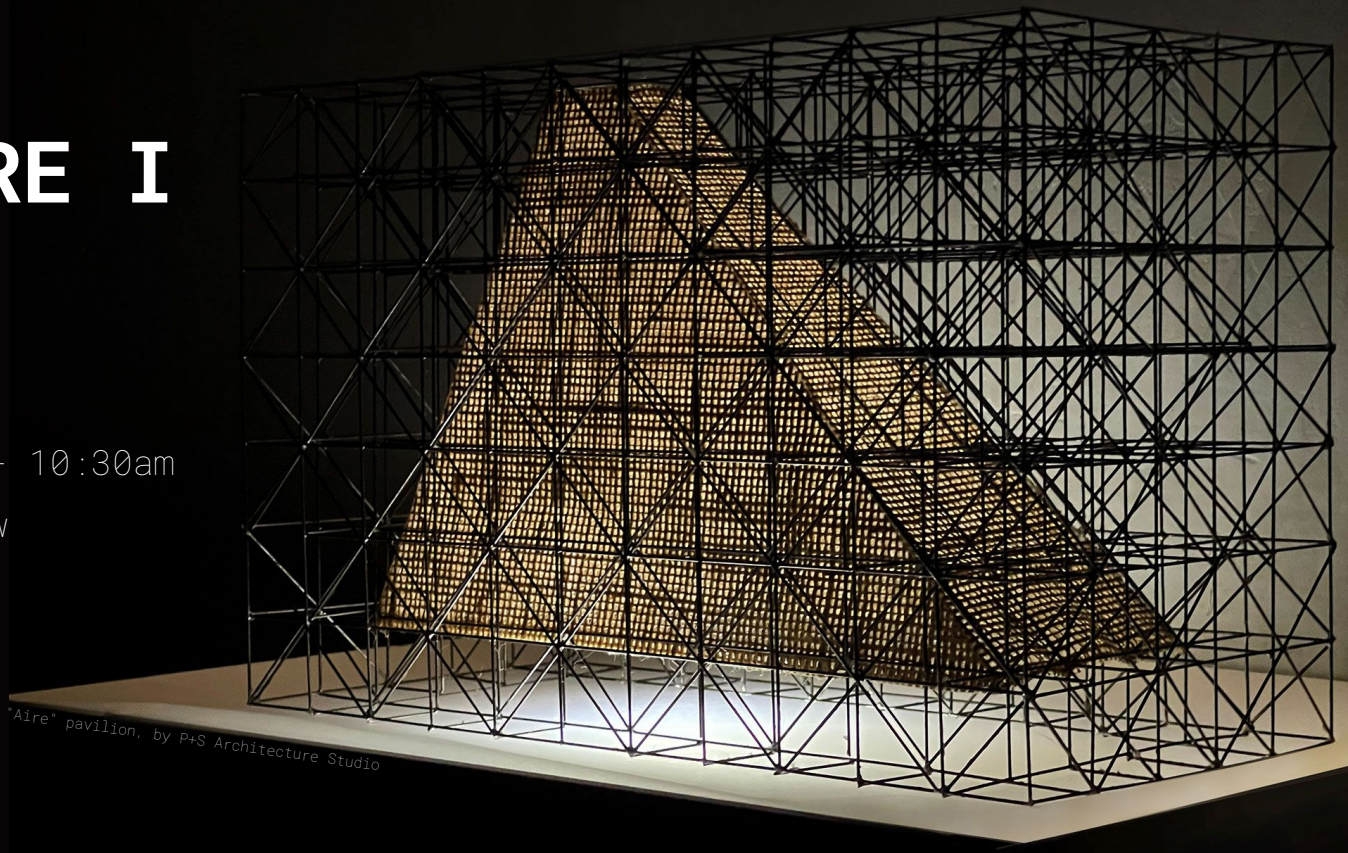
STRUCTURE I

ARCH-314

Friday(s): 9:30am - 10:30am

West Review

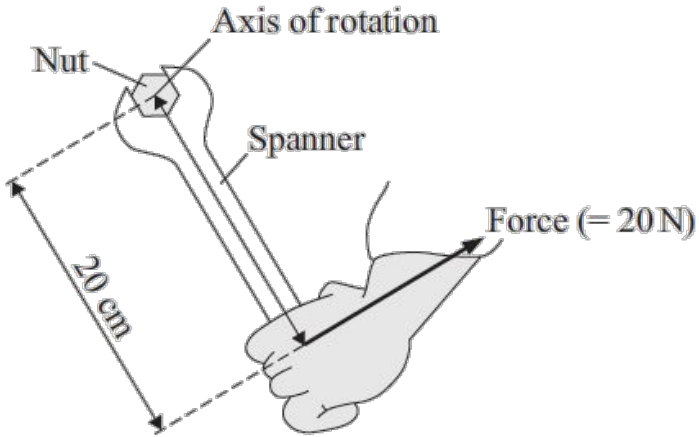

"Aire" pavilion, by P+S Architecture Studio

Today:

