Yonsei University

Dept. of Civil and Environmental Engineering

Mid-term Exam.

Structural Behavior RC

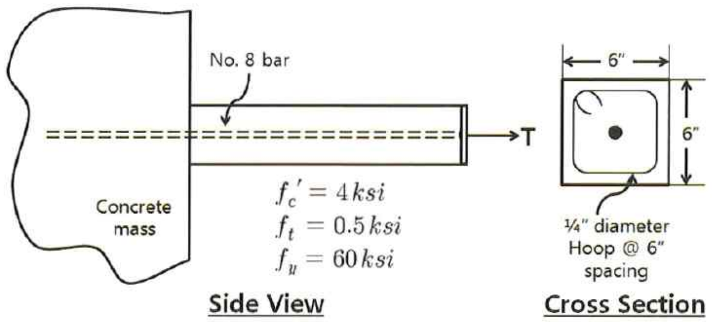
Prof. Jang-Ho Jay Kim

Concrete Structural Engrg. Lab

2019. 10. 15.

Problem 1. [50%]

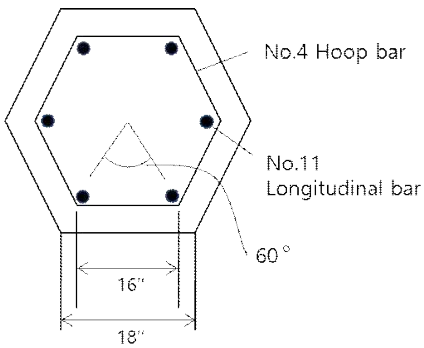
A tension member has a square cross section of 6 by 6 inches, and is reinforced with a single No. 8 bar. The member was cast as shown with a straight anchorage into a large mass of concrete



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

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.

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

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

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

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

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

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

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

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

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

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

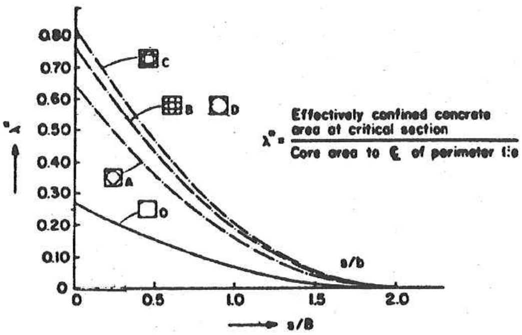


Fig. Effectively confined concrete area as a function of tie spacing and core size for various square steel configurations

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

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

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

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

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

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

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

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

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