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Sent: Wednesday, April 06, 2005 8:12 AM
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Subject: Homework assignment

The homework assignment for this week is

1. Design a 16" x 16" reinforced pilaster to support a moment of 34.4 ft-k. The in-class example used masonry with a compressive strength of 2500 psi and grade 60 reinforcement. No guarantee that will work with 16x16.

2. Design a reinforced composite brick-block wall for the wall on grid line 1 of the DPC Gymnasium. The wall is composed of a nominal 4 in. clay brick wythe, a 2 in. grouted callor joint, and a nominal 8 in. concrete masonry wythe to create an overall 13.25 in. thick wall. The reinforcement is located in the collar joint.

Grade 60 steel, Type N mortar, compressive strength of the masonry is 1500 psi and Em is 1.8(10)^6 psi. The block is hollow with face shell bedding. Compressive strength of the brick is 2000 psi with E=2.0(10)^6 psi. The brick is solid.

The wall is considered pinned at the top and bottom with a height of 29.33 ft and supports a load from wind of 20 psf.

You need to determine an area of steel and check the design for wind force applied from either direction. The face shell bedding may modify how you determine kd as noted in class. Also note that there are some tables that give areas of steel per foot width based on bar size and spacing.

Finally, I am going to be in North Jersey for most of the day on Monday so I won't be available for questions if you wait until the last minute.

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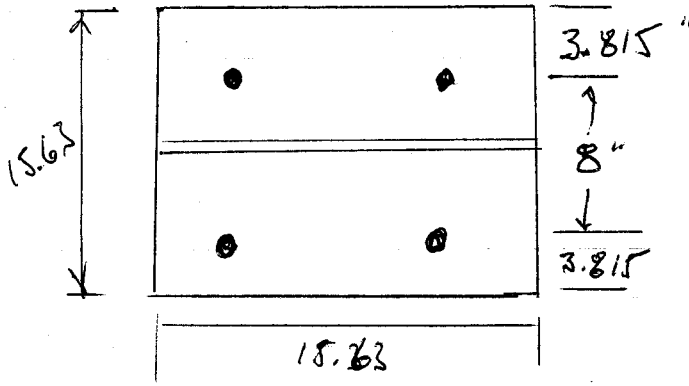
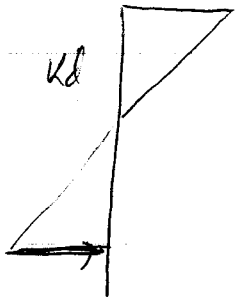
1. DESIGN A 16" x 16" (NOMINAL) REINFORCED PILASTER TO SUPPORT A MOMENT OF 34.4 K-ft.

TO START ASSUME $f'_m = 2500$ psi & GR 60 STEEL.

$E_m = 900(2500) = 2.25(10)^6$ psi

$n = 12.9$, ASSUMING FULL BEDDED & FULL GROUTED





$d = 11.815"$

$$\text{TRIAL } A_s = \frac{M}{F_s j d} = \frac{34.4 \text{ ft-k}(12000)}{1.33(24000)(.9)(11.815)} = 1.216 \text{ in}^2$$

TRY 2 #8 BARS $A_s = 1.58 \text{ in}^2$ (4 TOTAL TO BE PLACED)

$$nA_s = \frac{29\,000\,000}{2.25(10)^6} = 12.9(1.58) = 20.36 \text{ in}^2$$

$$20.36(11.815 - Kd) = \frac{15.63(Kd)^2}{2}$$

$$7.815(Kd)^2 + 20.36\,Kd - 240.55 = 0$$

$$Kd = 4.40$$

$$I = \frac{15.63(4.40)^3}{12} + 15.63(4.4)(2.2)^2 + 20.36(11.815 - 4.40)^2$$

$$I = 1563 \text{ in}^4$$

CHECK STRESSES

$$f_s = \frac{34.4(12000)(16.1)(11.815-4.4)}{1563} = 31529 \text{ psi}$$

$< 1.33(24000) = 31920$ ✓

$$f_b = \frac{34.4(12000)(4.4)}{1563} = 1162 \text{ psi}$$

$$\frac{2500}{3}(1.33) = 1108 \text{ psi}$$

INCREASING STEEL TO #9 BARS

OR INCREASE f'_m TO $\frac{1162(3)}{1.33} = \underline{2610}$ psi

SAY 2750 OR 3000 psi

WILL MAKE THE SECTION WORK.

#2 13.25" THICK WALL CONSISTING OF 4" CLAY BRICK, 2" GROUTED COLLAR JOINT, 8" CMU.

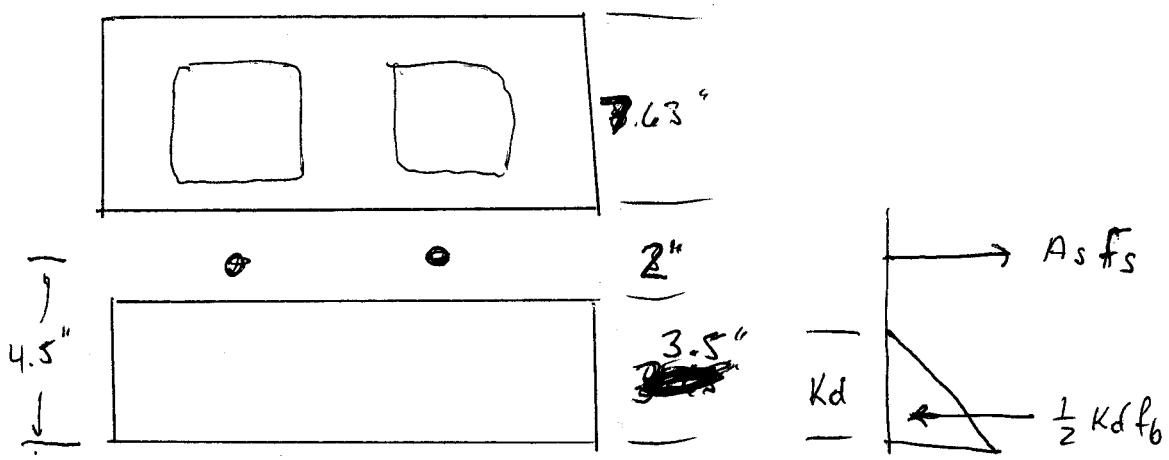
REINFORCEMENT IS PLACED IN THE COLLAR JOINT