- Moment of Forces
- Supports
- Support Reactions
- Problem set No.3
- Lab Activity: Moment o

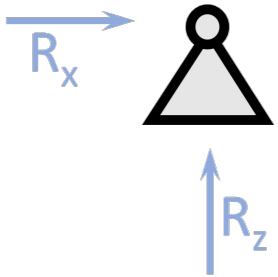
Moment:

Moment of force (M) (AKA torque), is a measure of the turning effect a force has on an object around a specific point, calculated by multiplying the force (F) by the perpendicular distance (d) from the line of action of the force to that point.

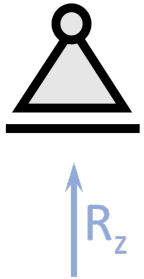


$$M = F \times d$$

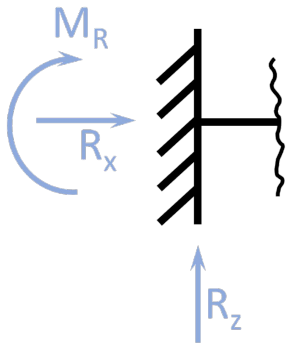
Supports:



Pin



Roller

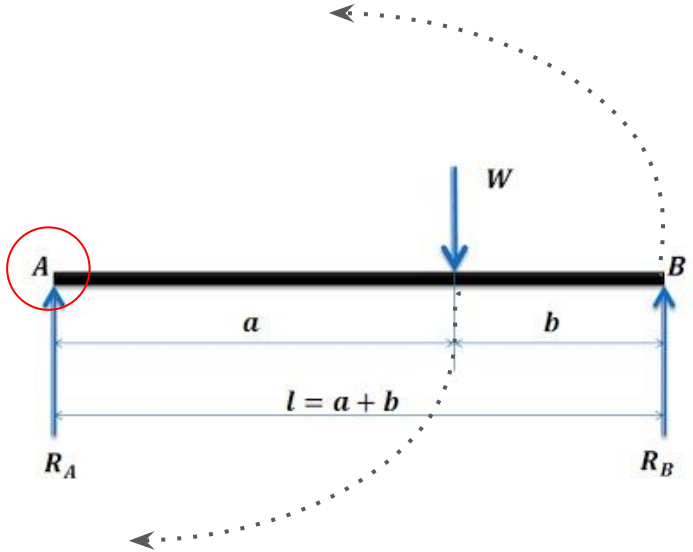


Fixed

Support Reactions:

$$\sum_{Fx} = 0 \Rightarrow R_{Ax} = 0$$

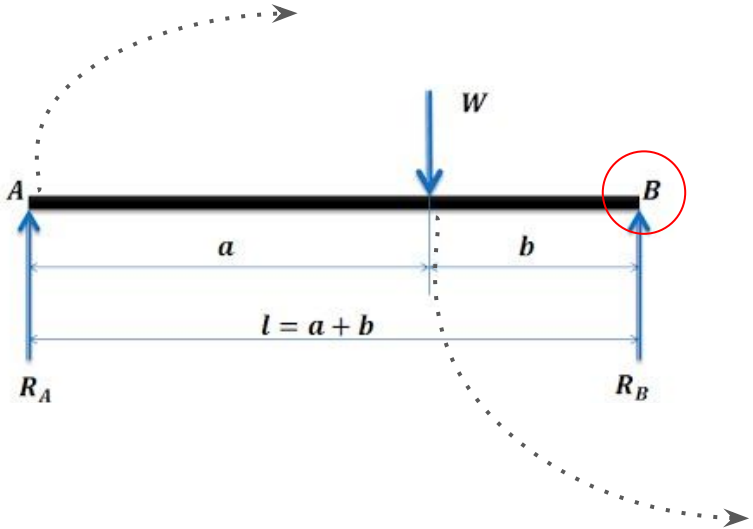
$$\sum_{M_A} = 0 \Rightarrow +W \times (a) - R_{B_Y} \times (b + a) = 0$$



