

Arch314

STRUCTURES I

Fall 2024
Recitation

FACULTY: Prof. Peter von Bülow
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Arch314: STRUCTURES I

Welcome to Recitation session 09/13

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Office hours:
By appointment

Please feel free to ask questions.

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Welcome to Recitation session 09/13

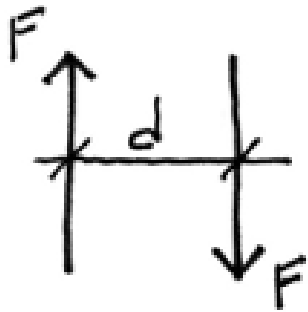
Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment (**Homework 3**)
- Answering student's questions
- Lab: **Moment of a Force**

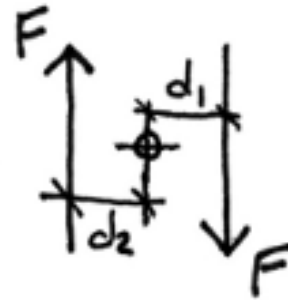
Please feel free to ask questions.

Recap of the week

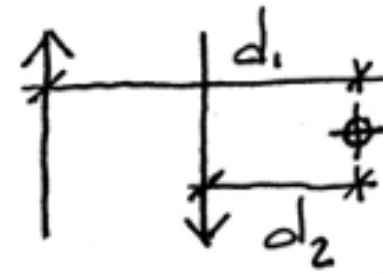
Force Couple



$$M = F \times d$$



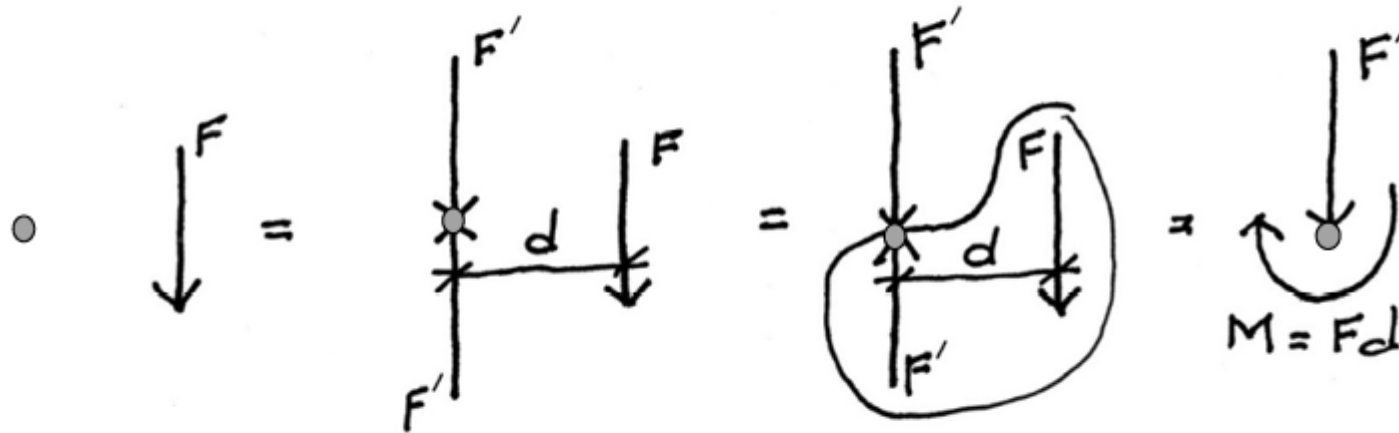
$$\begin{aligned} M &= F \times d_1 + F \times d_2 \\ &= F \times (d_1 + d_2) \\ &= F \times d \end{aligned}$$



$$\begin{aligned} M &= F \times d_1 - F \times d_2 \\ &= F \times (d_1 - d_2) \\ &= F \times d \end{aligned}$$

Recap of the week

Replacement of a force by a force + a couple



A force can be replaced (represented) by an equal force shifted some distance plus the moment of the original force times the shifted distance.

