Structure II Recitation 4/12

Masonry Walls

Before we start ...

Today's Tasks:

Homework Example (Masonry Walls)

Lab Session (Lateral Stability)

Reminder:

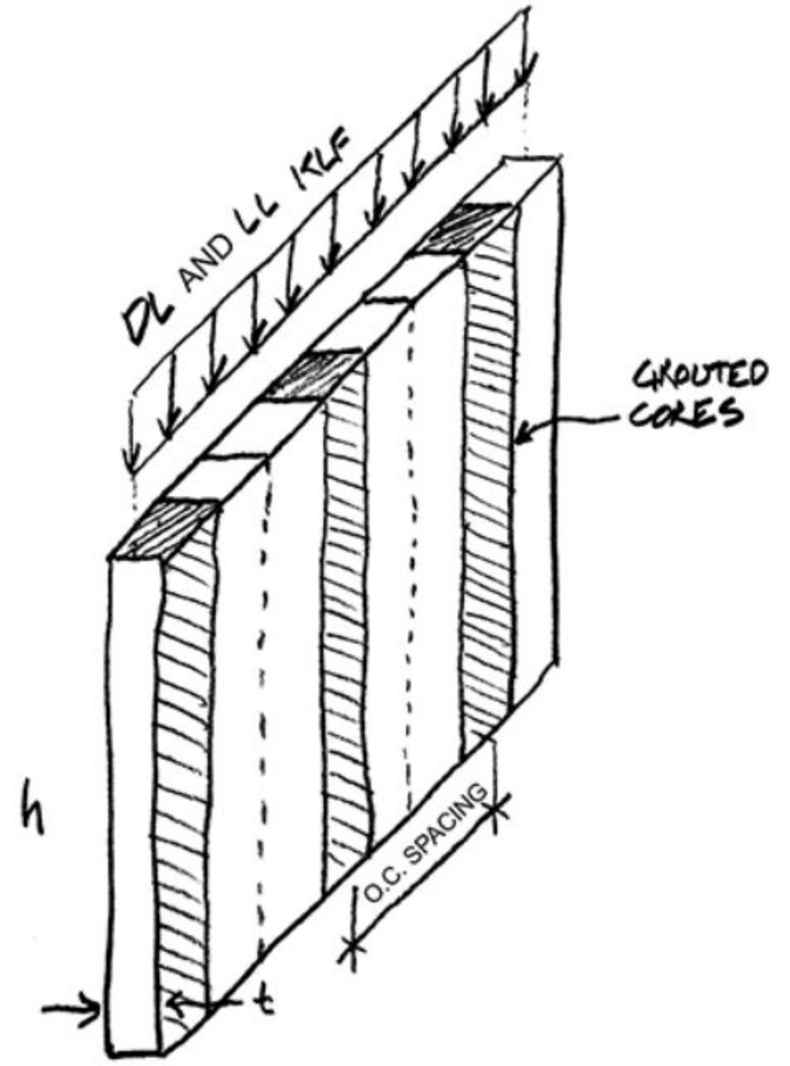
Course Evaluation (Bonus 20 points!!)

11. Masonry Walls

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)

DATASET: 1 -2- -3-

Height of wall, h	15 FT
Nominal thickness of wall	10 IN
grouted cells o.c. spacing	40 IN
Masonry compressive strength, f'm	2000 PSI
The wall DL	17 KLF
The wall LL	13 KLF



Rational Masonry Analysis

Procedure

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

Rational Approach

for axial compression

using TMS 402 (2016)

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.