Support Reactions:

$$\sum_{Fy} = 0 \Rightarrow R_{Ay} = 0$$

$$\sum_{M_B} = 0 \Rightarrow -W \times (b) + R_{A_Y} \times (b + a) = 0$$



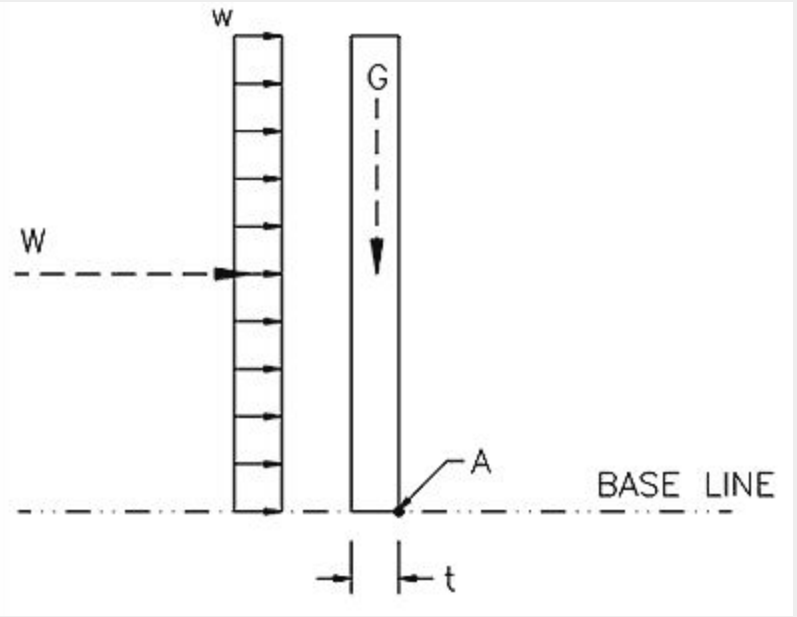
PROBLEM NO.3

3. 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: 2 -1- -3-

Wall thickness	14 IN
Density of wall	130 PCF
Height of wall	10 FT



PROBLEM NO.3

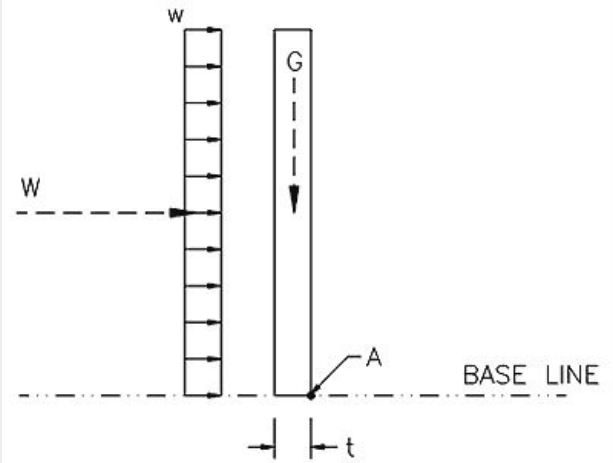
Question 1: **Total weight of 1 linear foot length of wall (G)**

$$PLF = Volume \times Density \times 1Ft$$

$$Volume = (Wall\ Thickness\ (Ft) \times Height\ of\ Wall\ (Ft) \times Lenght\ (Ft))$$

$$PLF = \left(14in \times \frac{1}{12} \times 10Ft \times 1Ft\right) \times 130PCF \times 1Ft$$

$$PLF = 1516.67$$



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DATASET: 2 -1- -3-

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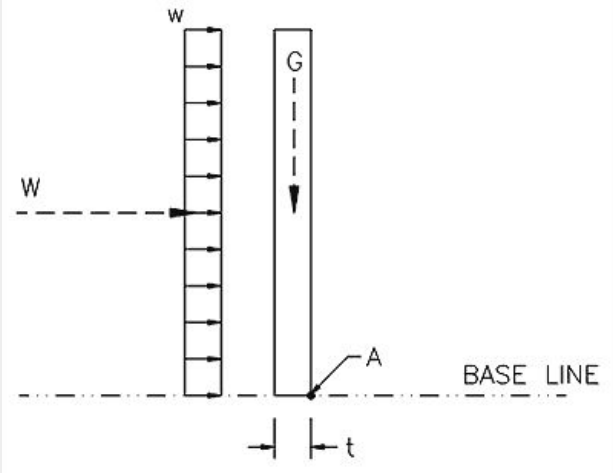
PROBLEM NO.3

