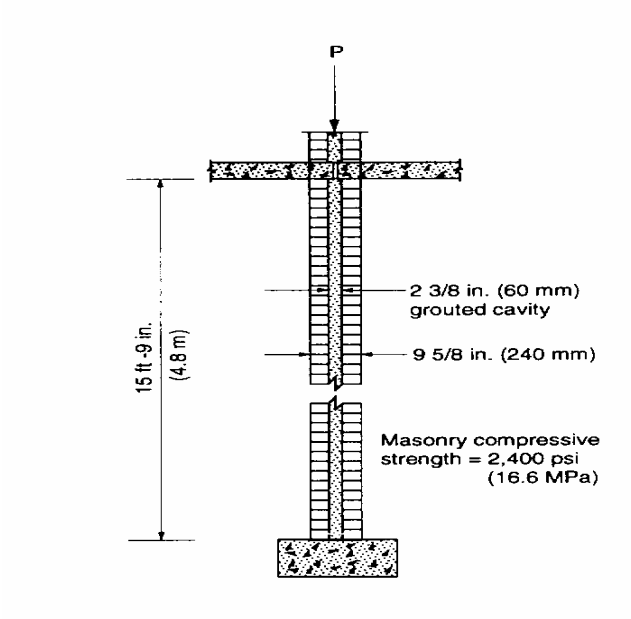
Ce 479
Homework 2 (Unreinforced Masonry using Allowable Stresses)
Fall 2006
Solution: JAR

1. For the wall of Problem #1, determine the allowable design axial load, P, according to the ACI 530 -Allowable Stress Provisions. The wall is fully grouted.

Solution:The wall is fully grouted to act as a unit. The prisms have been tested and the masonry compressive strength is 2400 psi. The load is concentrically applied along the length of the wall. Assuming pinned ends, determine h/r, where h is the wall height and r is the radius of gyration:




$h := 15.75 \cdot 12$

$h = 189$ inches

$I := 9.625 \cdot 9.625 \cdot 9.625 \cdot \frac{12}{12}$

$I = 891.666$ in3/ft

$Anet := 9.625 \cdot 12$

$Anet = 115.5$ in2/ft

$r := \sqrt{\frac{I}{Anet}}$

$r = 2.778$ inches

$\frac{h}{r} = 68.022$

Since h/r is less than 99, the failure load is overstimated by the buckling equation, (2-15). The empirical relationship, (2-12), best fits the available test results with a factor of safety of 4.0.

$fm := 2400$ psi

$Fa := 0.25 \cdot fm \cdot \left[1 - \left(\frac{h}{140 \cdot r}\right)^2\right]$ $\quad Fa = 458.356$ psi

$Pall := Fa \cdot Anet$ $Pall = 52940$ lbs

The wall stability must also be checked:

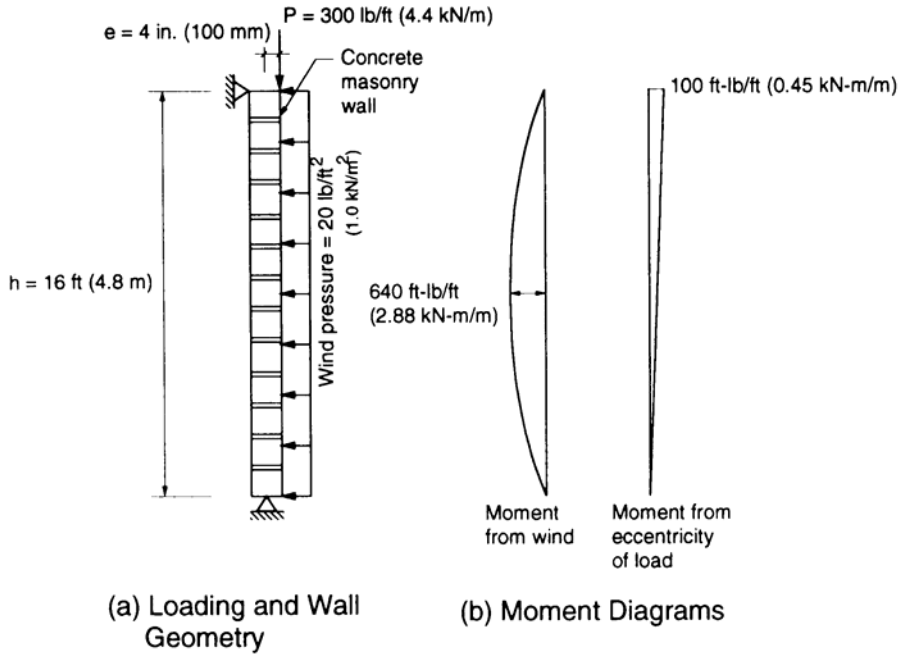
$E := 700 \cdot fm$ $E = 1.68 \times 10^6$ psi