(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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Q1: Actual Wall Thickness (t)

t

= thickness of the wall - 3/8"

= 10 - 3/8"

= **9.625 in**

Q2 & Q3: Net Area Per Foot of Wall (An) & Net Moment of Inertia Per Foot of Wall (In)

Look at Table TEK 14 - 1B (Canvas)

Answer: **An = 47.9 in²/ft, In = 605.7 in⁴/ft**

Table 4 — 10-inch (254-mm) Single Wythe Walls, 1¼ in. (32 mm) Face Shells (standard)

Step 1

4a: 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	530.0	110.1	48.0	606.3	126.0	3.55
Hollow	No grout	Full	48.0	606.3	126.0	48.0	606.3	126.0	3.55
100% solid/solidly grouted		Full	115.5	891.7	185.3	115.5	891.7	185.3	2.78
Hollow	16	Face shell	74.8	719.3	149.5	80.8	744.7	154.7	3.04
Hollow	24	Face shell	59.8	656.2	136.3	69.9	698.6	145.2	3.16
Hollow	32	Face shell	52.4	624.6	129.8	64.4	675.5	140.4	3.24
Hollow	40	Face shell	47.9	605.7	125.9	61.1	661.6	137.5	3.29
Hollow	48	Face shell	44.9	593.1	123.2	58.9	652.4	135.6	3.33

Step 2

Q4: Radius of Gyration Per Foot of Wall (r)

$r = (In / An)^{0.5} = (605.7 / 47.9)^{0.5} =$ **<u>3.55599 in</u>**

↑ Q3 ↑ Q2

Q5: Ratio of h/r

$h / r = 15 \times 12 / 3.55599 =$ **<u>50.6188</u>**

↑ Q4 ↑ Covert Unit (ft to in)

Q6: Which TMS Equation?

Check if your h/r < 99,

If yes – Equation 11, If no – Equation 12

For my situation use **<u>Equation 11</u>**

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

(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

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

Q7: Nominal Axial Strength (Pn)

Pn

$= 0.8 \times (0.8 \times A_n \times f'_m \times (1 - (h/140r)^2))$

(An: Q2; f'm: Given; h: Given; r: Q4)

$= 0.8 \times (0.8 \times 47.9\ \mathbf{in^2/ft} \times 2000\ \mathbf{lb/in^2} / 1000 \times (1 - (15\ \mathbf{ft} \times 12 / (140 \times 3.55599\ \mathbf{in}))^2))$

(1000: Pounds to Kips; 12: ft to in)

= **<u>53. 297 KLF (k/ft)</u>**

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Q8: Factored Nominal Axial Strength (ΦPn)

ΦPn = 0.9 x 53.297 = **47.967 KLF**

Q9: Axial Strength Required by Loads (Pu)

