

Arch 314- Structures I

Recitation 006



Vishakha Bagarao

13th Sept 2024



Contents

- General Instructions
- Quick Recap
 - Moment of a Force
 - Equilibrium Equations
 - Force Systems
 - Types of retaining walls
 - Problem Set 03
- Lab 2- Moment of a force

General Instructions:

- Please! Please! Please! Make sure you write your **full name** on the lecture quiz or recitation sheet (no preferred names or just first names)
- If you missed any **lectures**, they are posted online—watch them and complete the quiz to earn 10 points.
- Regularly complete the **topic quizzes**. If you have any questions, don't hesitate to reach out to me! 😊
- You are allowed one **free pass** for missing a recitation with no point deduction (provided you sign up for office hours and complete the lab problem). However, for each additional absence, there will be a 2-point deduction for the second missed session, 4 points for the third, and so on.

Moment of a force:

Forces acting on a body:



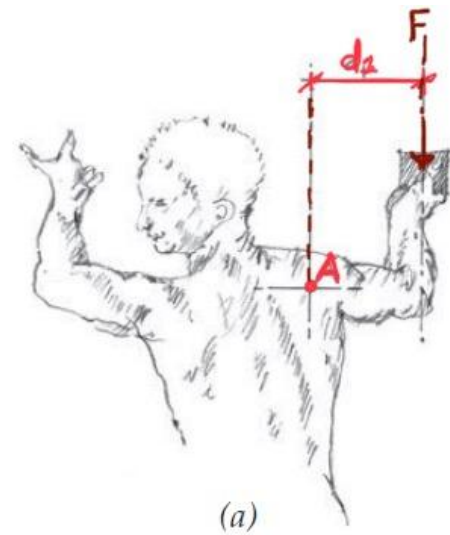
The tendency of a force to produce rotation of a body about some reference axis or point is called the moment of a Force.

$$M_A = F * d$$

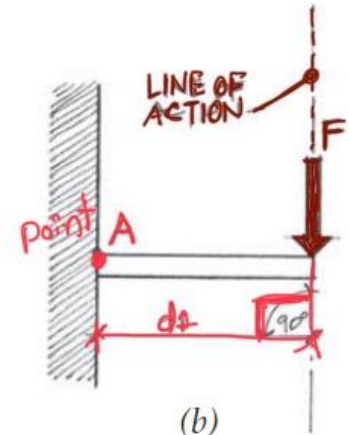
M_A = Moment.

F = Force applied.

d = perpendicular distance from f to point A.



(a)



(b)

Equilibrium Equations: Equilibrium refers to a state of rest or balance.

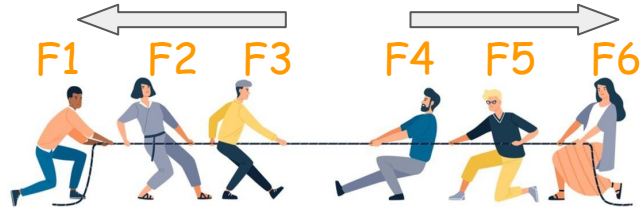
Force Systems

Collinear Force System

Action of forces along the same line of action.

$$\Sigma F_x = 0$$

$$-F_1 - F_2 - F_3 + F_4 + F_5 + F_6 = 0$$

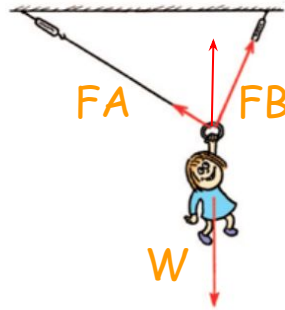


Concurrent Force System

When the resultant of all concurrent forces acting on a particle is zero, the particle is in a state of equilibrium.

$$R_x = \Sigma F_x = 0$$

$$R_y = \Sigma F_y = 0$$



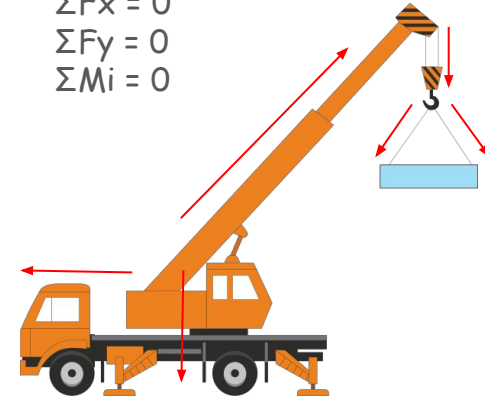
Nonconcurrent, Coplanar Force System

A rigid body is said to be in equilibrium when the external forces acting on it form a system of forces equivalent to zero.

