

WALL #1 ELEMENTS

STENNIS RIVERINE

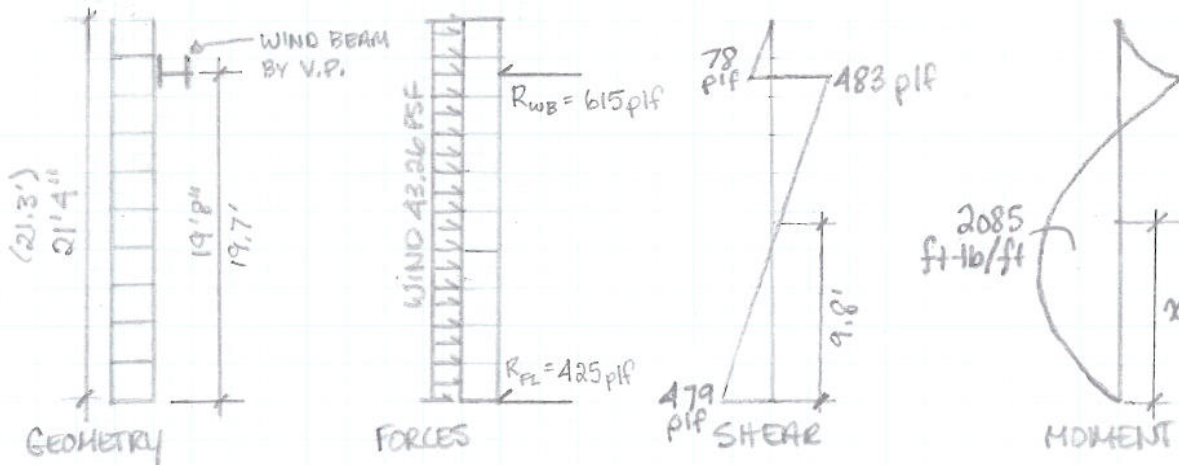
DESIGN OF REINFORCED CMU NONLOADBEARING WALL FOR FLEXURE BLDG 2441 — WALL #1 ELEMENT A

MATERIALS:

UNIT STRENGTH	4050 psi
MORTAR	TYPE N
f'_m	2500 psi
E_m	2.25×10^4
n	12.89
REINFORCEMENT	GRADE 60

LOADING:

WIND 130 MPH = 43.26 psf
NEGLECT SELF WEIGHT



REACTIONS:

$$R_{WB} = \text{REACTION @ WIND BEAM} = \frac{43.3 \cdot (21.3)^2}{2} = 615 \text{ plf}$$

$$R_{FL} = \text{REACTION @ FLOOR} = 43.3 \cdot \left(\frac{(19.7)^2}{2} - \frac{(1.6)^2}{2} \right) = 425 \text{ plf}$$

$$x = \frac{425}{43.3} = 9.8'$$

$$M = 425 \text{ plf} \cdot \left(\frac{9.8'}{2} \right) = 2085 \text{ ft-lb}$$

ESTIMATE REINFORCEMENTS:

Try 8" CMU, ASSUME STEEL @ MID DEPTH

$$d = \frac{7.625''}{2} = 3.8''$$

$$A_s = \frac{M}{F_s j d} = \frac{2085 \text{ ft-lb} \cdot 12}{24000 \text{ psi} \cdot 0.9 \cdot 3.8} = 0.3 \text{ in}^2$$

USE 1/3 ALLOWABLE SAFETY FACTOR

$$A_s = \frac{2085 \text{ ft-lb} \cdot 12}{24000 \text{ psi} \cdot 0.9 \cdot 1.33 \cdot 3.8} = 0.2 \text{ in}^2$$

DESIGN STRENGTH

USING 24" WIDE STRIP DESIGN MOMENT = 2085 ft-lb \cdot 2 = 4170 ft-lb.