CMU	BRICK	GROUT
f'_m = 1500 psi	2000 psi	2000 psi
E_m = 1.8(10)^6 psi	2(10)^6 psi	1(10)^6 psi
TYPE N MORTAR		
n = 16.1	14.5	
FACE SHELL BEDDING		

WALL IS NON-LOAD BEARING
WIND LOAD = 20 psf

$$M = \frac{20\,(29.33)^2}{8} = 2150 \text{ ft-lb} = 25{,}800 \text{ in-lbs}$$

WIND COULD BE ACTING IN EITHER DIRECTION SO 2 CONDITIONS NEED TO BE CONSIDERED.



USING 33% INCREASE FOR WIND LOAD & ASSUMING STEEL STRESS CONTROLS

$$A_s = \frac{M}{1.33 F_s j d} = \frac{25800}{1.33(24000)(.9)(4.5")} = 0.20 \text{ in}^2/\text{ft}$$

#4 @ 12" OR #5 @ 18"

USE #5 @ 18" TO GIVE FEWER BAR PLACEMENTS.

$$A_s = .31 in^2 \frac{(12")}{18"} = 0.207 \ in^2/ft$$

FIND Kd, $n = 14.5$ $nA_s = .207(14.5) = 3 \ in^2$

$$nA_s(d - Kd) = \frac{b\,Kd^2}{2}$$

$$3(4.5) - 3Kd = 6\,Kd^2$$

$$6(Kd)^2 + 3Kd - 13.5 = 0 \qquad Kd = 1.27"$$

$$I = \frac{12(1.27)^3}{12} + 12(1.27)\left(\frac{1.27}{2}\right)^2 + 3(4.5 - 1.27)^2$$

$$= 39.5 \ in^4$$

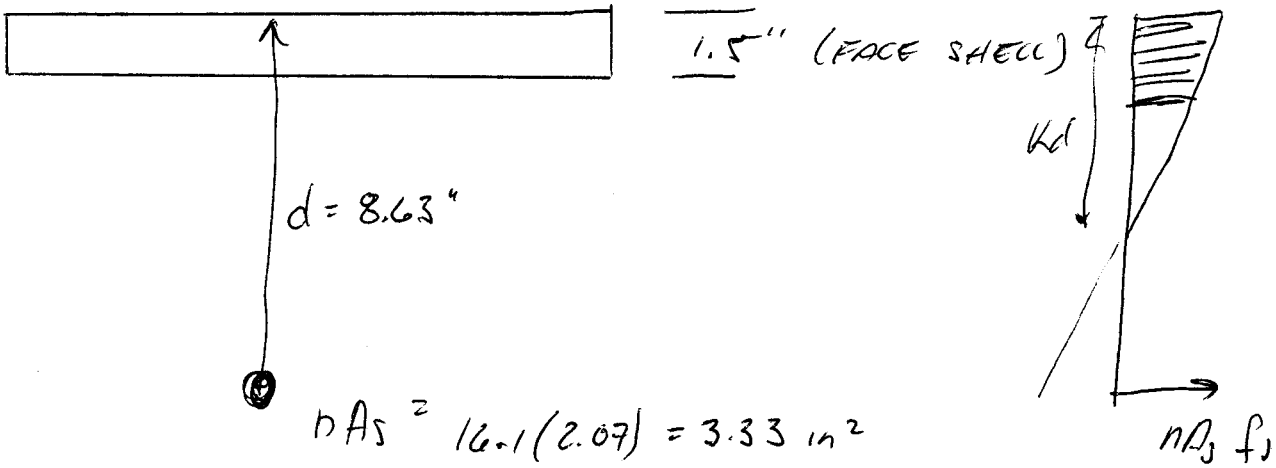
$$f_s = 25800 \ in\text{-}lb \frac{(4.5 - 1.27)}{39.5}(14.5) = 30590 \ psi$$

$1.33(24000) = 31920$ psi O.K.

$$f_b = \frac{25800(1.27)}{39.5} = 829.5 \ psi < 1.33\frac{(2000)}{3} = 886 \ psi$$

O.K.

CHECK SECTION WHEN WIND IS IN OPPOSITE DIRECTION



ASSUMING Kd IS GREATER THAN THE 1½" FACE SHELL

$$nA_s(d - Kd) = b(t)(Kd - t/2)$$

$$3.33(8.63 - Kd) = 12(1.5)(Kd - .75)$$

$$28.74 - 3.33Kd = 18Kd - 13.5$$

$$Kd = 1.98"$$

$$I = \frac{12(1.5)^3}{12} + 12(1.5)(1.23)^2 + 3.33(8.63 - 1.98)^2$$

$$I = 177.8 \text{ in}^4$$

$$f_s = \frac{25800(8.63 - 1.98)}{177.8}(16.1) = 15535 \text{ psi} < 24000(1.33)$$

O.K.

$$f_b = \frac{25800(1.98)}{177.8} = 287 \text{ psi} < \frac{1500}{3} \times 1.33$$

O.K.