$Pe := 9.86 \cdot E \cdot \frac{I}{h^2}$ $Pe = 413490$ lbs

$Pmax := \frac{Pe}{4}$ $Pmax = 103372$ lbs, which greater than the allowable. Thus OK!

2. Design the concrete block wall to carry a vertical load of 300 lb/ft with a 4-inch eccentricity in addition to a lateral load of 20 lb/ft2. The wall is 16 ft high and is simply supported at the top and at the bottom as shown in the figure. The wall is built with 8-inch CMU and face shell bedding of portland cement type S mortar. The self-weight of the wall is 720 lb/lineal ft of wall.
If the current thickness is not adequate in accordance with ACI 530-Allowable Stresses, increase it to a 12-inch CMU (net 11.625 inches, wall self-weight of 1024 lb/lineal ft of wall) with a 1.5 inch face shell bedding. Use a compressive strength for masonry of 2000 psi.

The approach is to check two load conditions, (1) Gravity load and no wind- the critical section is located at the top of wall, and (2) Gravity load plus wind- the critical section is located at mid-height of the wall.
1) Gravity load check:
i) compression controls



$fm2 := 2000$ psi

$Pax := 300$ lbs/ft $\quad Anet2 := 2 \cdot 1.25 \cdot 12 \quad Anet2 = 30$ in2/ft

$M := 100 \cdot 12 \quad M = 1.2 \times 10^3$ in-lb $\quad S2 := 81$ in3/ft

$fa2 := \frac{Pax}{Anet2} \quad fa2 = 10$ psi $\quad fb2 := \frac{M}{S2} \quad fb2 = 15$ psi

$h2 := 16 \cdot 12 \quad h2 = 192$ in $\quad I2 := 309$ in4/ft $\quad r2 := \left(\frac{334}{41.5}\right)^{\frac{1}{2}}$

$r2 = 2.837$ in/ft $\quad \frac{h2}{r2} = 68$ this is less than 99.

$Fa2 := 0.25 \cdot fm2 \cdot \left[1 - \left(\frac{h2}{r2 \cdot 140}\right)^2\right] \quad Fa2 = 383$ psi

$Fb2 := 0.3 \cdot fm2 \quad Fb2 = 600$ psi

$\left(\frac{fa2}{Fa2}\right) + \left(\frac{fb2}{Fb2}\right) = 0.051$ less than 1.0 therefore, OK.

Check wall stability: $E2 := 900 \cdot fm2 \quad E2 = 1.8 \times 10^6$ psi

$$Pe2 := 9.86 \cdot E2 \cdot \frac{334 \cdot \left[1 - 0.577 \cdot \left(\frac{4}{r2}\right)\right]^3}{h2^2} \quad Pe2 = 1.042 \times 10^3 \text{ lbs}$$

Since Pe2/4 = 260 lbs < 300 lbs, therefore N.G. Thus, try 12 inch CMU

ii) Tension limit:

$fa2 - fb2 = -5$ psi, tension < Ft, where Ft = 25 psi from Table 2.2.3.2

2. Check gravity load plus wind case with critical section at mid-height of the wall.
Maximum moment due to wind is 640 lb-ft

$Mmaxgw := 640 + 50 \quad Mmaxgw = 690$ ft-lb

$fbgw2 := \frac{Mmaxgw \cdot 12}{S2} \quad fbgw2 = 102$ psi

$fagw2 := 10 + \frac{720 \cdot 0.5}{31} \quad fagw2 = 22$ psi

i) Tension control $fagw2 - fbgw2 = -81$ psi. The wall is in tension!! N.G.
Thus, try 12 inch block

ii) Compression control

$\left(\frac{fagw2}{Fa2}\right) + \left(\frac{fbgw2}{Fb2}\right) = 0.227$

Therefore, OK for compression but wall thickness must be increased due to inadequate tension capacity and stability