Question 2: **Moment arm length for resisting gravity moment**

$$L_A = \frac{Wall\ Thickness}{2}$$

$$L_A = \frac{14}{2}$$

$$L_A = 7\ In$$



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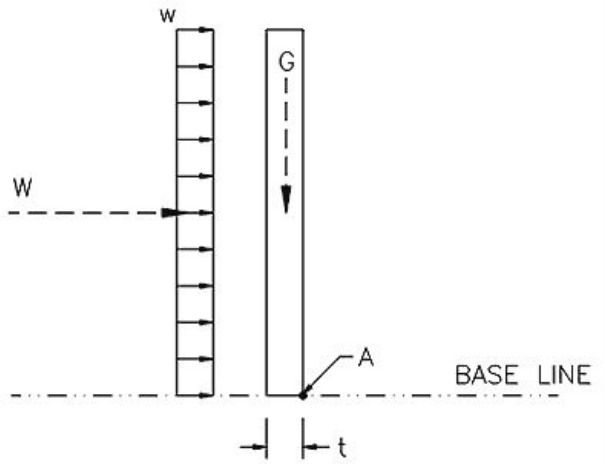
PROBLEM NO.3

Question 3:Resisting moment of 1 linear foot length of wall about point A (absolute value)

$$M = \left| - PLF(\ Question1) \times Moment\ Arm\ Lenght(\ Question2) \right|$$

$$M = \left| - 1516.67\ PLF \times 7\ In \times \left(\frac{1}{12} \right) \right|$$

$$M = 884.72\ FT.LBS$$



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Density of wall	130 PCF
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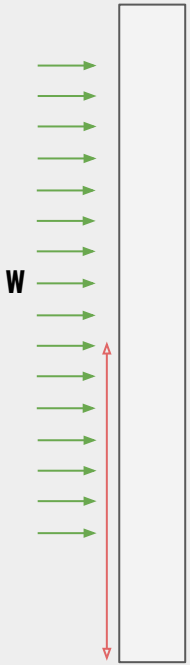
PROBLEM NO.3

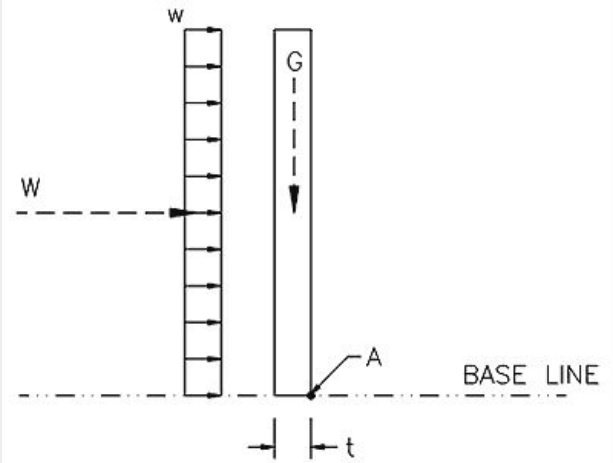
Question 4: **Moment arm length for overturning wind moment**

$$D = \frac{Height\ of\ Wall}{2}$$

$$D = \frac{10\ Ft}{2}$$

$$D = 5\ Ft$$





3. Moment of a Force

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DATASET: 2 -1- -3-

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PROBLEM NO.3

Question 5: **Overturning wind force W acting on a 1 linear foot length of wall**

$$\sum M_A = 0$$

$$+F(Wind) \times Wind\ Moment\ Lenght - W(Weight) \times Gravity\ Moment\ Lenght = 0$$

