Lovejeet Gehlot

Masonry Walls

Lab Recitation #11
Group #3

April 1 2020
University of Michigan, TCAUP

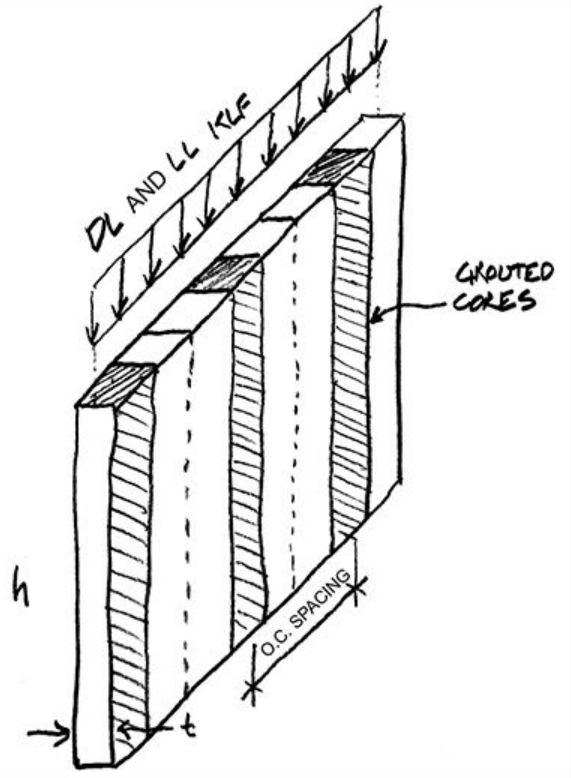
Masonry Walls

11. Masonry Walls

Using the strength method for axial compression described in TMS 402, determine the safety of the given concrete masonry wall (pass or fail). Calculate the factored nominal axial strength, phi_Pn and compare it to the required strength, Pu for the given loads. (loads are given without factors)

DATASET: 1 -2- -3-

Height of wall, h	21 FT
Nominal thickness of wall	16 IN
grouted cells o.c. spacing	40 IN
Masonry compressive strength, f'm	1500 PSI
The wall DL	17 KLF
The wall LL	13 KLF



Q#1 Actual wall thickness, t

T = 16” - ⅜” = 15 ⅝ “

(given) (common)

= **15.625”**

3/8" Mortar Joint Between Bricks (Most Common)

BRICK TYPE	SPECIFIED SIZE D X H X L (INCHES)	NOMINAL SIZE D X H X L	VERTICAL COURSE
Standard	3 5/8 x 2 1/4 x 8	Not modular	3 courses = 8"
Modular	3 5/8 x 2 1/4 x 7 5/8	4 x 2 2/3 x 8	3 courses = 8"
Norman	3 5/8 x 2 1/4 x 11 5/8	4 x 2 2/3 x 12	3 courses = 8"
Roman	3 5/8 x 1 5/8 x 11 5/8	4 x 2 x 12	1 course = 2"
Jumbo	3 5/8 x 2 3/4 x 8	4 x 3 x 8	1 course = 3"
Economy	3 5/8 x 3 5/8 x 7 5/8	4 x 4 x 8	1 course = 4"
Engineer	3 5/8 x 2 13/16 x 7 5/8	4 x 3 1/5 x 8	5 courses = 16"
King	2 3/4 x 2 5/8 x 9 5/8	Not modular	5 courses = 16"
Queen	2 3/4 x 2 3/4 x 7 5/8	Not modular	5 courses = 16"
Utility	3 5/8 x 3 5/8 x 11 5/8	4 x 4 x 12	1 course = 4"

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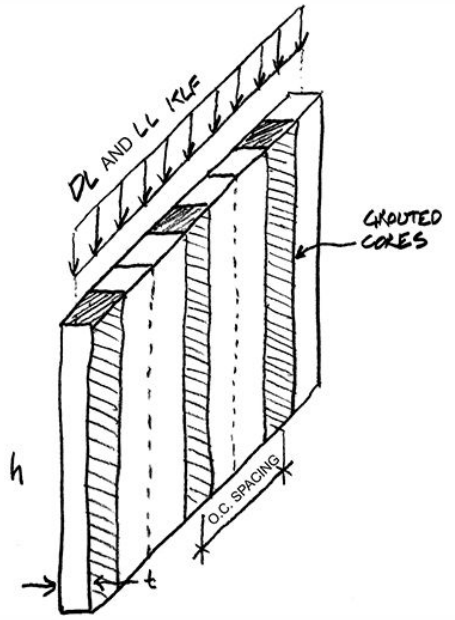

