TAUBMAN COLLEGE
ARCHITECTURE & URBAN PLANNING
UNIVERSITY OF MICHIGAN

Arch314
STRUCTURES I

Fall 2024
Recitation

FACULTY: Prof. Peter von Bülow
Mohsen Vatandoost

Welcome to Recitation session 11/01

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Office hours:

Room 3104
Wed: 11:30 – 13:30
Mon, Fri: 11:30 - 12:30

Please feel free to ask questions.

Welcome to Recitation session 11/01

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment **(Homework 10)**
- Answering student's questions
- Lab: **Elasticity**
- **Bridge_1** project (Monday is the test day!)

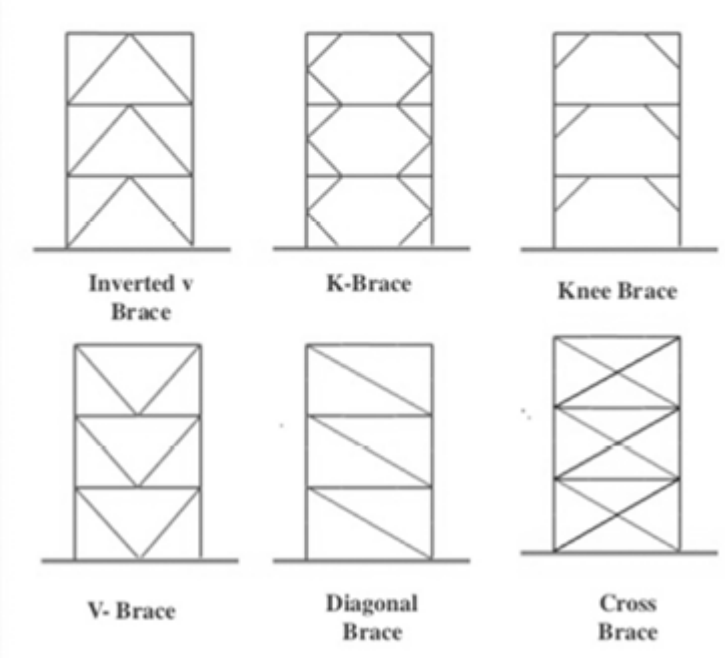
Please feel free to ask questions.

Contact: Mohsenv@umich.edu

Recap of the week

Frame Bracing

types of bracing

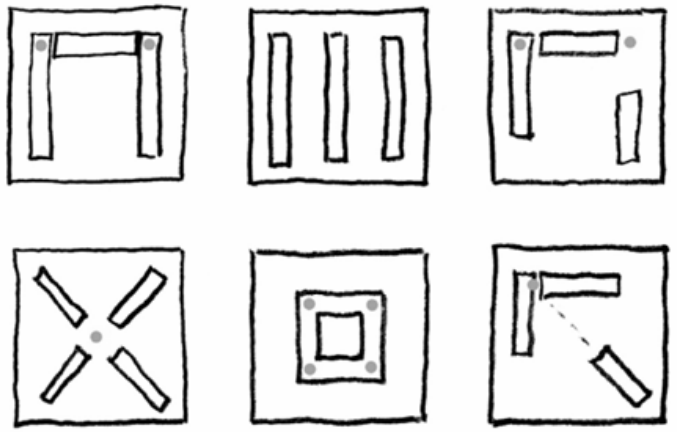


Lateral Force Resistance

Stability requires at least 2 points of intersection.