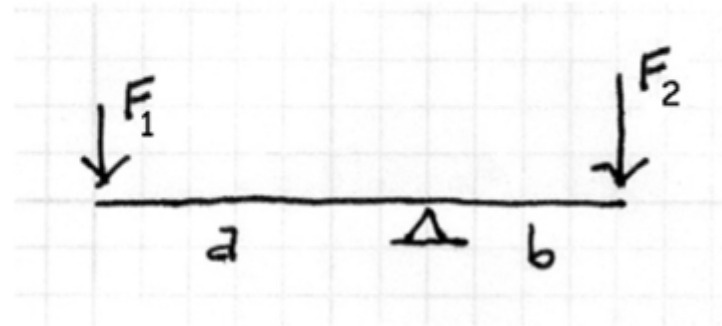
Recap of the week

Archimedes Lever

Two forces will balance at distances reciprocally proportional to their magnitudes.

$$\mathbf{F_1 \times a = F_2 \times b}$$

$$\mathbf{F_1 = F_2 \frac{b}{a}}$$



Provide the solution for the assignment – HW3

4. Moment of a Force

Find the total wind force (W) in LBS normal to the wall that would cause an overturning moment equal to the resisting moment from gravity (G).

DATASET: 1

-2-

-3-

Wall thickness

9 IN

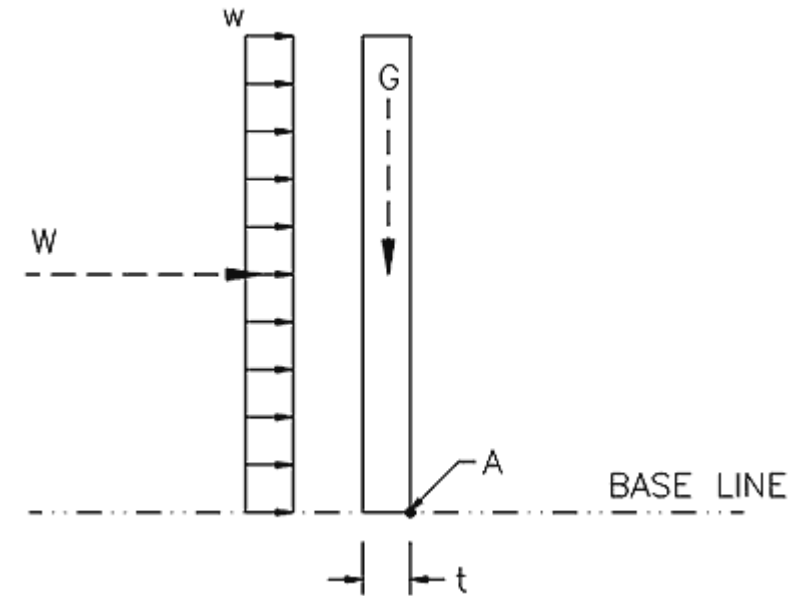
Density of wall

100 PCF

Height of wall

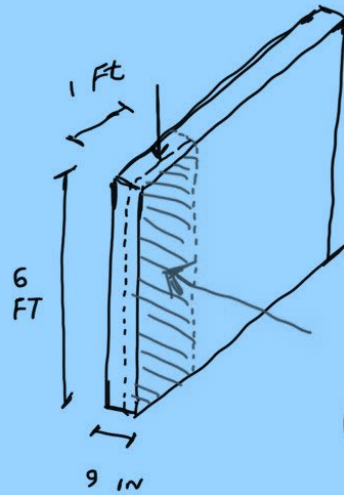
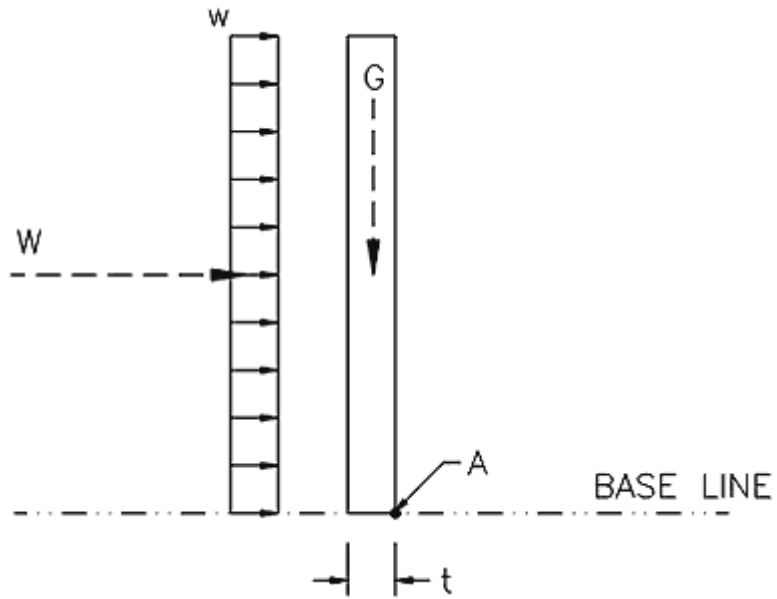
6 FT