Q#2 Net area per foot of wall, A_n

Find A_n at Tek 14 - 1B table (available in canvas)

DATASET: 1	-2-	-3-
Height of wall, h		21 FT
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An = **63**

Look for 40” grout spacing

Table 7—16-inch (406-mm) Single Wythe Walls, 1¼ in. (32 mm) Face Shells (standard)

7a: Horizontal Section Properties (Masonry Spanning Vertically)

Unit	Grout spacing (in.)	Mortar bedding	Net cross-sectional properties[A] A_n (in.²/ft)	I_n (in.⁴/ft)	S_n (in.³/ft)	Average cross-sectional properties[B] A_{avg} (in.²/ft)	I_{avg} (in.⁴/ft)	S_{avg} (in.³/ft)	r_{avg} (in.)
Hollow	No grout	Face shell	30.0	1,553.7	198.9	63.2	2,030.6	259.9	5.67
Hollow	No grout	Full	63.2	2,030.6	259.9	63.2	2,030.6	259.9	5.67
100% solid/solidly grouted		Full	187.5	3,814.7	488.3	187.5	3,814.7	488.3	4.51
Hollow	16	Face shell	112.4	2,737.2	350.4	123.5	2,896.2	370.7	4.84
Hollow	24	Face shell	85.0	2,342.7	299.9	103.4	2,607.7	333.8	5.02
Hollow	32	Face shell	71.2	2,145.5	274.6	93.4	2,463.4	315.3	5.14
Hollow	40	Face shell	63.0	2,027.1	259.5	87.3	2,376.9	304.2	5.22
Hollow	48	Face shell	57.5	1,948.2	249.4	83.3	2,319.1	296.9	5.28
Hollow	72	Face shell	48.3	1,816.7	232.5	76.6	2,223.0	284.5	5.39
Hollow	96	Face shell	43.7	1,751.0	224.1	73.3	2,174.9	278.4	5.45
Hollow	120	Face shell	41.0	1,711.5	219.1	71.3	2,146.0	274.7	5.49

Q#3 Net moment of inertia per foot of wall, I_n

Find moment of inertia, I_n at Tek 14 - 1B table (available in canvas)

DATASET: 1	-2-	-3-
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I_n = **2027.1**

Look for 40” grout spacing

Table 7—16-inch (406-mm) Single Wythe Walls, 1¹/₄ in. (32 mm) Face Shells (standard)

7a: Horizontal Section Properties (Masonry Spanning Vertically)

Unit	Grout spacing (in.)	Mortar bedding	Net cross-sectional properties[A] A_n (in.²/ft)	I_n (in.⁴/ft)	S_n (in.³/ft)	Average cross-sectional properties[B] A_{avg} (in.²/ft)	I_{avg} (in.⁴/ft)	S_{avg} (in.³/ft)	r_{avg} (in.)
Hollow	No grout	Face shell	30.0	1,553.7	198.9	63.2	2,030.6	259.9	5.67
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Q#4 Find radius of gyration per foot of wall

$$r = \sqrt{I/A}$$

(Ans3) (Ans2)

$$= \sqrt{2027.1/63}$$

$$= \mathbf{5.6724}$$

DATASET: 1 -2- -3-

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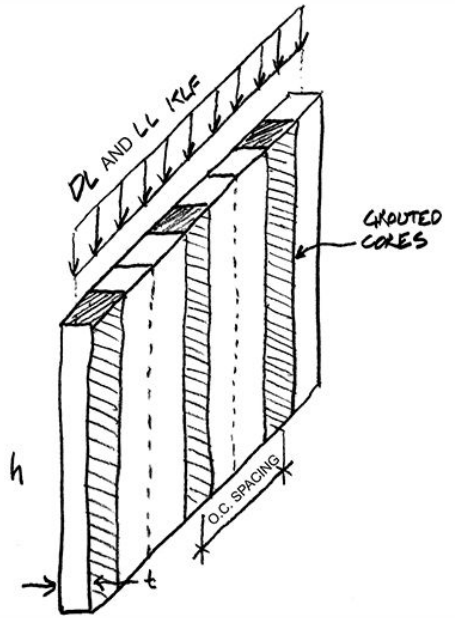