Force is more evenly resisted with centroid of walls in the kern of slab

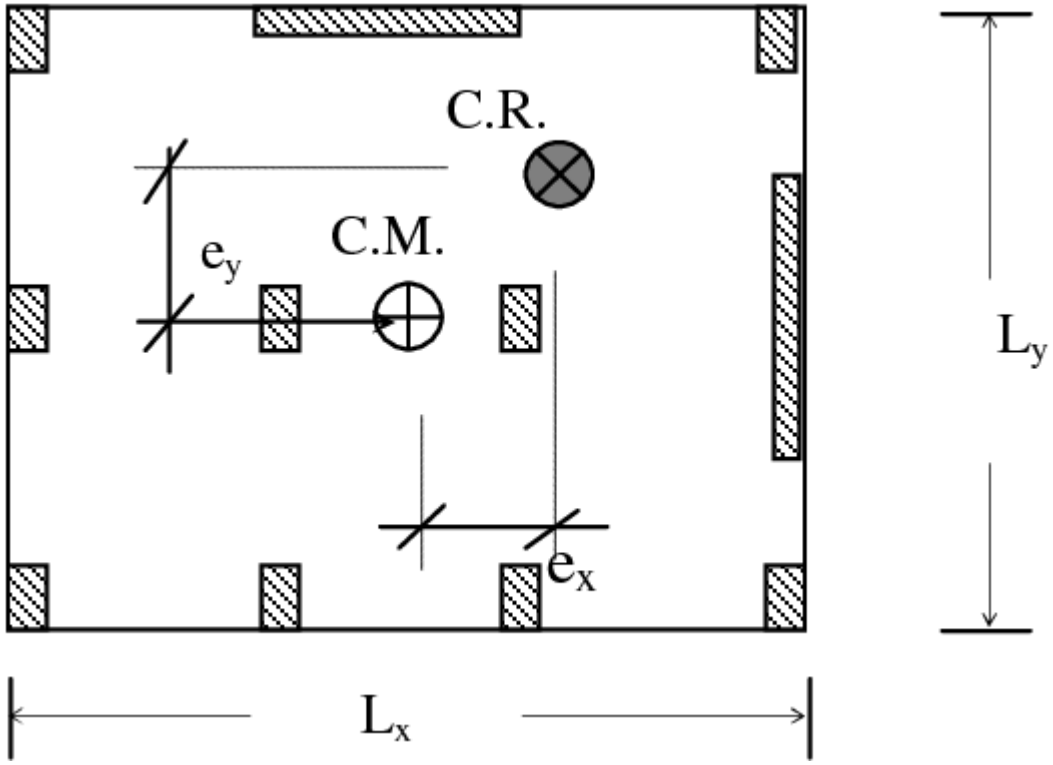
Center of Mass
Center of Rigidity

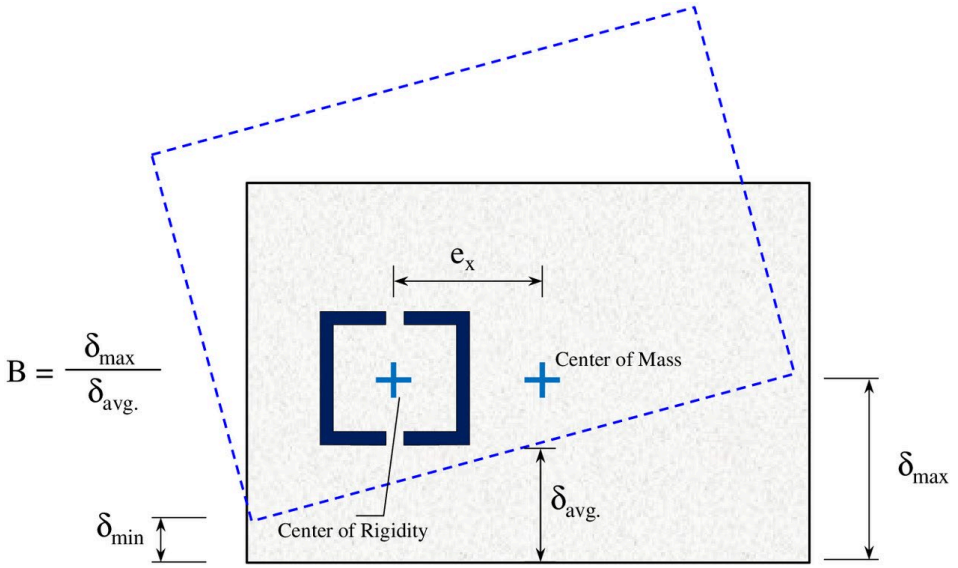


Recap of the week

Center of Mass

Center of Rigidity





Eccentricity will lead to rotation

Recap of the week

Architecture 314

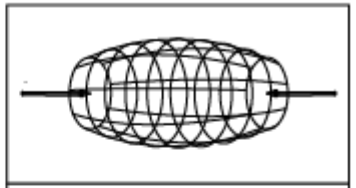
Structures I

Stress and Strain

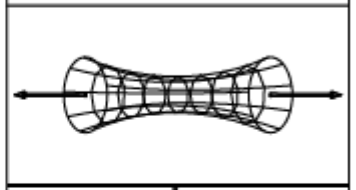
- Stress
- Strain
- Analysis – ASD vs. LRFD
- Modes of Failure