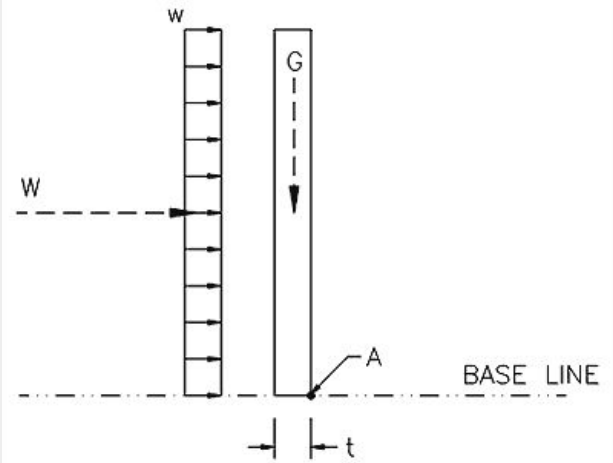
$$+F(Wind) \times Wind\ Moment\ Lenght\ (Question\ 4) - W(Question\ 1) \times Gravity\ Moment\ Lenght(Question2) = 0$$

$$+F(Wind) \times 5\,FT - 1516.67\,PLF \times 7 \times \left(\frac{1}{12}\right) = 0$$

$$+F(Wind) = \frac{884.72 = Question3}{5Ft}$$

$$F(Wind) = 176.94\,LBS$$

On 1 linear foot length of wall



3. Moment of a Force

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DATASET: 2 -1- -3-

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PROBLEM NO.3

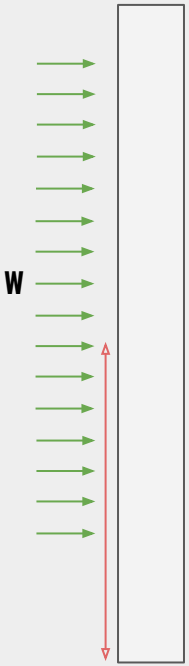
Question 6: **Wind pressure on wall**

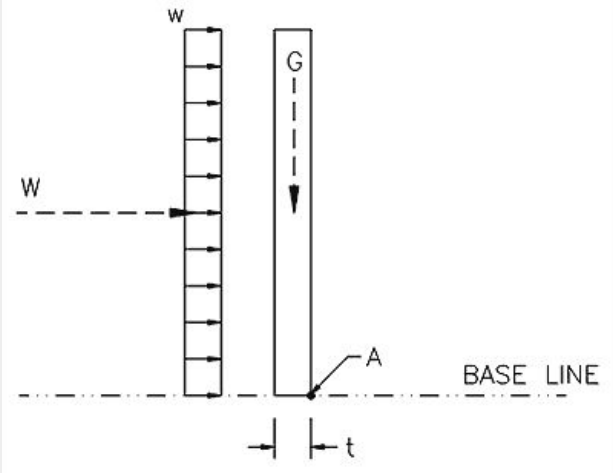
$$F(\,Wind\,) = 176.94\ LBS$$

$$P(\,Pressure\,) = \frac{Force(\,Question5\,)}{Area(\,Height\ of\ \ Wall\,)}$$

$$P = \frac{176.64}{10}$$

$$P = 17.66\ PSF$$





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Lab Activity:

Description

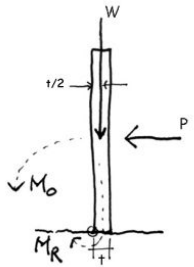
This project is intended to give a sense the moment of a force. It looks at the effect of distance on the magnitude of an overturning moment

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

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?

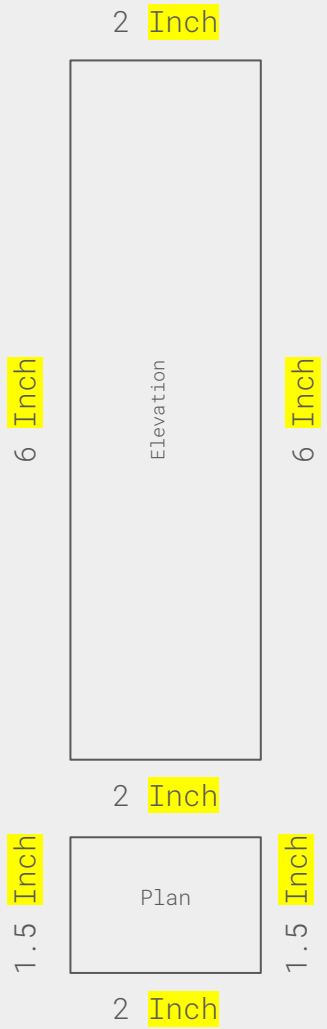


Lab 2. Moment of Forces

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.

$$W = Volume \times Density$$

$$Volume = (Block\ Thickness\ (Ft) \times Height\ of\ Block\ (Ft) \times Lenght\ (Ft))$$

