Arch 324
Structures II

Winter 2026 Recitation 004

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Recitation 004

Welcome to session 12! Last one!!

- Quick Lecture Recap
- Homework #11 Masonry Walls
- Lab: Masonry Walls

Tower Final Report Sunday 4/19!
Submit Course Evals! (Email me proof)

Feel free to ask questions anytime

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Lecture: Masonry Walls (4/15)

Analysis and Design

Empirical approach
- based on experience
- limits on lateral loading
- limits on height
- limits on eccentricity
- (basically, no flexure)
- non-reinforced

Rational approach
- based on Strength Design (LRFD)
- either reinforced or non-reinforced
- limited by strength

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Lecture: Masonry Walls (4/15)

Rational Masonry Analysis

Procedure

Strength Design (LRFD) – **non-reinforced**

Given: geometry, material

Find: axial compressive load capacity, Pn

1. Determine the masonry strength, f'm, based on unit strength, fu, and mortar type (table)
2. Find the net area, A_n, and Moment of Inertia, I_n (see NCMA TEK 14-1B with HW problem pdf.)
3. Calculate radius of gyration, $r = \sqrt{I/A}$
4. Calculate h/r
5. Choose the axial strength equation, Pn:
   If $h/r < 99$ use TMS 402 eq.9-11
   If $h/r > 99$ use TMS 402 eq.9-12
6. Calculate øPn where ø for axial force = 0.90
7. Check that øPn is greater than Pu.

Rational Approach
for axial compression
using TMS 402 (2016)

(Equation 9-11) for h/r < 99

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

(Equation 9-12) for h/r > 99

$$P_n = 0.80\left[0.80 A_n f'_m\left(\frac{70r}{h}\right)^2\right]$$

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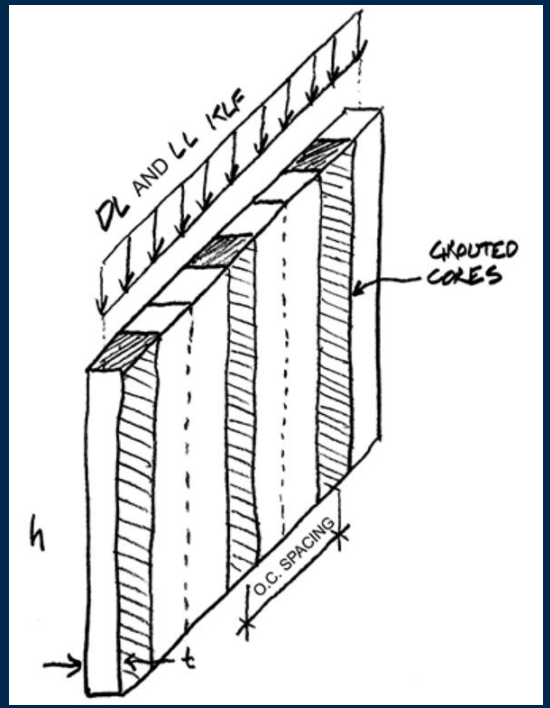
HW #11: Composite Sections

Using the strength method for axial compression (masonry spanning vertically) 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)

Height of wall, h	15 FT
Nominal thickness of wall	10 IN
grouted cells o.c. spacing	32 IN
Masonry compressive strength, f'm	3000 PSI
The wall DL	28 KLF
The wall LL	21 KLF