Type of Stress

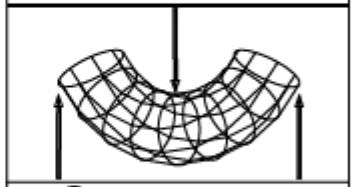
$$\sigma = \frac{P}{A}$$



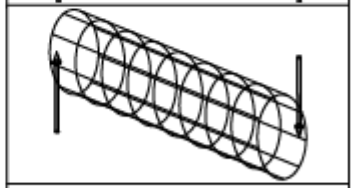
$$\sigma = \frac{P}{A}$$



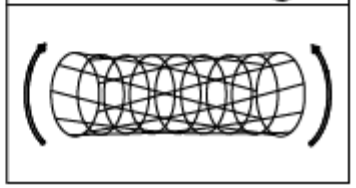
$$\sigma = \frac{M\ c}{I}$$



$$\tau = \frac{P}{A} or \frac{VQ}{Ib}$$



$$\tau = \frac{T\ r}{J}$$

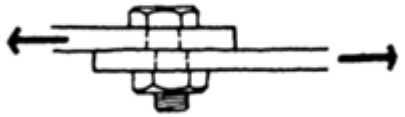


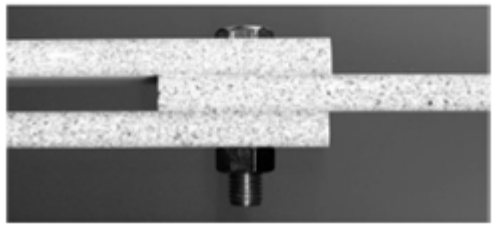
Recap of the week

Stress

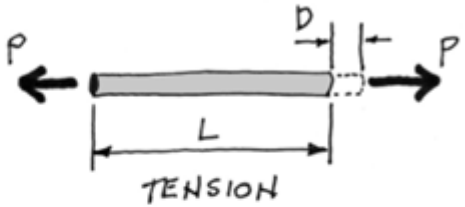
Stress is the result of a force being applied to the area of a material.

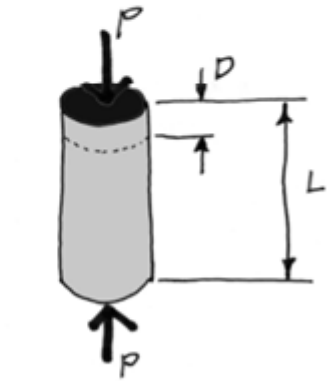
$$\sigma = \frac{P}{A}$$





Shear Stress





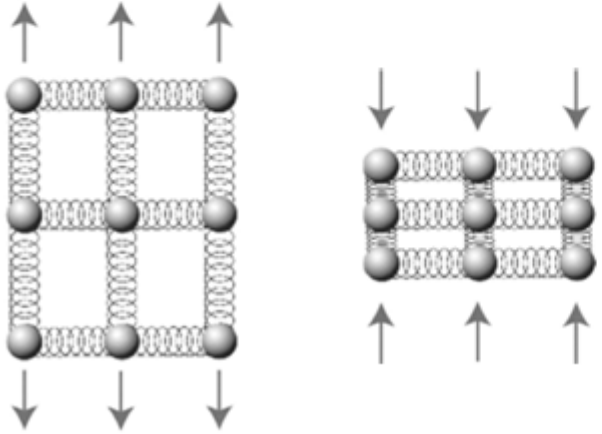
Recap of the week

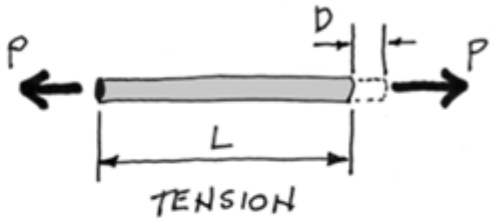
Strain

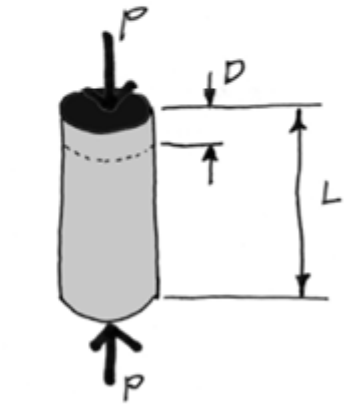
Strain is the amount of deformation in the material, per unit length.

$$\varepsilon = \frac{D}{L}$$

Deformation occurs either in stretching (tension) or in compressing (compression) but not always at the same rate.