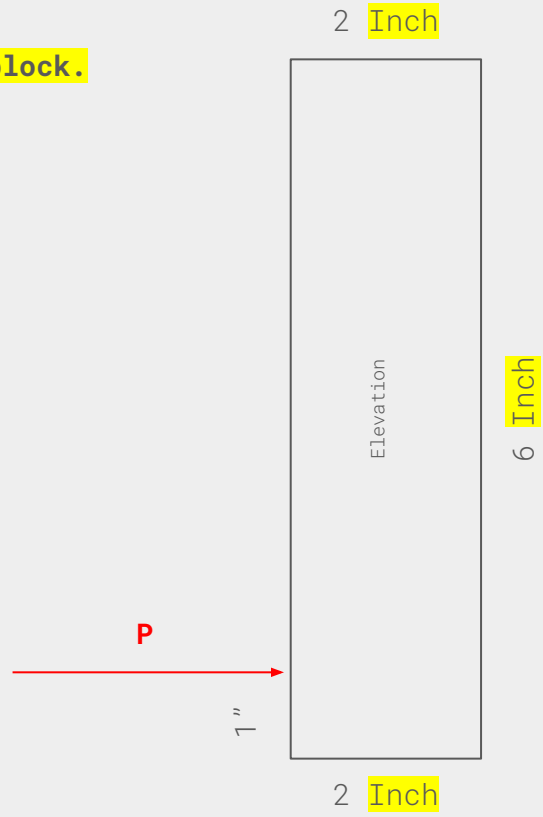


Lab 2. Moment of Forces

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.



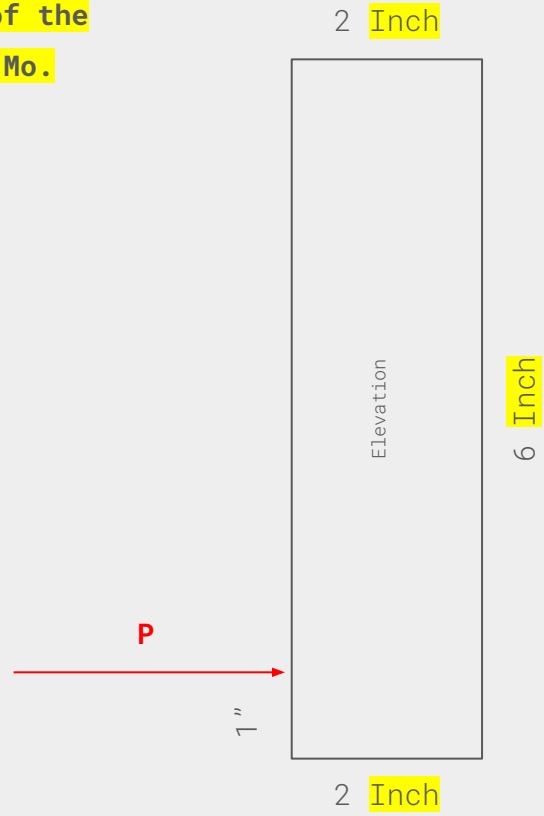
Lab 2. Moment of Forces

3.Make a sketch of the system and calculate first the resisting moment of the wall Mr. Then set this resisting moment equal to the overturning moment Mo. Next solve for the force P needed to overturn the block