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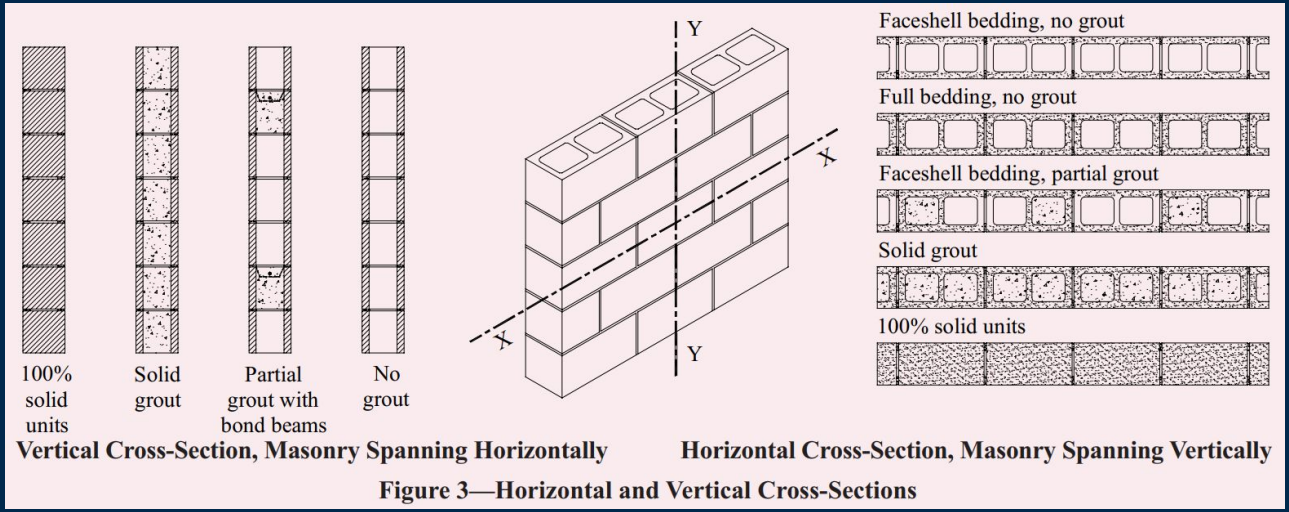
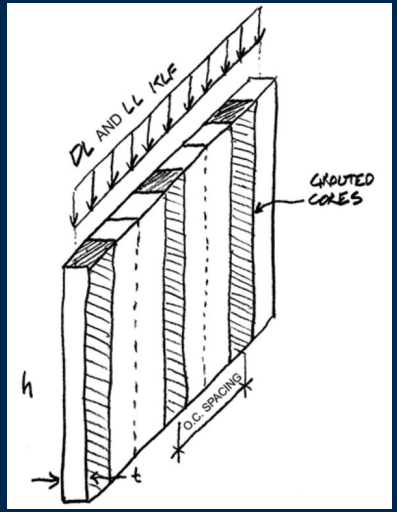
HW #11: Composite Sections



NCMA TEK 14 - 1B



HW - Given

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HW #11: Composite Sections

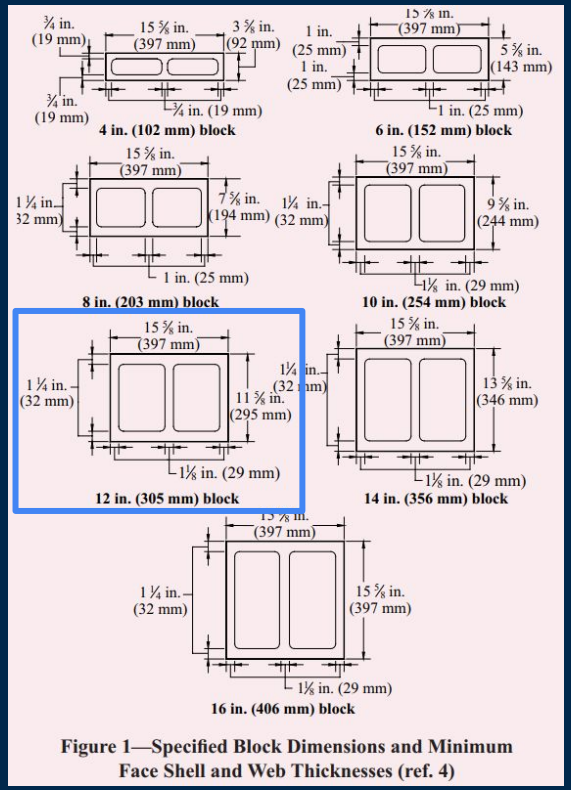
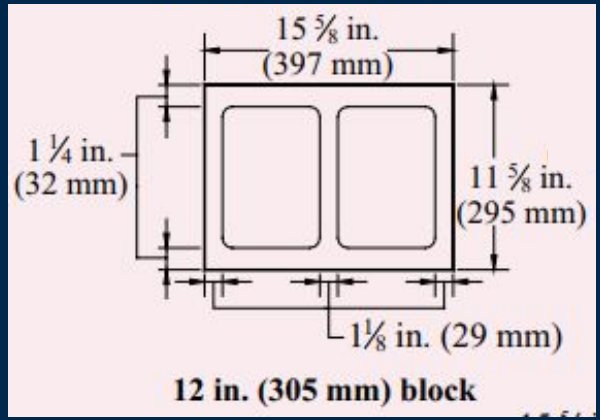