Provide the solution for the assignment – **HW10**

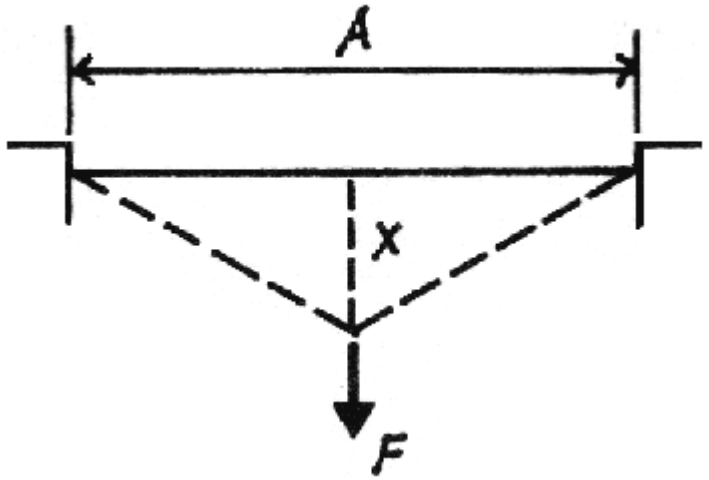
- Problem:

11. Elastic Deformation

Find the final stretched length of the cable deflected distance x, and the load F needed to cause the deflection. Determine the resulting tensile force in the cable along with the stress and strain.

DATASET: 1 -2- -3-

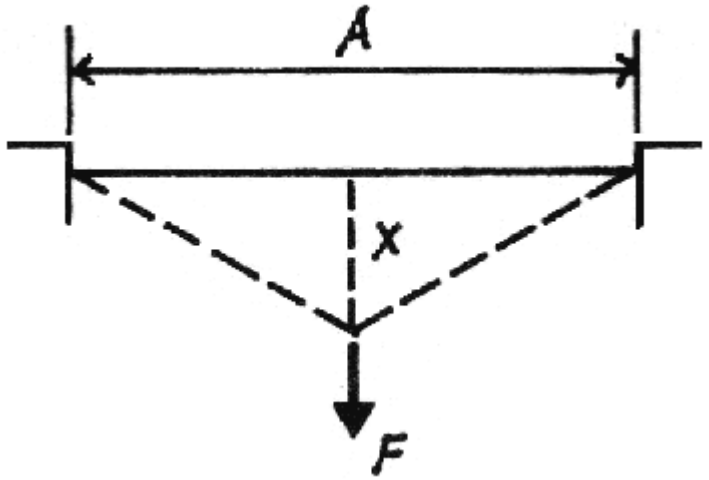
Span, A	56 FT
Sag, x	1.6471 FT
Cable Area	1.8065 IN^2
Young's Modulus, E	20185 KSI



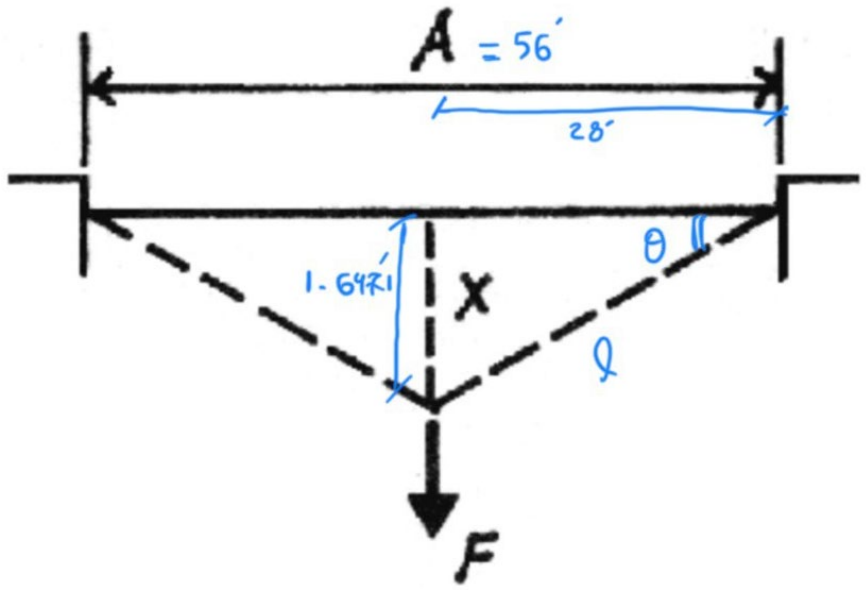
Provide the solution for the assignment – **HW10**