- Problem:



#	Question	Your Response
1	Total weight of 1 linear foot length of wall (G)	<input type="text"/> PLF
2	Moment arm length for resisting gravity moment	<input type="text"/> INCH
3	Resisting moment of 1 linear foot length of wall about point A (absolute value)	<input type="text"/> FT-LBS
4	Moment arm length for overturning wind moment	<input type="text"/> FT
5	Overturning wind force W acting on a 1 linear foot length of wall area	<input type="text"/> LBS
6	Wind pressure on wall	<input type="text"/> PSF

Provide the solution for the assignment – HW3



$$\textcircled{1} \quad \rho = \frac{M}{V} \rightarrow M = \rho \cdot V$$

$$W_{\text{wall}} = 100 \text{ PCF} \times \left(\frac{9}{12} \times 6 \times 1 \right) = 450 \text{ LBS}$$

Unit Conversion

$$\textcircled{2}, \textcircled{3} \quad M_R = W_{\text{wall}} \times \frac{t}{2} = 450 \times \frac{9}{2} \times \frac{1}{12} = 168.75 \text{ Ft. LBS}$$

$$\textcircled{4} \quad \frac{6}{2} = 3$$

wind force

$$\textcircled{5} \quad M_o = M_R \rightarrow W \times 3 = 168.75 \text{ Ft. LBS}$$

$$\rightarrow W = 56.25 \text{ LBS}$$

$$\textcircled{6} \quad \text{wind pressure} = \frac{\text{wind force}}{\text{wall surface}}$$

$$= \frac{56.25}{6 \times 1} = 9.375 \text{ PSF}$$

Lab: Moment of a Force

Moment of a Force

Description

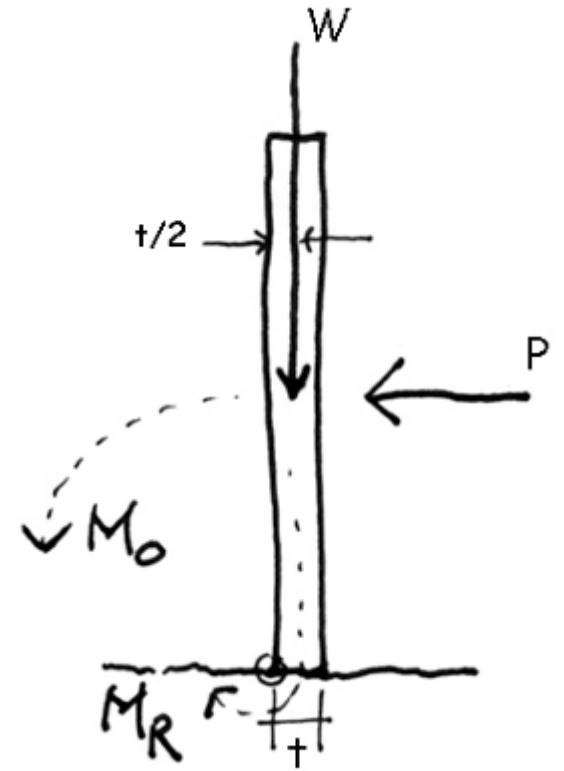
This project is intended to give a sense the moment of a force. It looks at the effect of distance on the magnitude of an overturning moment

Goals

To review dead load calculation

To observe the effect of position on an overturning moment using a physical model

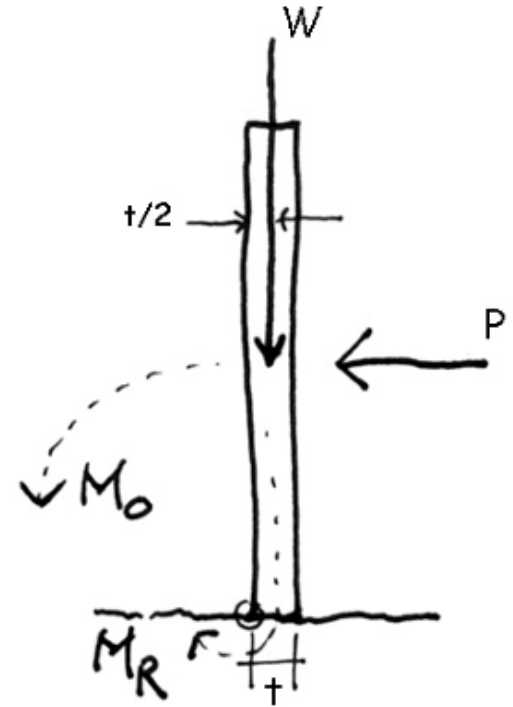
To show calculate a moment based on equilibrium