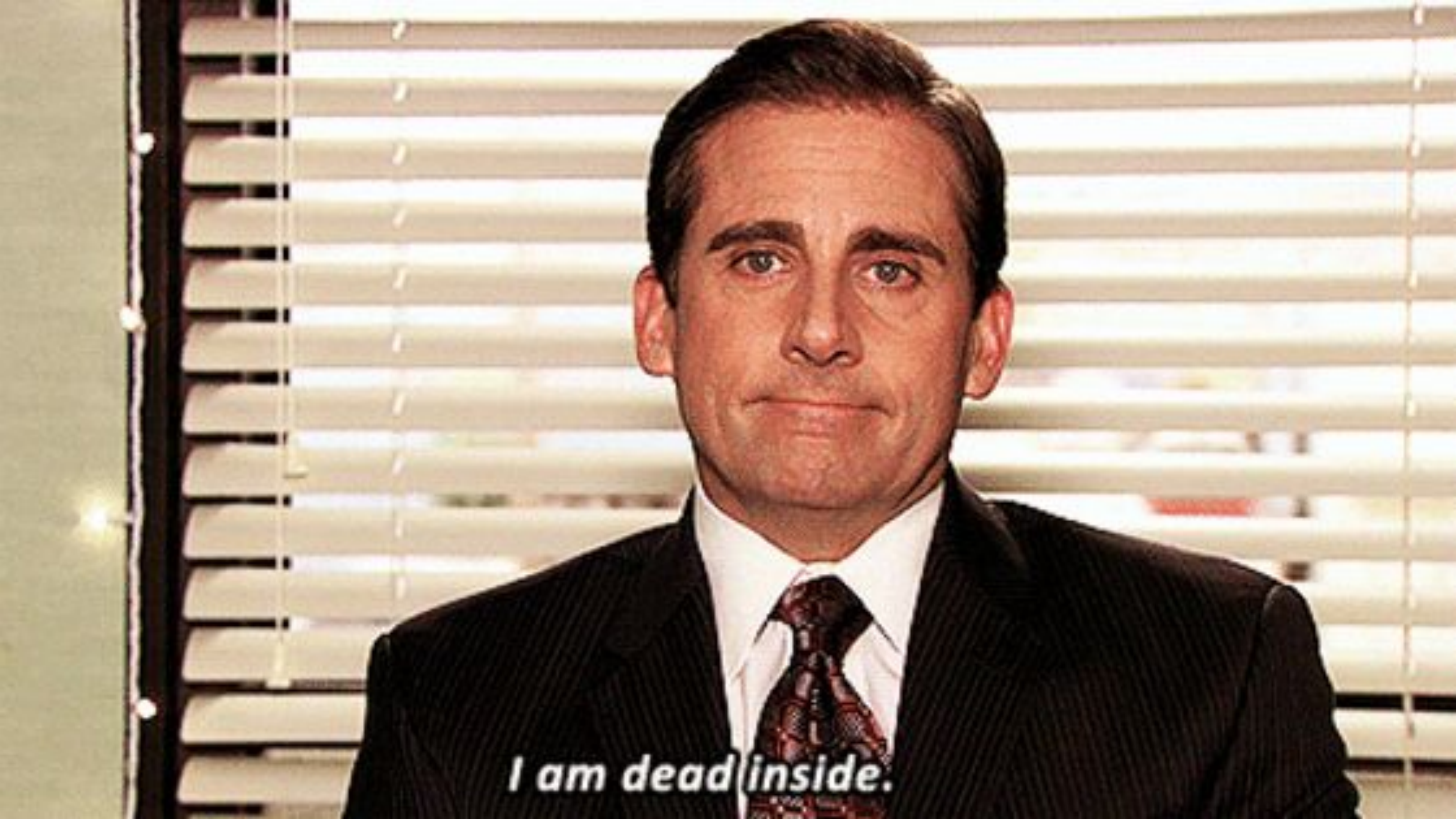
Pu = 1.2 x DL + 1.6 x LL = 1.2 x 17 + 1.6 x 13 = **41.2 KLF**

Q10: Does the Wall Pass or Fail?

Check if ΦPn is bigger than Pu,
If yes – Pass, If no – Fail

For my situation, ΦPn > Pu, **It's a Pass!**

$$M_u = \frac{(1.2w_{DL} + 1.6w_{LL})l^2}{8}$$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Lateral Stability

Description

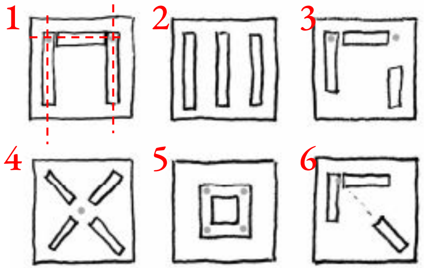
This project investigates stable arrangements of structural walls against lateral loading.

Goals

To observe the effects of lateral loading
To investigate the criteria of stable wall patters
To develop stable arrangements of shear walls based on the 2 point rule

Procedure

1. Arrange the small wood walls on the foam core base to support the MDF slab.
2. Make each of the six arrangements.
3. Apply lateral and torsional accelerations to the base and note the effects on the assembly. Mark on the diagrams below which fail and which remain stable.
4. Make your own stable and unstable arrangement.
5. Sketch the arrangements below and mark the intersection points.



Stable	Unstable

Due