- **Problem:**

#	Question	Your Response	
1	Final stretched length of the full cable		FT
2	Deformation D of full cable		FT
3	Force in the stretched cable		KIPS
4	Horizontal component of the force in the cable		KIPS
5	Vertical component of the force in the cable		KIPS
6	Total force F applied to cable		KIPS
7	Stress in the cable		KSI
8	Strain of the cable		IN/IN



Provide the solution for the assignment – **HW10**



elongated Cable length: (ℓ) [half of cable]

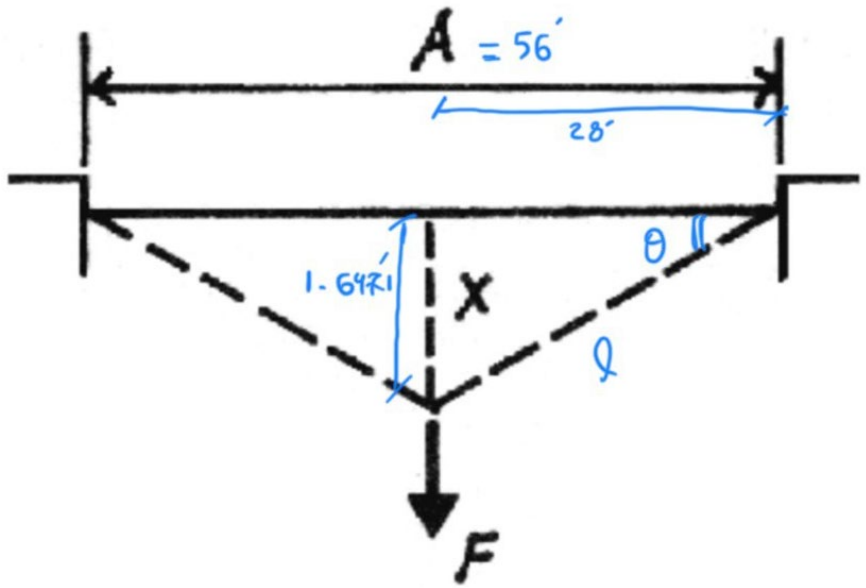
$$\ell^2 = \left(\frac{A}{2}\right)^2 + x^2$$

$$\ell^2 = \left(\frac{56}{2}\right)^2 + (1.6471)^2 \longrightarrow \ell = 28.048 \text{ FT}$$

Final strengh length of full cable:

$$2\ell = 56.0968 \quad (1)$$

Provide the solution for the assignment – **HW10**



Stress = Force / Area

Strain = Deformation / original Length

Deformation of Full Cable:

$D = L' - L = 56.0968 - 56 = 0.0968\ FT$ (2)

Stress & Strain Relation:

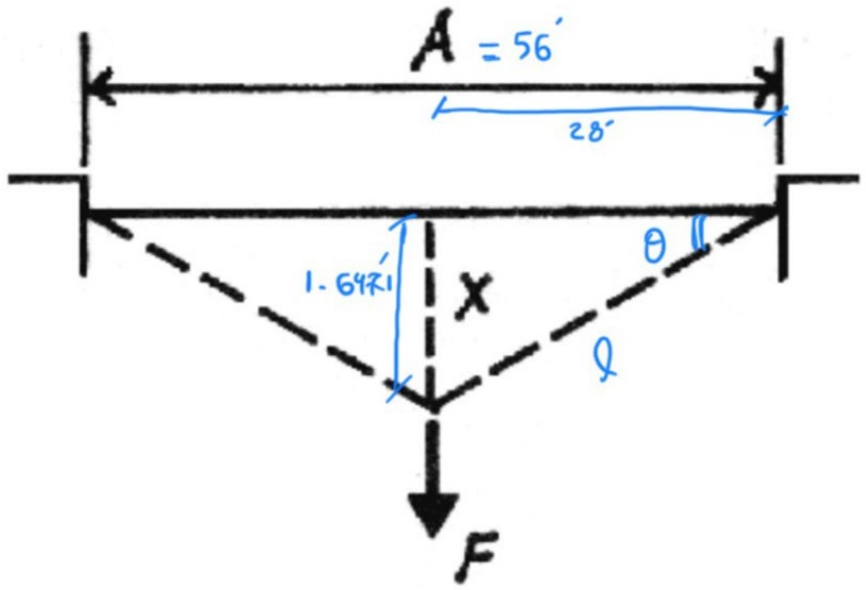
$\sigma = E\varepsilon \rightarrow \frac{D}{\ell}$