1st. $$M_r = W \times \frac{t\ (Ft)}{2}$$

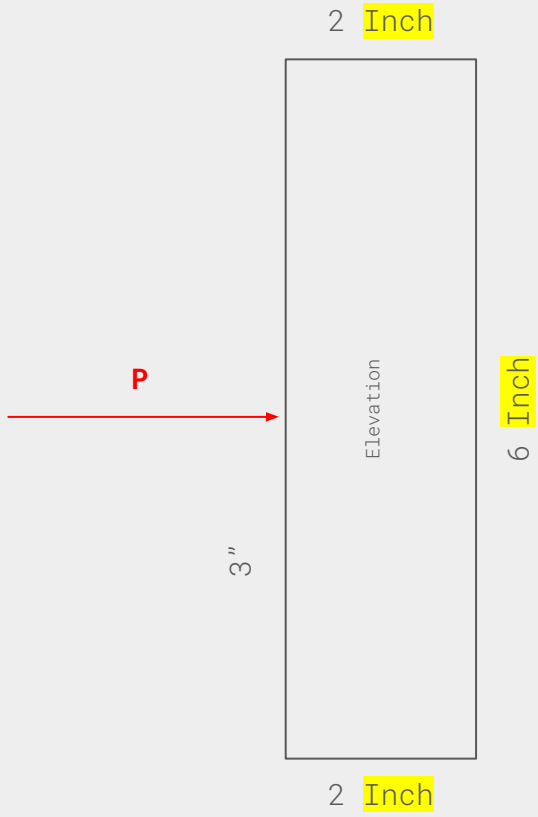
2nd. $$M_r = M_o$$

$$\Rightarrow \quad M_r = P \times Distance\ from\ Surface$$



Lab 2. Moment of Forces

4. **Now move your finger to the mid height of the block at 3”**

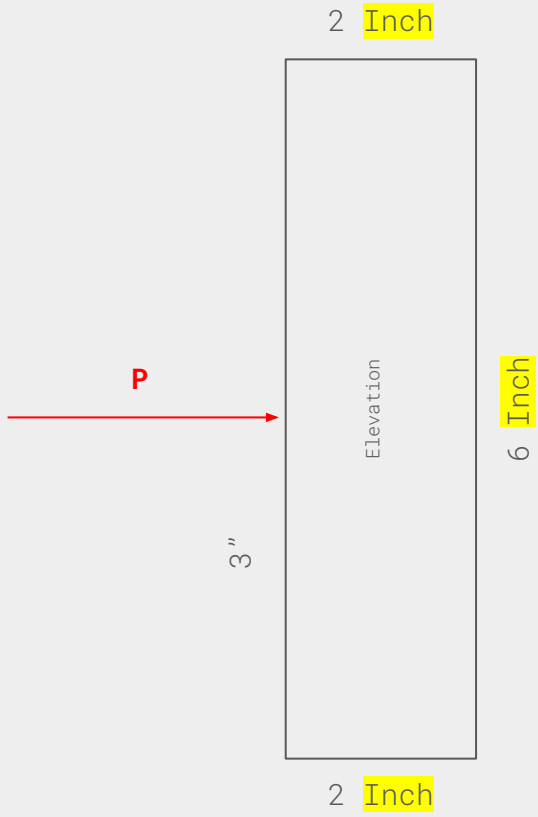


Lab 2. Moment of Forces

5.Again make a sketch of the system and calculate the force P needed to overturn the block.

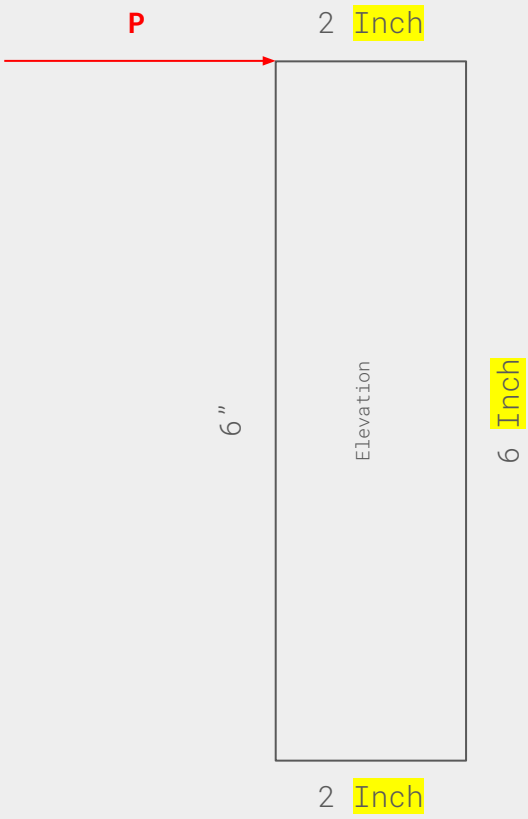
$$M_r = M_o$$

$$\Rightarrow \quad M_r = P \times Distance\ from\ Surface$$



Lab 2. Moment of Forces

6. Move your finger to the top of the block at 6" and again calculate the force P needed to overturn the block.



$$M_r = M_o$$

$$\Rightarrow \quad M_r = P \times Distance\ from\ Surface$$

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, Mr now?

1st. $$M_r = W \times \frac{t_{NEW}(Ft)}{2}$$

$$M_r = M_o$$

$$\Rightarrow \quad M_r = P \times Distance\ from\ Surface$$