Figure 1—Specified Block Dimensions and Minimum Face Shell and Web Thicknesses (ref. 4)

NCMA TEK 14 - 1B



Given nominal thickness = 12”

Actual wall thickness = 11 ⅝” Q1

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HW #11: Composite Sections

Table 5—12-inch (305-mm) Single Wythe Walls, $1^1/_4$ in. (32 mm) Face Shells (standard)

5a: 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	811.2	139.6	53.1	971.5	167.1	4.28
Hollow	No grout	Full	53.1	971.5	167.1	53.1	971.5	167.1	4.28
100% solid/solidly grouted		Full	139.5	1,571.0	270.3	139.5	1,571.0	270.3	3.36
Hollow	16	Face shell	87.3	1,208.9	208.0	95.0	1,262.3	217.2	3.64
Hollow	24	Face shell	68.2	1,076.3	185.2	81.0	1,165.4	200.5	3.79
Hollow	32	Face shell	58.7	1,010.1	173.8	74.1	1,116.9	192.2	3.88
Hollow	40	Face shell	52.9	970.3	166.9	69.9	1,087.8	187.2	3.95
Hollow	48	Face shell	49.1	943.8	162.4	67.1	1,068.4	183.8	3.99
Hollow	72	Face shell	42.7	899.6	154.8	62.4	1,036.1	178.3	4.07
Hollow	96	Face shell	39.6	877.5	151.0	60.1	1,020.0	175.5	4.12
Hollow	120	Face shell	37.6	864.2	148.7	58.7	1,010.3	173.8	4.15

Q2 Q3

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HW #11: Composite Sections

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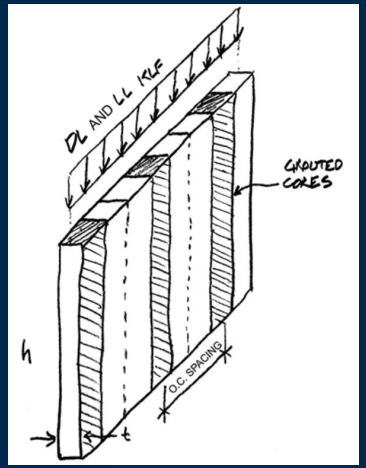

4. Radius of gyration per foot of wall

$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{624.6\ in^4}{52.4\ in^2}} = 3.45\ in$ (I: #3, A: #2)

5. Ratio of h/r

$\frac{\text{height of wall}}{\text{radius}} = \frac{15 \times 12}{3.45} = 52.17 < 99$ (convert; radius: #4)

7. Nominal axial strength

$P_n = 0.80\left\{0.80 A_n f'_m \left[1 - \left(\frac{h}{140r}\right)^2\right]\right\}$ (#2, #4)

$= 0.80\left\{0.80(52.4)(3000)\left[1 - \left(\frac{15 \times 12}{140(3.45)}\right)^2\right]\right\}$ (convert)

$= 0.80\,(108{,}294.007)$

$= 86{,}635.21 \times \frac{1}{1000}$ - convert!