$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

$$\Sigma M_i = 0$$

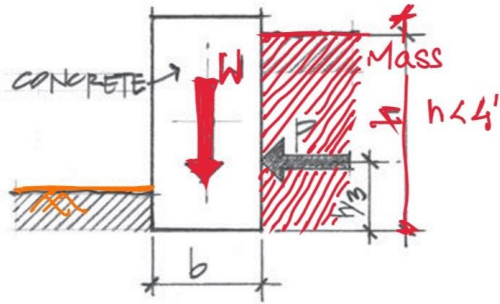


Retaining Walls: Retaining walls are used to hold back (retain) mass or other granular material to maintain a difference in ground elevation.

Types of Retaining Walls

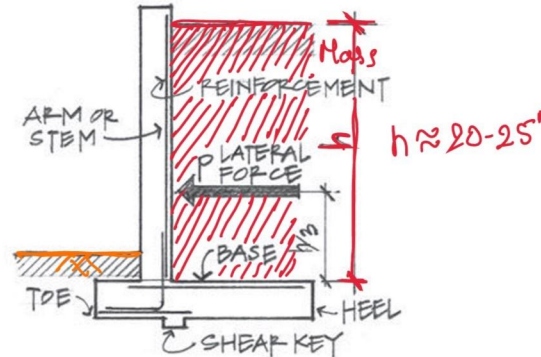
Gravity Wall

Generally built on plain concrete or masonry.
 $H < 4'$



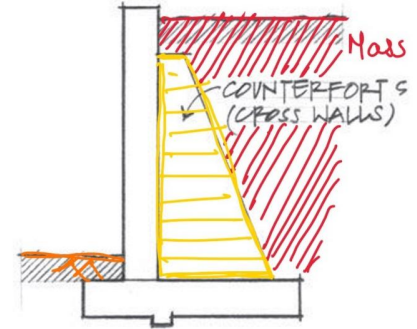
Reinforced concrete cantilever wall

Most frequently used, which consist of a relatively thin stem and a base slab.
 H about 20-25'



Counterfort wall

The addition of counterforts provides the additional depth at the base to absorb the large bending stresses.
Buttresses



Formulas:

- Total weight of 1 linear length of wall:

$$(G) = \text{Volume} \times \text{Density [Pounds linear foot]}$$

- Moment arm length for resisting gravity moment:

$$(d1) = t/2 \text{ [inch]}$$

- Resisting moment of 1 linear foot length of wall about point A [absolute value]:

$$(Mr) = \text{Force of wall } (G) \times \text{Distance of overturning point } (d1)$$

- Moment arm length for overturning wind moment:

$$(d2) = h/2 \text{ [ft]}$$

- Overturning wind force W acting on a 1 linear foot length of wall area:

$$M_o = M_r$$

$$(F_{\text{wind}}) \times d2 = M_r$$

- Wind pressure on wall:

$$(P) = F_{\text{wind}} / \text{Area} \text{ (Area} = h \times 1')$$

Example:

Logged in as: Vishakha Bagarao

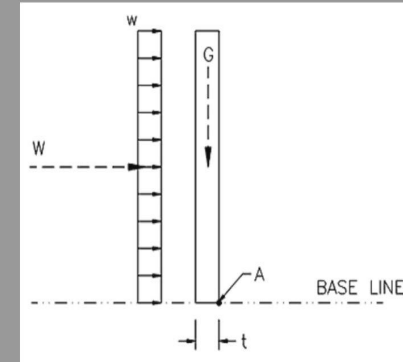
3. Moment of a Force

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 13 IN
Density of wall 110 PCF
Height of wall 10 FT



#	Question	Your Response	Correct Answer	Score
1	Total weight of 1 linear foot length of wall (G)	1191.63 PLF	1191.67 PLF	5
2	Moment arm length for resisting gravity moment	6.5 INCH	6.5 INCH	5
3	Resisting moment of 1 linear foot length of wall about point A (absolute value)	629.197 FT-LBS	645.486 FT-LBS	5
4	Moment arm length for overturning wind moment	5 FT	5 FT	5
5	Overturning wind force W acting on a 1 linear foot length of wall area	129.101 LBS	129.097 LBS	5
6	Wind pressure on wall	12.9101 PSF	12.9097 PSF	5