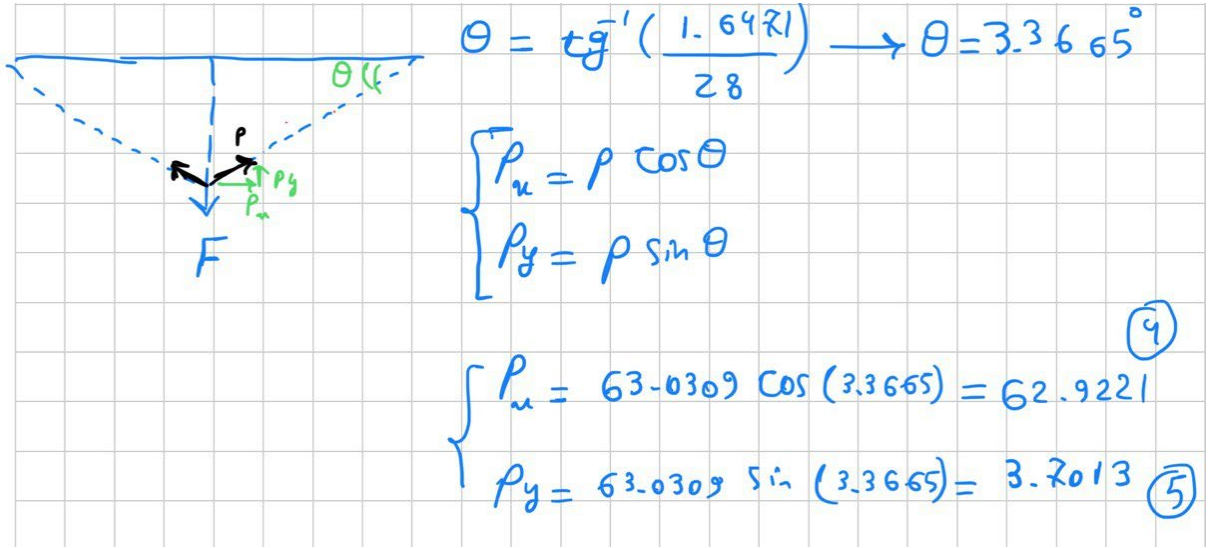
$\varepsilon = \frac{D}{\ell} = \frac{0.0968}{56} = 0.001728$ (6)

$\sigma = (20185)_{KSI} \times \frac{0.0968}{56} \rightarrow \sigma = 34.8912\ KSI$ (7)

$\sigma = \frac{P}{A} \rightarrow P = \sigma \cdot A = 34.8912_{KSI} \times 1.8065_{in^2} = 63.0309\ KIps$ (3)

