Masonry Analysis and Design
Homework 1

f'_m = 1500
GR40
Med wt units w/ 140 pcf grout
f'_m = 1500
GR40 steel
grout solid

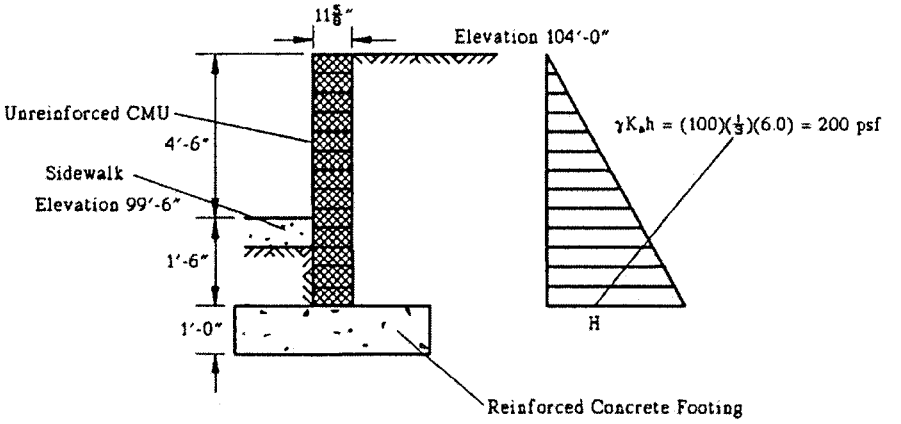
1. A solid grouted 8-in concrete masonry beam is reinforced with two #4 reinforcing bars and has an effective depth of 32.5 inches. Determine the allowable moment. What is the allowable load if the effective span is 10.67 ft?

2. A 10-in.-wide simply-supported brick lintel with a span of 15 feet is to carry a service load of 875 lb/ft, not including its own weight. The overall depth of the beam is 36 in. The flexural reinforcement consists of two #5 bars. Determine the allowable moment for the beam. Is the beam safe?

3. A retaining wall is to be made of 12" unreinforced CMU. Determine if the wall is sufficient.

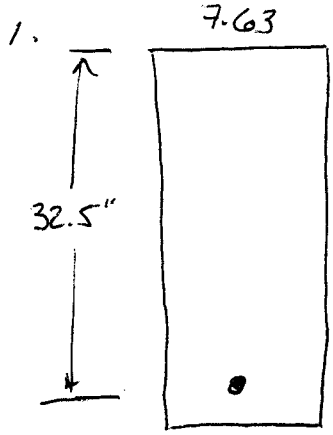
f'_m = 1,500 psi — Weight of masonry (12-in. thick - solid grouted) = 100 psf
Type N mortar (PCL) — Running bond
Weight of soil γ = 100 pcf — Active earth pressure coefficient K = ⅓

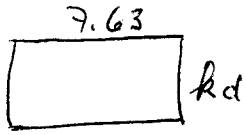
Calculations and Discussion	**Code Reference**



MASONRY

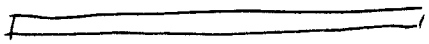
1.





$f'_m = 1500$ psi
Gr 40 steel
Medium wt unit w/ 140 pcf grouted solid

$A_s = 0.40\ in^2$

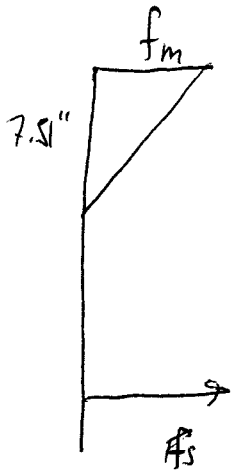


$n A_s = \frac{29000000}{1.35(10)^6} \cdot .4 = 21.5(.4)$

$= 8.6\ in^2$

$$\frac{7.63(kd)^2}{2} = 8.6(32.5 - kd)$$

$$kd^2\ 3.815 + 8.6\,kd - 279.5 = 0 \qquad kd = 7.51"$$



$$M = C\left(d - \frac{kd}{3}\right)$$

$$= \frac{1}{2}(7.51)(500)(7.63)\left(32.5 - \frac{7.51}{3}\right)$$

$$= 35810\ \text{ft-lb}$$

(compression controlled)

