Masonry Walls 4/12

HW – Masonry Walls

Lab – Lateral Stability

Structure II
Section 004

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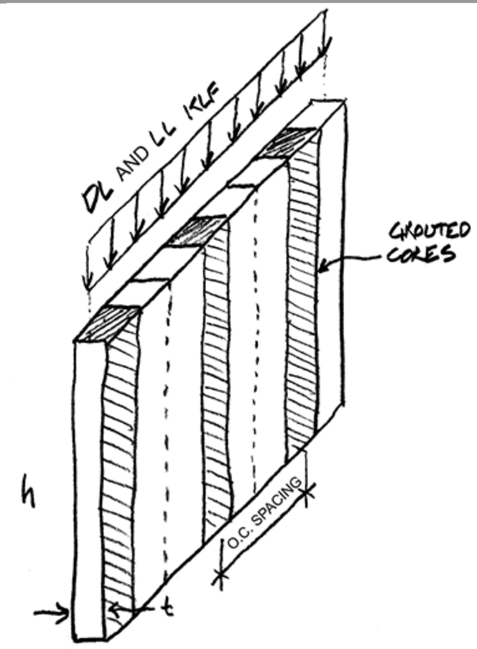
Using the strength method for axial compression (masonry spanning vertically) described in TMS 402, determine the safety of the given concrete masonry wall (pass or fail). Calculate the factored nominal axial strength, phi_Pn and compare it to the required strength, Pu for the given loads. (loads are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

DATASET: 1 -2- -3-

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



HW - Masonry Walls

Data:
geometry, material

Required:
axial compressive load capacity, Pn

1. Determine the masonry strength, f'm, based on unit strength, fu, and mortar type
2. Find the net area, An, and Moment of Inertia, In(see TEK 14-1B)
3. Calculate r = $\sqrt{I/A}$
4. Calculate h/r
5. Choose the axial strength equation, Pn: If h/r<99,useTMS402eq.3-11
   If h/r>99,useTMS402eq.3-12
6. Calculate øPn where ø for axial force = 0.90
7. Check that øPn is greater than Pu

(Equation 3-11) 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 3-12) 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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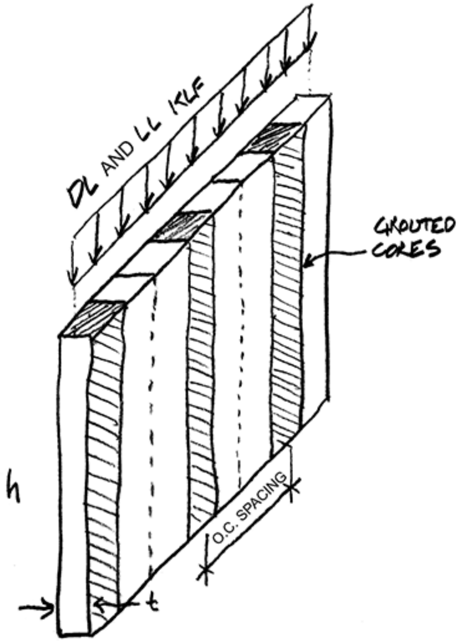