Provide the solution for the assignment – **HW10**





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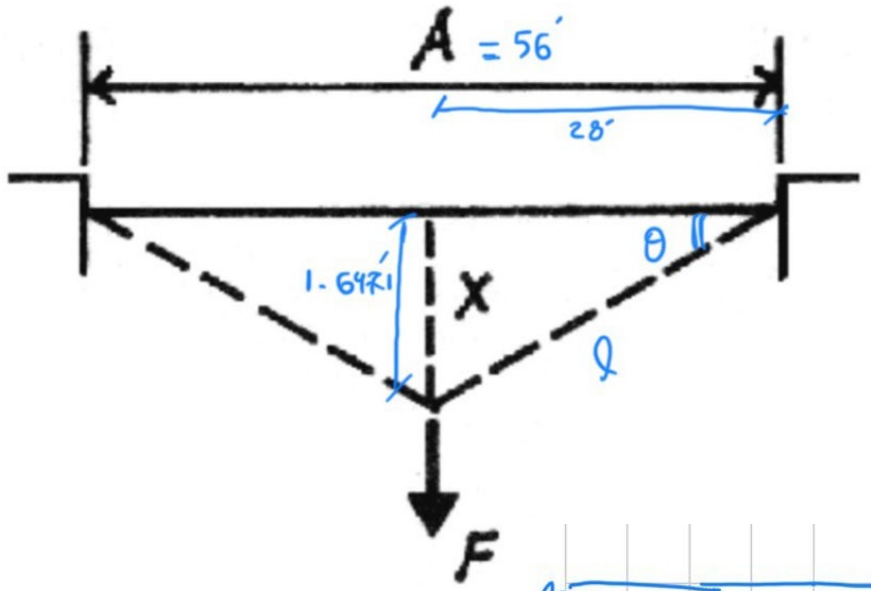
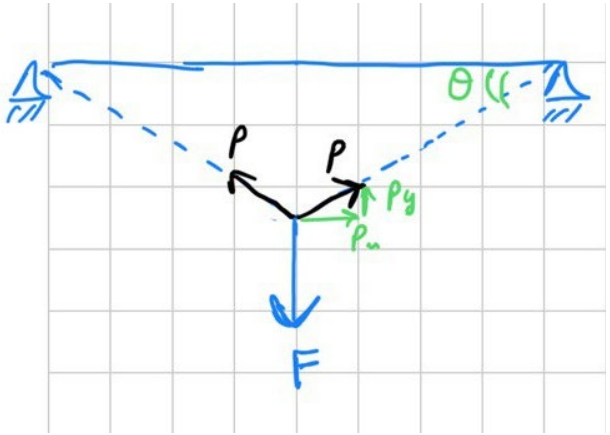


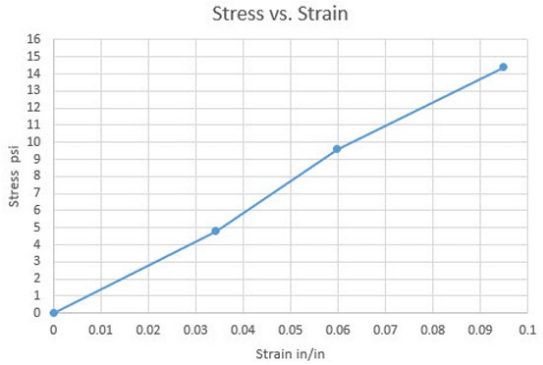


"F" should be balanced by the Tension Force in the Cable:

$$\Sigma F_y = 0$$

$$F = 2P_y = 2(3.7013) = 7.4026$$

Lab: Elasticity



Elasticity

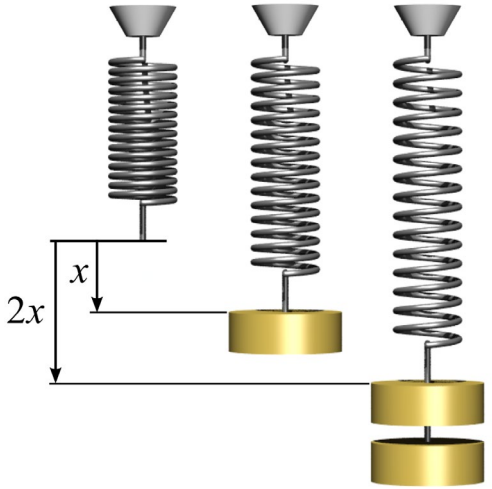
Description

This project uses Hooke's Law to find the elastic modulus of a material.

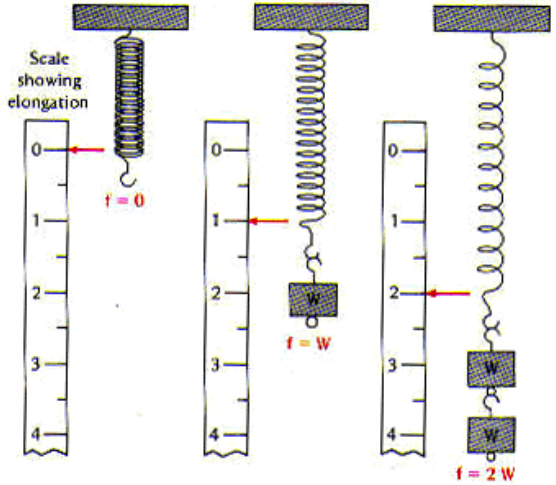
Goals

To observe elastic behavior of a material.
To calculate stress and strain from a physical test.
To produce a stress vs. strain graph and calculate the E modulus.