Q#5 Ratio of h/r

h/r

(given) (Ans4)

= (21 x 12) /5.6724

(convert h to inches) (Ans 4)

= **44.425**

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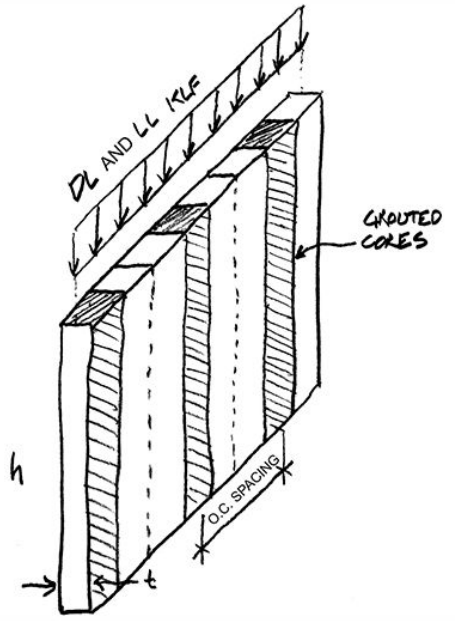

Q#6 Which tms equation is used, 11 or 12

h/r = 44.425

(Ans 5)

= 44.425 < 99

Hence use equation 3 - 11

11

(a) For members having an h/r ratio not greater than 99:

$$P_n = 0.80\left\{0.80 A_n f'_m \left[1-\left(\frac{h}{140r}\right)^2\right]\right\} \quad \text{(Equation 3-11)}$$

(b) For members having an h/r ratio greater than 99:

$$P_n = 0.80\left[0.80 A_n f'_m \left(\frac{70r}{h}\right)^2\right] \quad \text{(Equation 3-12)}$$

(find these equations at TMS 402, available in canvas)

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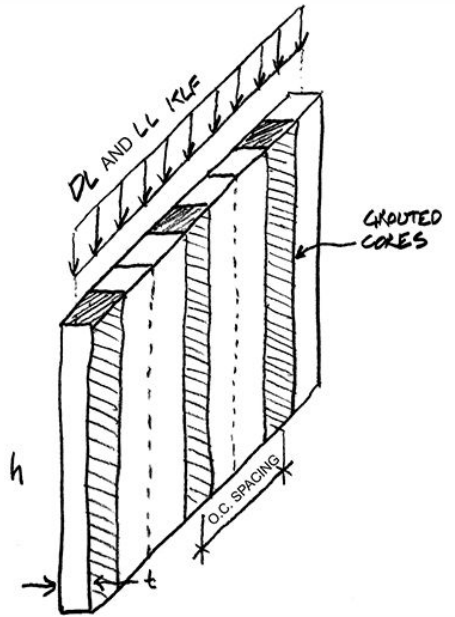

Q#7 Nominal axial strength, Pn

Using equation 3 - 11

(given) (given)

$$P_n = 0.80\left\{0.80 A_n f'_m \left[1-\left(\frac{h}{140r}\right)^2\right]\right\}$$

(Ans 2) (Ans4)

(a) For members having an h/r ratio not greater than 99:

$$P_n = 0.80\left\{0.80 A_n f'_m \left[1-\left(\frac{h}{140r}\right)^2\right]\right\} \quad \text{(Equation 3-11)}$$

(b) For members having an h/r ratio greater than 99:

$$P_n = 0.80\left[0.80 A_n f'_m \left(\frac{70r}{h}\right)^2\right] \quad \text{(Equation 3-12)}$$

(find these equations at TMS 402, available in canvas)

(An) (f'm in KSI) (h in inches) (r)

$$= 0.80[0.80 \times 63 \times 1.5 \times [1 - \{(21 \times 12)/(140 \times 5.6724)\}^2]$$

