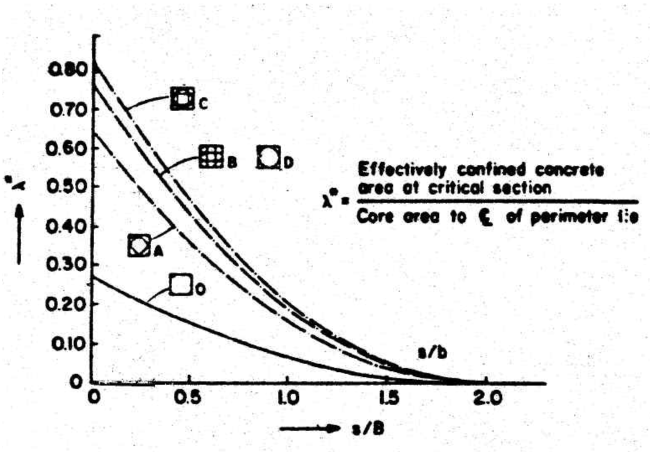


Fig. Effectively confined concrete area as a function of tie spacing and core size for various square steel configurations

$$Z = 0.5/\left[\frac{3+0.002f'_c}{f'_c - 1000} + \frac{3}{4}\rho_s\sqrt{\frac{h}{3}} - 0.002\right]$$

$$\ell_{db} = \frac{5500A_b}{\phi k\sqrt{f'_c}}$$

$$K_{tr} = \frac{A_{tr} f_y}{1500s}$$

$$\rho_s \geqq 0.12\frac{f'_c}{f_y}$$

$$A_{sh} = 0.3\left(\frac{A_g}{A_c} - 1\right)\frac{f'_c}{f_y}sh$$

$$f_{cmax} = f'_c + 4.1f_r$$

$$f_c = f_{cmax}\left[1 - z(\epsilon_c - \epsilon_o k)\right]$$

$$K = K_{tr} + c$$

bar #	d_b (in)	A_b (in^2)
3	3/8	0.11
4	4/8	0.20
5	5/8	0.31
6	6/8	0.44
7	7/8	0.60
8	1	0.79
9	1.12	1.00
11	1.44	1.56