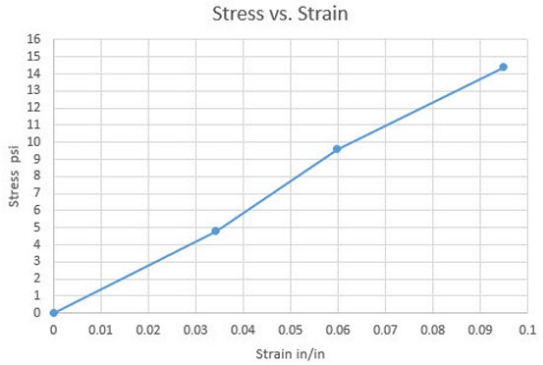
Lab: Elasticity



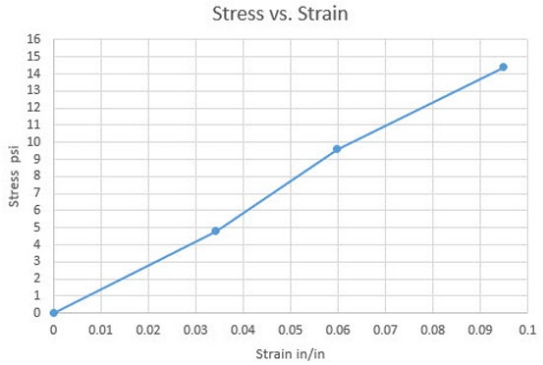
Hook's law



Hookes Law - Force proportional to Stretch



Lab: Elasticity



Procedure

1. Pin the large graph paper to the wall.
2. Put a clip on each end of the rubber cord hanging it so that the top clip is at the top of the graph paper. Adjust the bottom clip to the edge of a large, dark square. The larger squares are each ½ inch.
3. Measure the length of the cord between the ends by counting the squares.
4. Hang one weight from the cord.
5. Measure the deformation of the cord (the amount it stretches). Each small square is 0.1 inch.
6. Next hang two weights on the chord and measure the total deformation.
7. Finally hang three weights on the chord and measure the total deformation again.
8. Calculate the stress ($f=P/A$) and strain ($\varepsilon=D/L$). The area of the 1/8"x1/16" cord is 0.007813 in^2 and each washer weighs ½ oz. = 0.03125 lbs.
9. Plot the stress vs. strain.
10. Find the slope of the line to determine the modulus of elasticity, $E = f/\varepsilon$.

Bridge Project

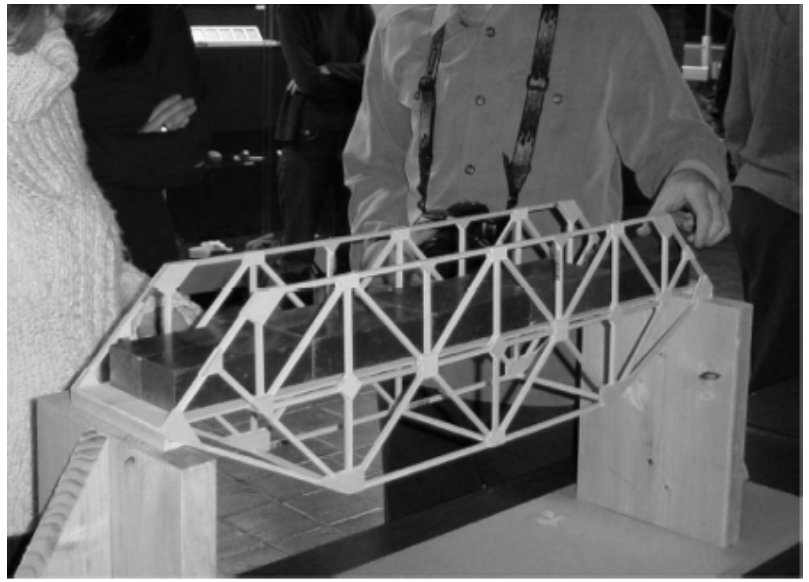
FEEDBACKS +

Evaluations + Comments

Answering Questions

Span=160 ft (scaled = 30 in)
Max. Depth = 53 ft (10 in)
Max. Deck = 8 in (1/8 in thick)

Max Weight = 68k (4 oz)
Material = wood + glue



Thank you.

Any question?

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