Lab: Moment of a Force

Procedure

1. Calculate the total weight (W) in pounds of the wooden block. The block measures 6"x2"x1.5" and has a density of 48 PCF.
2. Place the block on a surface so that $t=2$ " and apply a load P with your finger at 1" above the surface to tip the block. You may need to restrain the block from sliding.
3. Make a sketch of the system and calculate first the resisting moment of the wall M_r . Then set this resisting moment equal to the overturning moment M_o . Next solve for the force P needed to overturn the block.
4. Now move your finger to the mid height of the block at 3".
5. Again make a sketch of the system and calculate the force P needed to overturn the block.
6. Move your finger to the top of the block at 6" and again calculate the force P needed to overturn the block.
7. Finally, press hard on the top of the block and again try to tip it from the side. Now it is much different. What has changed? Approximately what is the resisting moment, M_r now?



Lab: Moment of a Force

$$\text{density} = \frac{\text{mass}}{\text{volume}} \quad \rho = \frac{m}{V}$$

$$\text{Volume} = 6 \times 2 \times 1.5 = 18 \text{ in}^3 \xrightarrow[\text{unit conversion}]{\times 0.0005787} 0.010416 \text{ ft}^3$$

$$\left\{ \begin{array}{l} 1 \text{ ft} \longrightarrow 12 \text{ in} \\ 1 \text{ in} \longrightarrow \frac{1}{12} \text{ ft} \end{array} \right.$$

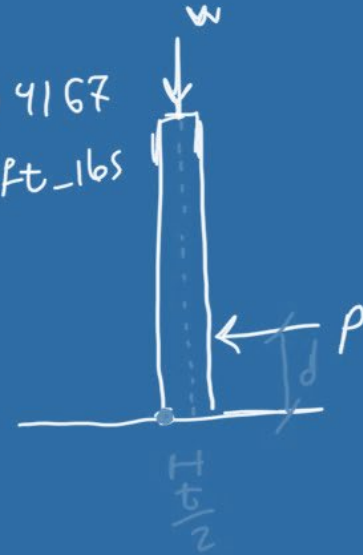
$$\text{mass} = \text{density} \times \text{Volume} = 48 \times 0.010416 = 0.50 \text{ LBS}$$

Lab: Moment of a Force

$$M_R = W \times \frac{t}{2} = 0.5 \times \frac{2}{2} \times \frac{1}{12} = 0.04167 \text{ ft-lbs}$$

+)

$$M_o = P \times d$$

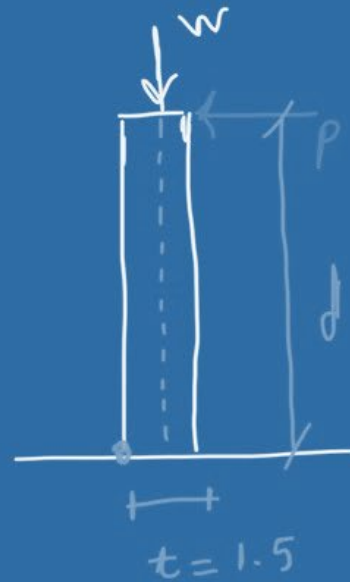


$$\textcircled{1} \quad M_R = M_o \longrightarrow 0.04167 = P \times \frac{1}{12} \longrightarrow P = 0.5 \text{ LBS}$$

$$\textcircled{2} \quad M_R = M_o \longrightarrow 0.04167 = P \times \frac{3}{12} \longrightarrow P = 0.167 \text{ LBS}$$

$$\textcircled{3} \quad M_R = M_o \longrightarrow 0.04167 = P \times \frac{6}{12} \longrightarrow P = 0.083 \text{ LBS}$$

Lab: Moment of a Force



$$\textcircled{4} \quad M_R = 0.04167 \times \frac{1.5}{2} \times \frac{1}{12} = 0.0026 \quad \text{ft-lbs}$$

$$M_o = p \times \frac{d}{12}$$

$$M_R = M_o \rightarrow 0.0026 = p \times \frac{6}{12}$$
$$\rightarrow p = 0.052 \quad \text{lbs}$$

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Thank you.

Any question?

Please feel free to ask questions.