1. Actual wall thickness, t (see TEK 14-1B)

t = 9.625 in

2. Net area per foot of wall, An

An= 52.4 in²

3. Net moment of inertia per foot of wall,In

In= 624.6 in^4

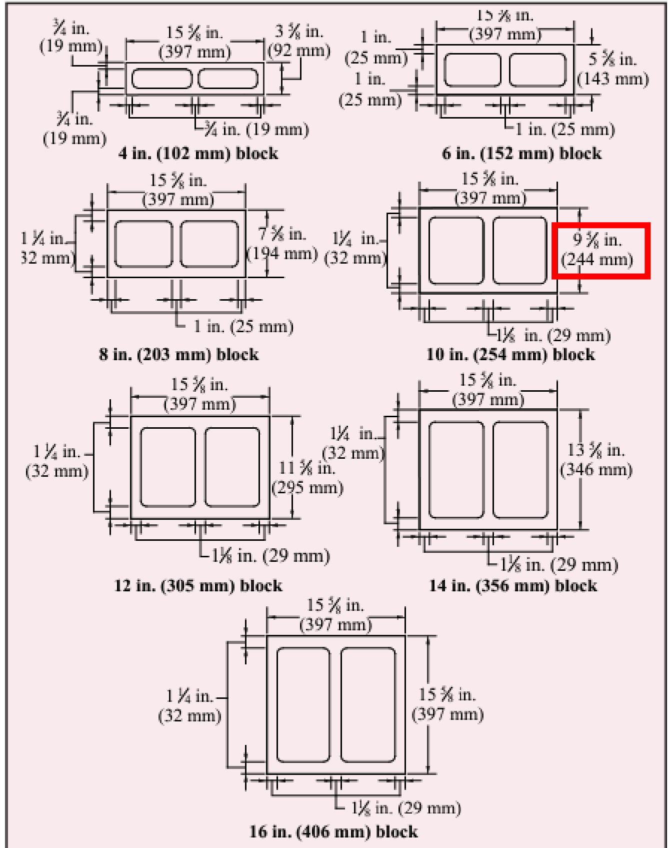

Figure 1—Specified Block Dimensions and Minimum Face Shell and Web Thicknesses (ref. 4)

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

4a: Horizontal Section Properties (Masonry Spanning Vertically)

			Net cross-sectional properties[A]			Average cross-sectional properties[B]			
Unit	Grout spacing (in.)	Mortar bedding	A_n (in.²/ft)	I_n (in.⁴/ft)	S_n (in.³/ft)	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
Hollow	72	Face shell	39.9	572.0	118.9	55.3	637.0	132.4	3.39
Hollow	96	Face shell	37.5	561.5	116.7	53.5	629.3	130.8	3.43
Hollow	120	Face shell	36.0	555.2	115.4	52.4	624.7	129.8	3.45

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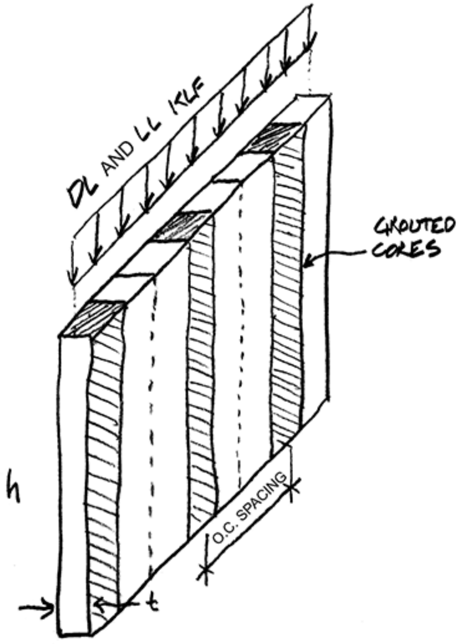

4. Radius of gyration per foot of wall

r = $\sqrt{In/An}$ = $\sqrt{624.6/52.4}$ = 3.45 in

5. Ratio of h/r

h/r = 15*12/3.45 = 52.17

6. Which TMS equation used? 11 or 12

h/r = 52.17 < 99 chose 3-11

(Equation 3-11) for h/r < 99

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

(Equation 3-12) for h/r > 99

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

7. Nominal axial strength, Pn

(Equation 3-11) for h/r < 99

$$P_n = 0.80\left\{0.80A_n f'_m\left[1-\left(\frac{h}{140r}\right)^2\right]\right\} = 0.8*\left\{0.8*52.4*3000*\left[1-\left(\frac{15*12}{140*3.45}\right)^2\right]\right\}/1000 = 86.64 \text{ klf}$$

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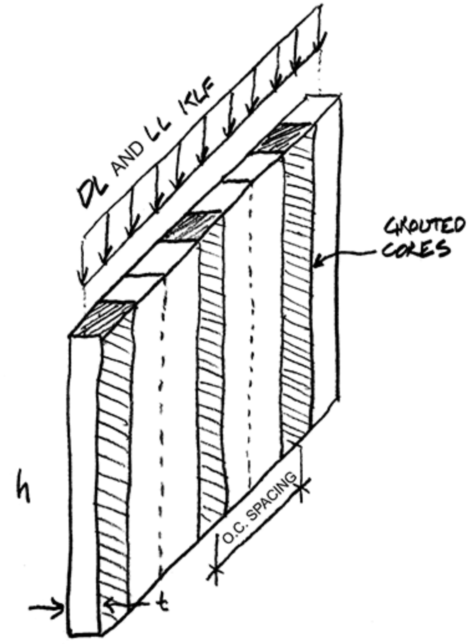


8. Factored nominal axial strength, phi_Pn

$øPn = 0.9 * 86.64 = 77.98$ klf

9. Required axial strength, Pu

$Pu = 1.2DL + 1.6LL = 1.2*28 + 1.6*21 = 67.2$ klf

10. Does the wall pass or fail?

$Pu = 67.2 < øPn = 77.98$ Pass!