$$M = T(d - kd/3)$$

$$= .4(20000)\left(32.5 - \frac{7.51}{3}\right)$$

$$= \underline{20000\ \text{ft-lb}}$$

Tension in the steel controls

WT OF BEAM = 78 psf

$= 78 \text{ psf}\left(\frac{36.0}{12}\right) = 234 \text{ lb/ft}$

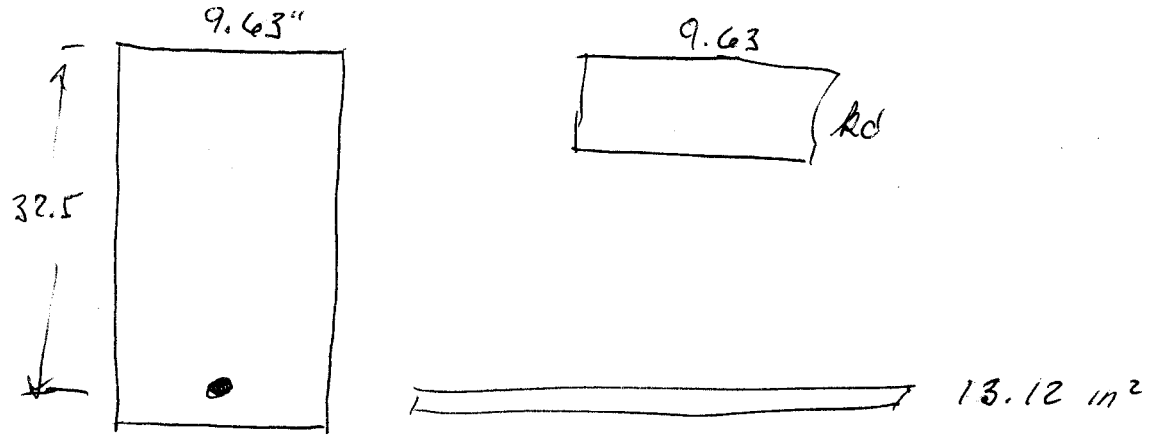
(36" TOTAL BEAM HEIGHT ESTIMATED)

$M = 20000 \text{ ft-lb} = \frac{(234 + w)(10.67)^2}{8}$

$w = 1171 \text{ lb/ft}$ ALLOWABLE LOAD

* NOTE: SOLVED AS CONCRETE MASONRY. PROBLEM IS ACTUALLY CLAY WHICH EFFECTS E_m

2. 10" WIDE BEAM, $f'_m = 1500$ psi
GR 40 STEEL
MEDIUM WT FULLY GROUTED @ 140 pcf



$A_s = 2\#5 = 0.61\ in^2$
$n = 21.5$

$$\frac{9.63(kd)^2}{2} = 13.12\ in^2(32.5 - kd)$$

$$4.815(kd)^2 + 13.12\,kd - 426.4 = 0$$

$$kd = 8.15"$$

M BASED ON COMPRESSION FAILURE

$$M = \tfrac{1}{2}(500\ psi)(8.15)(9.63")\left(32.5" - \frac{8.15"}{3}\right)\frac{1\ ft}{12"}$$

$$= 48700\ ft\text{-}lb$$

M BASED TENSION IN THE STEEL

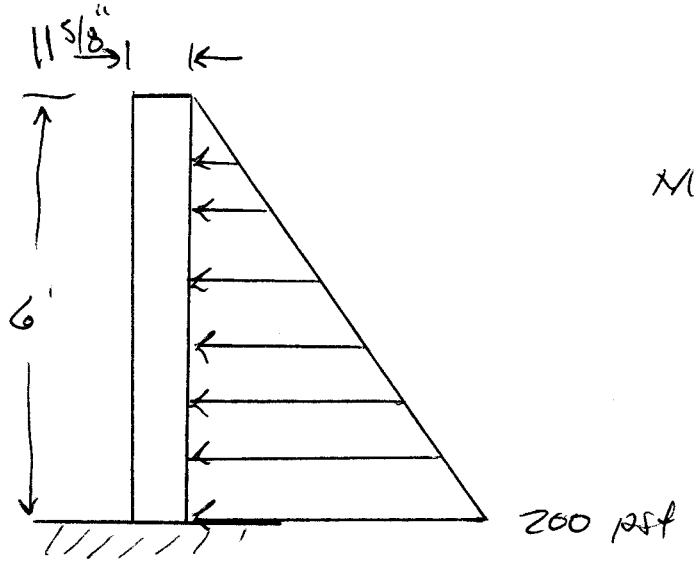
$$M = .61in^2(20000\ psi)\left(32.5" - 8.15"/3\right)\frac{1}{12} = 30280\ ft\text{-}lb$$

WT OF WALL $= 98\ lb/ft^2\,(36/12) = 294\ lb/ft$

$$M = \frac{(875 + 294)(15)^2}{8} = 32878\ ft\text{-}lb > 30280\ ft\text{-}lb$$

BEAM FAILS.

3.



$$M = \frac{1}{2}\left(200 \frac{lb}{ft^2}\right)(6')(1')(2')$$

$$= 1200 \text{ ft-lb/ft}$$

$$V = 600 \text{ lb}$$

$$f_{mt} = \frac{M}{S} = \frac{1200 \text{ ft-lb}\,(12''/ft)}{270 \text{ in}^3} = 53.3 \text{ psi} < 63 \text{ psi}$$

$$f_v = \frac{VQ}{Ib} =$$

$$= 3/2 \frac{V}{A} \quad \text{FOR RECT. SECTION}$$

$$= \frac{3}{2}\left(\frac{600 \text{ lb}}{140 \text{ in}^2}\right) = 6.42 \text{ psi} \quad < 1.5\sqrt{1500'} = 58 \text{ psi}$$

$$< 120 \text{ psi}$$

$$< 60 + \frac{N_u}{A_n}$$

$$60 + \frac{100 \text{ psf}(6'X1')}{140}$$

$$= 64.3 \text{ psi}$$

SHEAR & MOMENT ARE O.K.