$= 86.64\ KLF$

(Equation 9-11) for h/r < 99

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

(Equation 9-12) for h/r > 99

$$P_n = 0.80\left[0.80 A_n f'_m \left(\frac{70r}{h}\right)^2\right]$$

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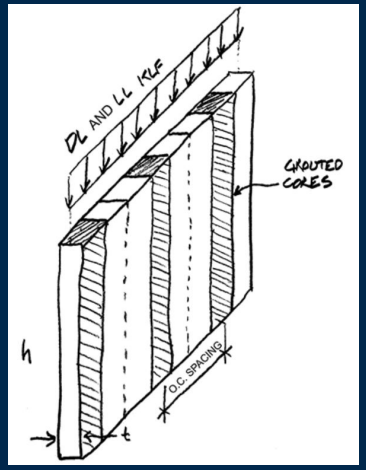

8. Factored nominal strength

$\phi P_n = 0.9(86.64)$

$= \boxed{77.97 \text{ KLF}}$

9. Axial strength required by loads

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

$= 1.2(28) + 1.6(21)$

$= \boxed{67.2 \text{ KLF}} < \phi P_n = 77.97$

✓PASS ☺

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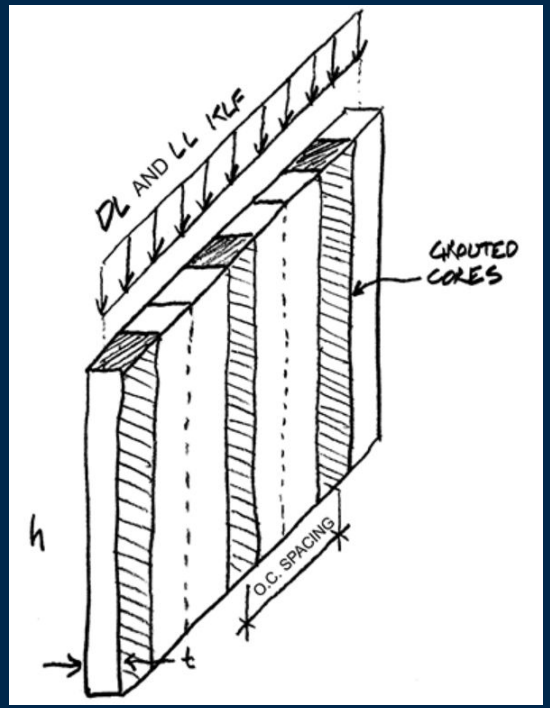

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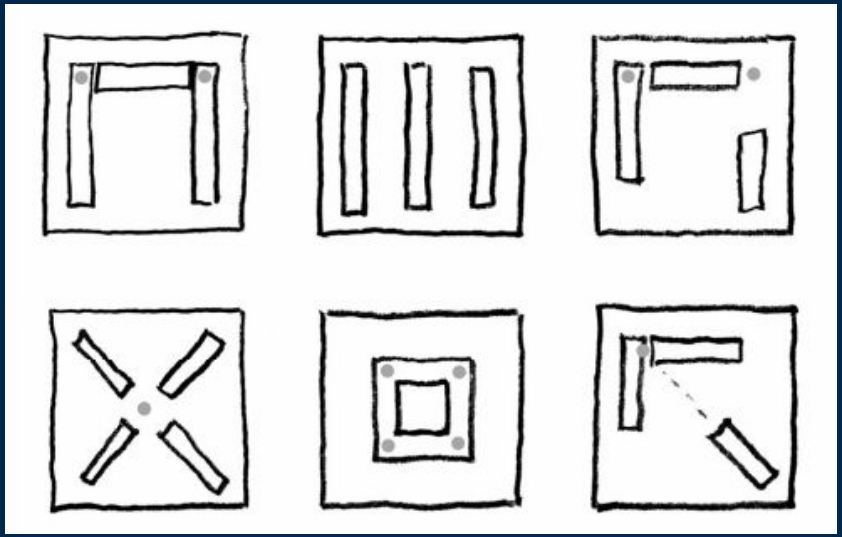

Lab: Masonry Walls

<u>Reminders</u>:
Tower Report Due Sunday!
Send me proof of completed course evals for bonus points!

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