$$p = \frac{A_s}{b \cdot d} = \frac{0.20 \text{ in}^2}{24 \cdot 3.8} = 0.002$$

$$pn = 0.002 \cdot 15.26 = 0.03$$

$$K^2 + 2pnK - 2pn = 0$$

$$K^2 + 0.06K - 0.06 = 0$$

$$j = 1 - \frac{K}{3} = 0.928$$

$$K = \frac{-0.06 \pm \sqrt{(0.06)^2 - 4(1)(-0.06)}}{2}$$

$$K = \frac{-0.06 \pm 0.19}{2} = 0.215''$$

ALLOWABLE CAPACITY IN TENSION

TRY #4 @ 12" O.C

$$M_t = A_s j d F_s = 0.4 \text{ in}^2 \cdot 0.9 \cdot 3.8'' \cdot 24000 \text{ psi} \cdot \frac{1.33}{12} = 3640 \text{ ft-lb/ft.}$$

3640 < 4170 ft-lb/ft. DOES NOT WORK

TRY #5 @ 12" O.C.

$$M_t = 0.62 \text{ in}^2 \cdot 0.9 \cdot 3.8'' \cdot 24000 \text{ psi} \cdot \frac{1.33}{12} = 5640 \text{ ft-lb/ft.}$$

5640 > 4170 ft-lb/ft. \therefore OK

ALLOWABLE CAPACITY IN COMPRESSION

$$F_b = \frac{1}{3} f'_m \cdot 1.33 = \frac{1}{3} (1500) \cdot 1.33 = 665 \text{ psi}$$

$$M_m = \frac{bd^2}{2} \cdot K \cdot j \cdot F_b = \frac{24'' \cdot 3.8''^2}{2} (0.215)(0.928) \frac{665 \text{ psi}}{12} = 1916 \text{ ft-lb}$$

1916 < 4170 ft-lb/ft DOES NOT WORK

ASSUME NEW f'_m

$$\text{ESTIMATE REQ'D STRENGTH: } \frac{4170}{1916} \cdot 1500 \text{ psi} = 3265 \text{ psi UNIT STRENGTH}$$

NEW $f'_m = 2500 \text{ psi}$ - TYPE N MORTAR \Rightarrow 4,050 psi UNIT STRENGTH

$$F_b = 1795 \text{ psi}$$

$$M_m = 5170 \text{ ft-lb/ft} \quad \therefore \text{OK}$$

USE #5 @ 12" O.C. w/ 8" CMU (2500psi) TYPE N MORTAR

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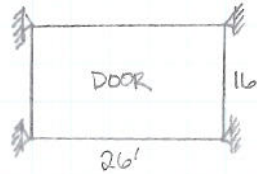
DESIGN OF REINFORCED CMU NONLOADBEARING WALL FOR FLEXURE
BLDG 2441 ELEMENT B (DESIGN FOR 26' x 16' OPENING)

MATERIALS:

UNIT STRENGTH	4050 psi
MORTAR	TYPE N
f'_m	2500 psi
E_m	2.25×10^6 psi
n	12.89
REINFORCEMENT	GRADE 60

LOADING:

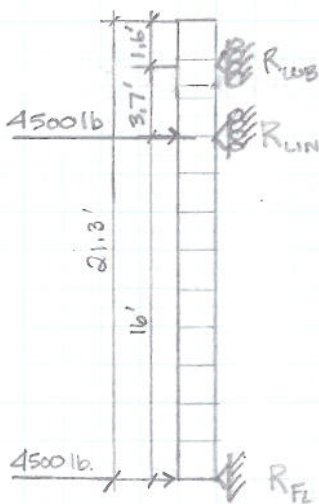
WIND 130 MPH = 43.26 psf
NEGLECT SELF WEIGHT



$$R = \frac{(16 \cdot 26 \cdot 43.3)}{4}$$

$$R = 4500 \text{ lbs}$$

REACTIONS @ LINTEL AND FLOOR FROM DOOR



$$R_{LIN} = \left(\frac{4500 \text{ lbs} \cdot 16'}{16'} \right) = 4500 \text{ lbs} = 346 \text{ plf}$$

$$R_{FL} = \left(\frac{4500 \text{ lbs} \cdot 0'}{16'} \right) + 4500 \text{ lbs} = 4500 \text{ lbs}$$

TOTAL = 9000 lbs.