Final Report

Reference Report

Tower Project Score Sheet

PRELIMINARY REPORT (re-submit with final report)	**40**	
TESTING	**60**	
Tower weight ≤ 4oz (15 pts); height = 48" (5 pts); holds ≥ 50 lbs (5 pts) Correct Materials (5 pts) (scaled if doesn't meet requirements)	30	
Efficiency (4/weight OZ)+(load LBS/50)+(load LBS/weight OZ)x1.5 (scaled based on class rank)	30	
FINAL REPORT REQUIREMENTS	**150**	
Preliminary Design Development	**20**	
How cross-sectional design of preliminary tower was chosen	4	
How elevation of preliminary tower was developed (e.g. bracing, taper, etc.)	4	
Why/how cross-section was or was not adjusted from preliminary report	4	
Why/how elevation of tower was or was not adjusted from preliminary report	4	
Discussion of how basic principles of columns supported these decisions	4	
Revised/Tested Tower Design Analysis [SHOW WORK AND UNITS!]	**50**	
Calculated/modeled axial forces and derivation of required member cross-sectional areas from axial forces (consider both crushing and buckling)	10	
Estimated weight calculation using actual member sizes used – include weight from members, glue, and gussets, etc.	7	
Member properties table: A, r, L, slenderness ratio (L/r), utilization ratio (actual load / allowable load)	7	
Indicate critical member (largest utilization ratio)	8	
Tower stability (as a whole) - buckling calculation	8	
Prediction of capacity of tower and mode of failure	10	
Illustration of Final/Tested Design	**20**	
Cross-section and elevations(s) of tower	5	
Perspective(s) or isometric of tower (no screenshots!)	5	
Overall dimensions labeled (height, width, etc.) with units	5	
Member sizes labeled (cross-sectional area, length of vertical members and cross-bracing) with units	5	
Testing Results	**30**	
Final weight and height of tower	6	
Tested capacity of tower	6	
Observations of testing (loading, any buckling observed, etc.)	6	
Description of mode of failure	6	
Images of failure	6	
Post-Testing Analysis	**30**	
Comparison of testing results with predicted capacity and modes of failure	10	
Discussion of discrepancies between results	10	
Suggested improvements for future designs with reasoning discussed	10	
FINAL GRADE	**250**	

(Note: re-submit your Preliminary Design Proposal with your Final Report.)

Due Apr 12th

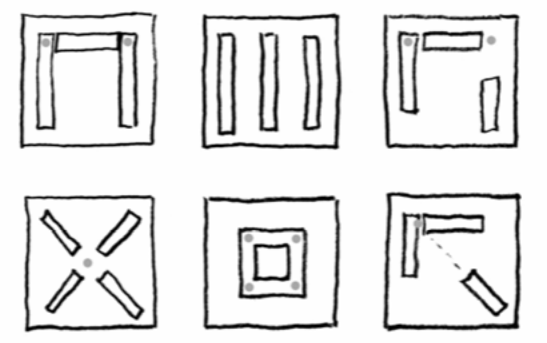
LAB - Lateral Stability

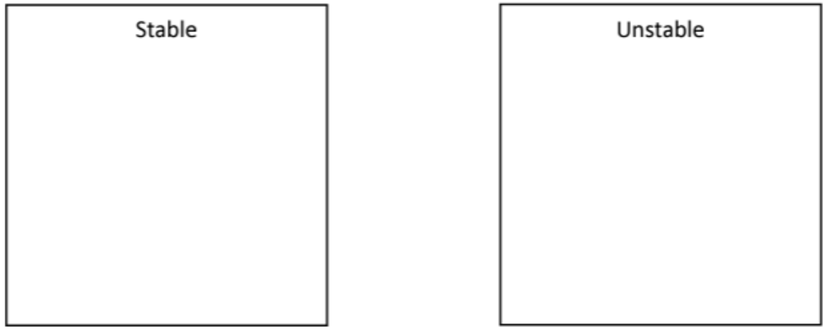
Procedure

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.