= **54.39**

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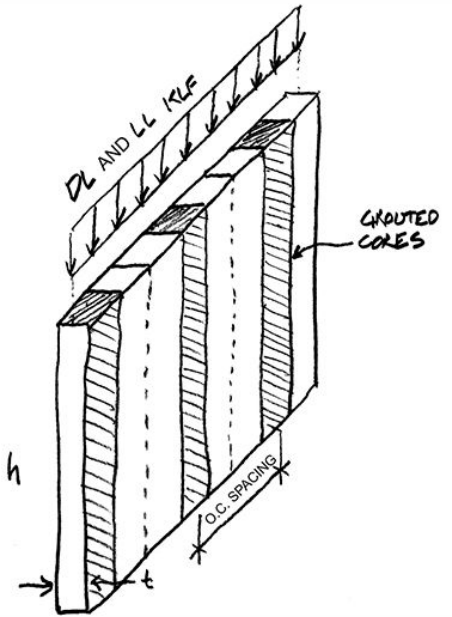

Q#8 Factored nominal axial strength, Phi_Pn

Phi_Pn = 0.9 x Pn

(Ans 7)

(Phi for axial force is 0.9)

= 0.9 x 54.39

= **48.95**

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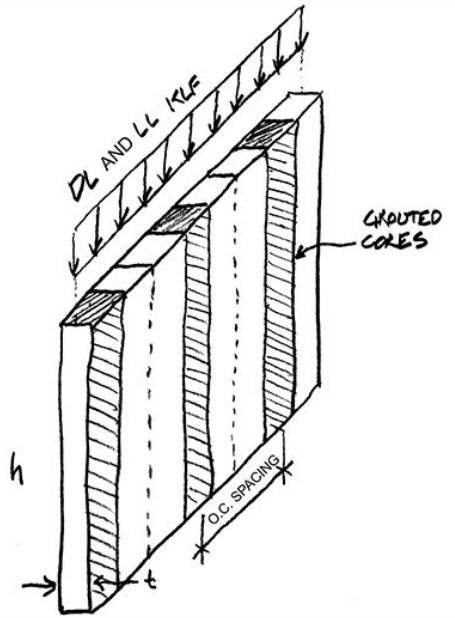

Q#9 Required axial strength, P_u

$P_u = 1.2\,(DL) + 1.6(LL)$

$= 1.2(17) + 1.6(13)$

$= \mathbf{41.2}$

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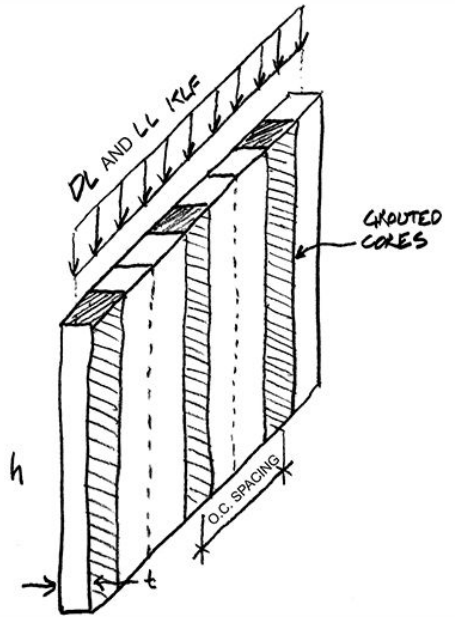

Q#10 Does the wall pass or fail?

If $P_u > \text{phi } P_n$ - Fail

If $P_u < \text{phi } P_n$ - Pass

41.2 < 49.95

(Pu, Ans 9) (phi Pn, Ans 8)

= **Pass**

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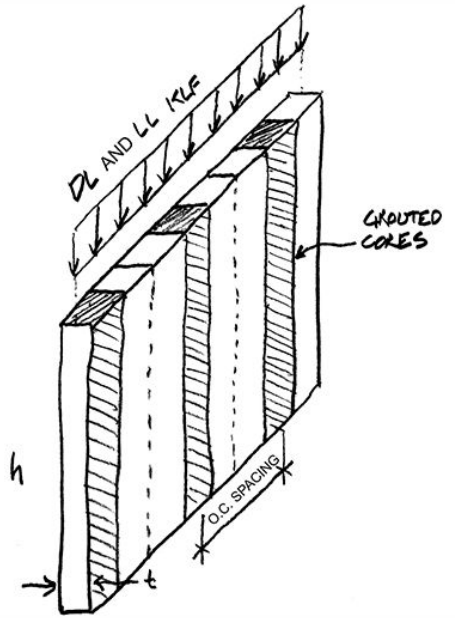

Any Questions?

Contact: gehlot@umich.edu