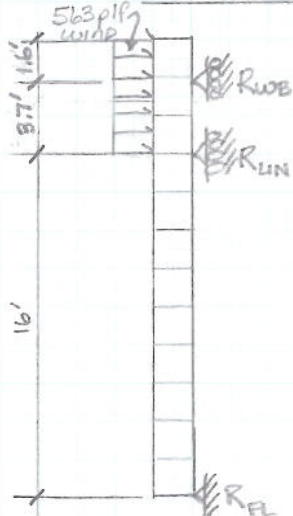
ACTUAL: $[43.3 \text{ psf} \cdot (13' \cdot 16')] = 9000$

MAXIMUM MOMENT = $0 \text{ lbs} \cdot 16' = 0 \text{ ft-lb/ft}$

∴ OK

$$\text{WIND LOAD} = W = \frac{(26' \cdot 43.3 \text{ psf})}{2} = 563 \text{ plf}$$

REACTIONS @ WIND BEAM AND LINTEL FROM AREA ABOVE DOOR:



$$R_{WB} = \left(\frac{43.3 \cdot (5.3)^2 / 2}{3.7'} \right) = 164.4 \text{ plf} (13') = 2136 \text{ lbs}$$

$$R_{LIN} = \left[43.3 \left(\frac{3.7^2}{2} - \frac{16^2}{2} \right) \right] / 3.7' = 65.1 \text{ plf} (13') = 847 \text{ lbs}$$

2983 lbs

$$x = \frac{65.1}{43.3} = 1.5'$$

ACTUAL = $[43.3 \text{ psf} (5.3' \cdot 13')] = 2983$

∴ OK

$$\text{MAX MOMENT} = (164.4 - 65.1) \left(\frac{1.5}{2} \right) = 74.8 \text{ ft-lb/ft}$$

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MOMENT @ HEAD LOCATION FROM UNIFORM WIND ON WAU. ELEM. B

$$\text{MAX MOMENT} = 425 \text{ plf} \cdot 21.3' - 43.3 \text{ psf} \left(\frac{116^2}{2} \right) = 1260 \text{ ft.-lb./ft.}$$

DESIGN MOMENT

ASSUME 32" JAMB

$$\begin{aligned} \text{MAX MOMENT} &= (74.8 \text{ ft.-lb./ft} \cdot 13') + (1260 \text{ ft.-lb./ft} \cdot 2.67') \\ &= (9724 \text{ ft.-lb.} + 3364 \text{ ft.-lb.}) = 13,088 \text{ ft.-lb.} \end{aligned}$$

ESTIMATE REINFORCEMENT:

8" CMU ASSUME $J=0.9$ FOR ESTIMATE $d=3.8"$

$$A_s = \frac{M}{F_s J d} = \frac{13088 \text{ ft-lb} \cdot 12 \text{ in/ft}}{24000 \text{ psi} \cdot 0.9 \cdot 1.33 \cdot 3.8"} = 1.4 \text{ in}^2/\text{ft.}$$

TRY (8) #4 REBAR PER FOOT

ALLOWABLE CAPACITY IN TENSION

$$M_t = A_s \cdot j \cdot d \cdot F_s = 1.6 \text{ in}^2 \cdot 0.9 \cdot 3.8" \cdot 24000 \text{ psi} \cdot \frac{1.33}{12} = 14555 \text{ ft-lb.}$$

$M_t > \text{REQ. } M: 13,088 \text{ ft-lb.} \therefore \text{OK}$

ALLOWABLE CAPACITY IN COMPRESSION

$$p = \frac{(1.6)^2}{32 \text{ in} \cdot 3.8"} = 0.02 \quad np = 12.89 \cdot 0.02 = 0.2578$$

$$K = \frac{-0.5 \pm \sqrt{0.5^2 - 4 \cdot 1 \cdot (-0.5)}}{2}$$

$$j = \left(1 - \frac{K}{3}\right) = \left(1 - \frac{0.5}{3}\right) = 0.83$$

$$K = \frac{-0.5 \pm 1.5}{2} = 0.5$$

$$M_m = \frac{bd^2}{2} \cdot K \cdot j \cdot F_b = \frac{32 \text{ in} \cdot 3.8^2}{2} (0.5)(0.83) \frac{1795 \text{ psi}}{12} = 14342 \text{ ft-lb.}$$

$$F_b = \frac{1}{3}(4050) \cdot 1.33 = 1795 \text{ psi}$$

$M_m > \text{REQ } M: 13,088 \text{ ft-lb.} \therefore \text{OK}$