Current Score: 30 / 30

Problem Menu

Logout

Problem Set 03

Contact

Schedule

Lectures

Recitation

Bridges1

Bridges2

Problems

Logged in as: Vishakha Bagarao

3. Moment of a Force

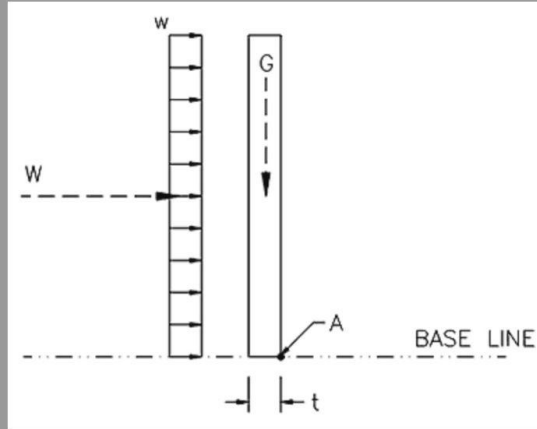
Find the total wind force (W) in LBS normal to the wall that would cause an overturning moment equal to the resisting moment from gravity (G).

DATASET: 2

-1-

-3-

Wall thickness	13 IN
Density of wall	110 PCF
Height of wall	10 FT



#	Question	Your Response	Correct Answer	Score
1	Total weight of 1 linear foot length of wall (G)	1191.63 PLF	1191.67 PLF	5
2	Moment arm length for resisting gravity moment	6.5 INCH	6.5 INCH	5
3	Resisting moment of 1 linear foot length of wall about point A (absolute value)	629.197 FT-LBS	645.486 FT-LBS	5
4	Moment arm length for overturning wind moment	5 FT	5 FT	5
5	Overturning wind force W acting on a 1 linear foot length of wall area	129.101 LBS	129.097 LBS	5
6	Wind pressure on wall	12.9101 PSF	12.9097 PSF	5

Date: / /

Given Data:

$$t = 13'' = 1.083'$$

$$D = 110 \text{ pcf}$$

$$h = 10'$$

Question:

1. Total weight of 1 linear

foot length of wall (G).

$$\text{Weight} = \text{volume} \times \text{density}$$

$$G = 10' \times 1.083' \times 1' \times 110$$

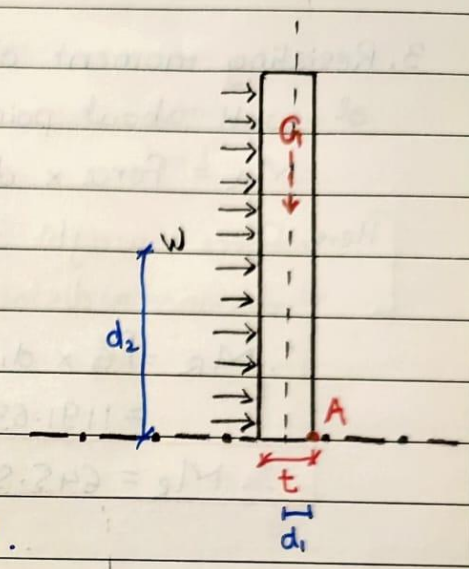
$$\therefore \text{Weight} = 1191.63 \text{ PLF}$$

2. Moment arm length for resisting gravity moment.

$$d_1 = \frac{t}{2} = \frac{13}{2} = 6.5'' = 0.541\bar{8}'$$

3.

Problem Set 02



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

$$M_R = \text{Force} \times \text{distance}$$

[Here, Force = weight of wall \rightarrow resisting the wind
distance = distance of overturning point]