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 patterns
To develop stable arrangements of shear walls based on the 2 point rule

Any Questions?

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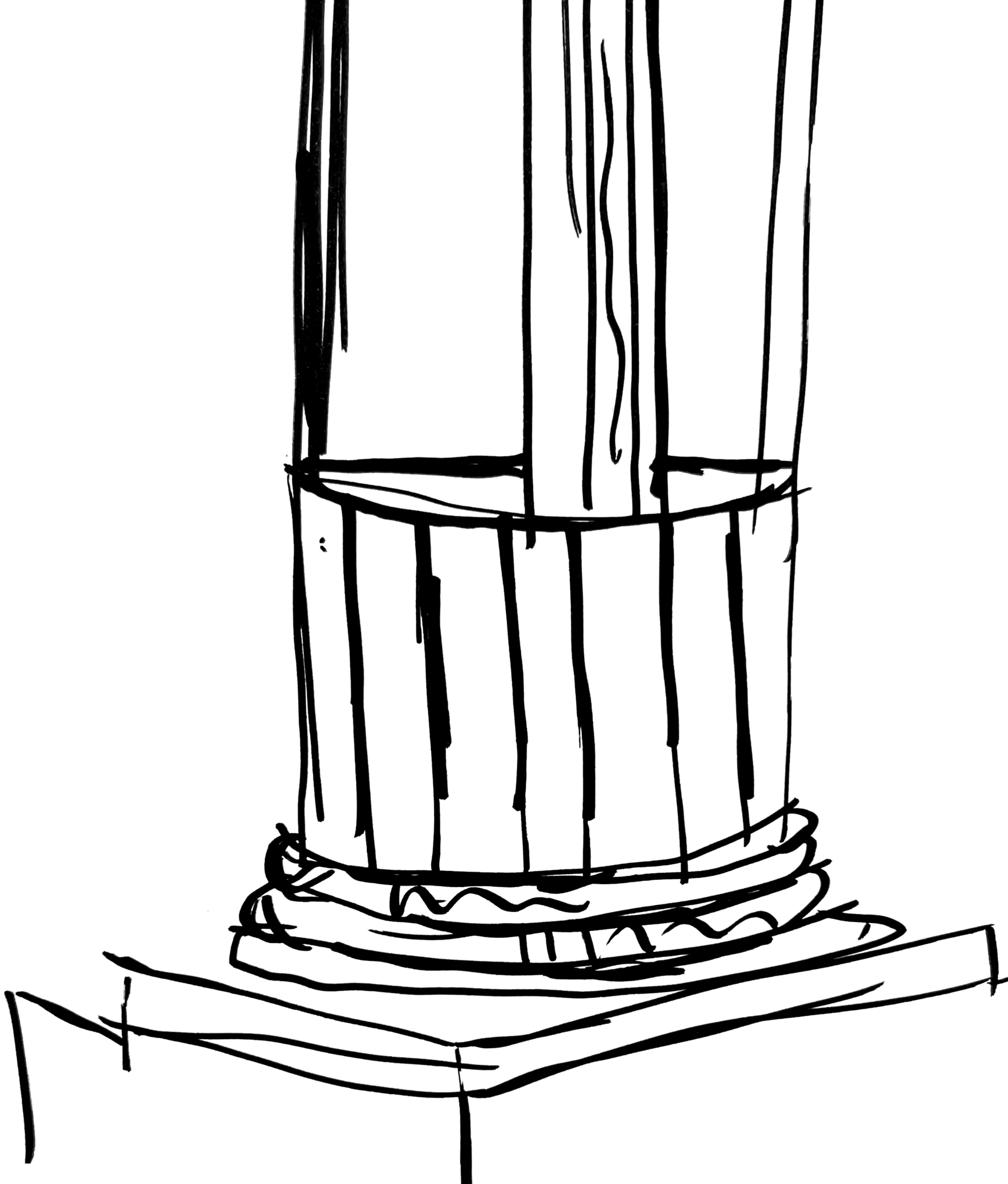

Thank You!