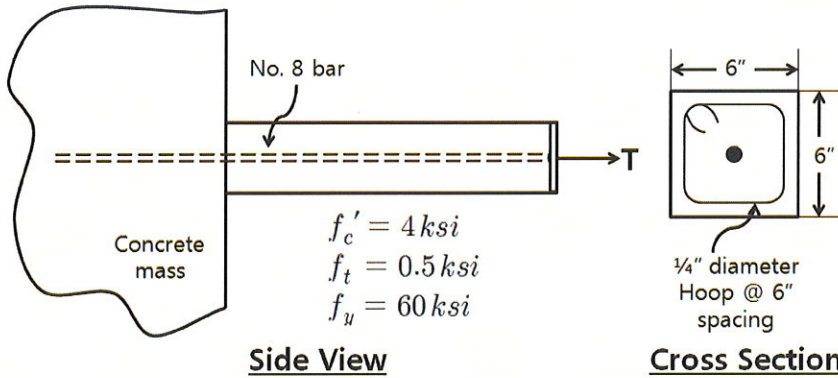


Mid-term Exam

Structural Behavior of RC

Problem 1 [50%]

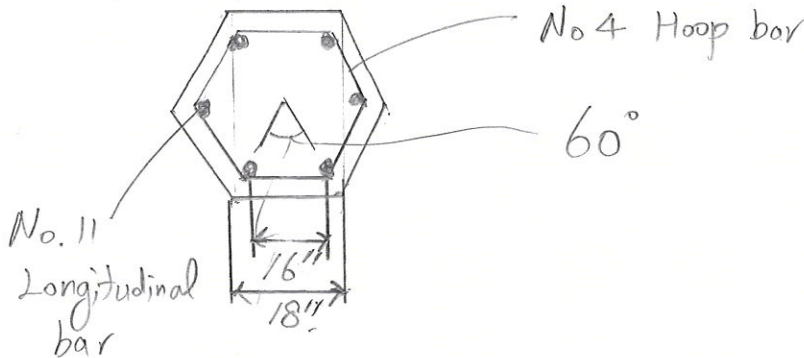
A tension member has a square cross section of 6 by 6 inches, and is reinforced with a single No. 8 bar. The member was cast as shown with a straight anchorage into a large mass of concrete.



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

A RC compression member has a hexagonal cross section as shown. $f_{ck}=5,000 \text{ psi}$ and $f_y=60 \text{ ksi}$. 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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

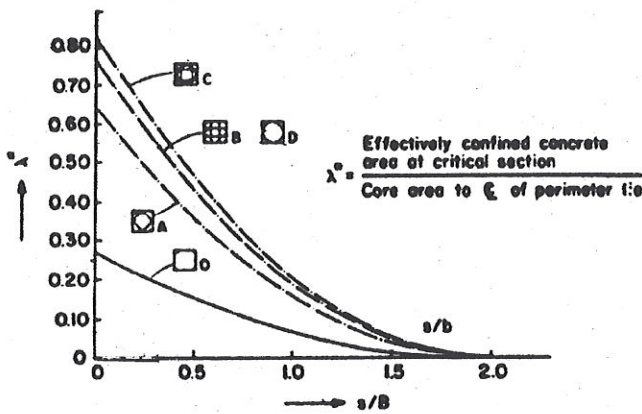


Fig. Effectively confined concrete area as a function of tie spacing and core size for various square steel configurations