$$\therefore M_R = FG \times d_1 \text{ (in feet)}$$

$$= 1191.63 \times 0.5417$$

$$\therefore M_R = 645.506 \text{ ft-lbs}$$

4. Moment arm length for overturning wind moment.

$$d_2 = \frac{h}{2} = \frac{10}{2} = 5'$$

5. Overturning wind force W acting on a 1 linear foot length of wall area.

Moment of overturning = Moment of Resistance

$$M_o = M_R$$

$$F_{\text{wind}} \times d_2 = F_G \times d_1$$

$$F_{\text{wind}} \times 5 = \frac{645.506}{5} = 129.1012 \text{ lbs}$$

$$\therefore F_{\text{wind}} = 129.1012 \text{ lbs}$$

MATRIKAS

Logged in as: Vishakha Bagarao

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

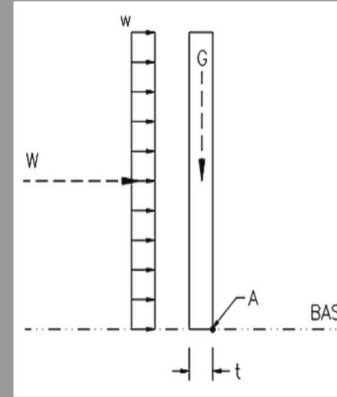
13 IN

Density of wall

110 PCF

Height of wall

10 FT



Question

Your Response

Correct Answer

1 Total weight of 1 linear foot length of wall (G)

1191.63 PLF

1191.67 PLF

2 Moment arm length for resisting gravity moment

6.5 INCH

6.5 INCH

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

629.197 FT-LBS

645.486 FT-LBS

4 Moment arm length for overturning wind moment

5 FT

5 FT

5 Overturning wind force W acting on a 1 linear foot length of wall area

129.101 LBS

129.097 LBS

6 Wind pressure on wall

12.9101 PSF

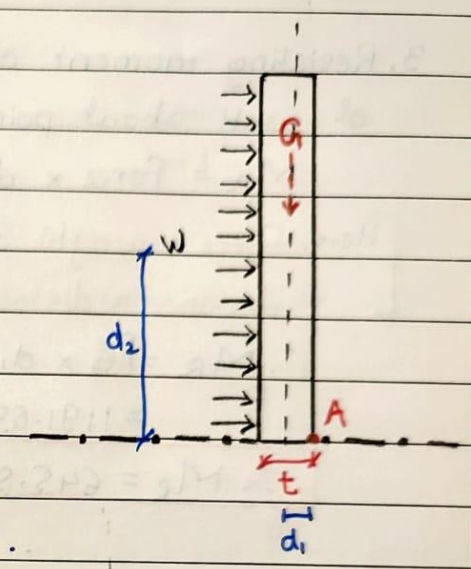
12.9097 PSF

Current Score:

Problem Menu

Logout

Problem Set 02

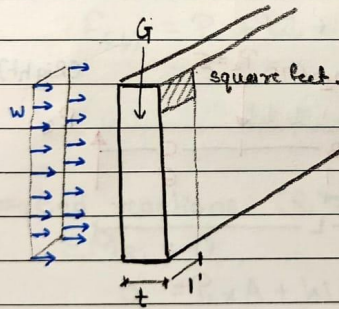


6. Wind Pressure on wall

$$\text{pressure} = \frac{\text{Force}}{\text{Area}} = \frac{F_{\text{wind}}}{h \times 1'}$$

$$P = \frac{129.1012}{10 \times 1}$$

$$\therefore P = 12.9101 \text{ psf}$$



Logged in as: Vishakha Bagarao

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

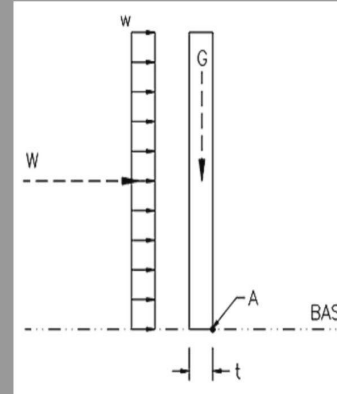
13 IN

Density of wall

110 PCF

Height of wall

10 FT



Question

1 Total weight of 1 linear foot length of wall (G)

Your Response

1191.63 PLF

Correct Answer

1191.67 PLF

2 Moment arm length for resisting gravity moment

6.5 INCH

6.5 INCH

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

629.197 FT-LBS

645.486 FT-LBS

4 Moment arm length for overturning wind moment

5 FT

5 FT

5 Overturning wind force W acting on a 1 linear foot length of wall area

129.101 LBS

129.097 LBS

6 Wind pressure on wall

12.9101 PSF

12.9097 PSF

Current Score:

Problem Menu

Logout

Recitation- Lab 02

Arch 314

Name 2 _____

Name 3 _____

Moment of a Force

Description

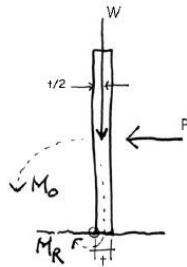
This project is intended to give a sense the moment of a force. It looks at the effect of distance on the magnitude of an overturning moment

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

Procedure

1. Calculate the total weight (W) in pounds of the wooden block. The block measures $6'' \times 2'' \times 1.5''$ 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?



Due

During recitation

