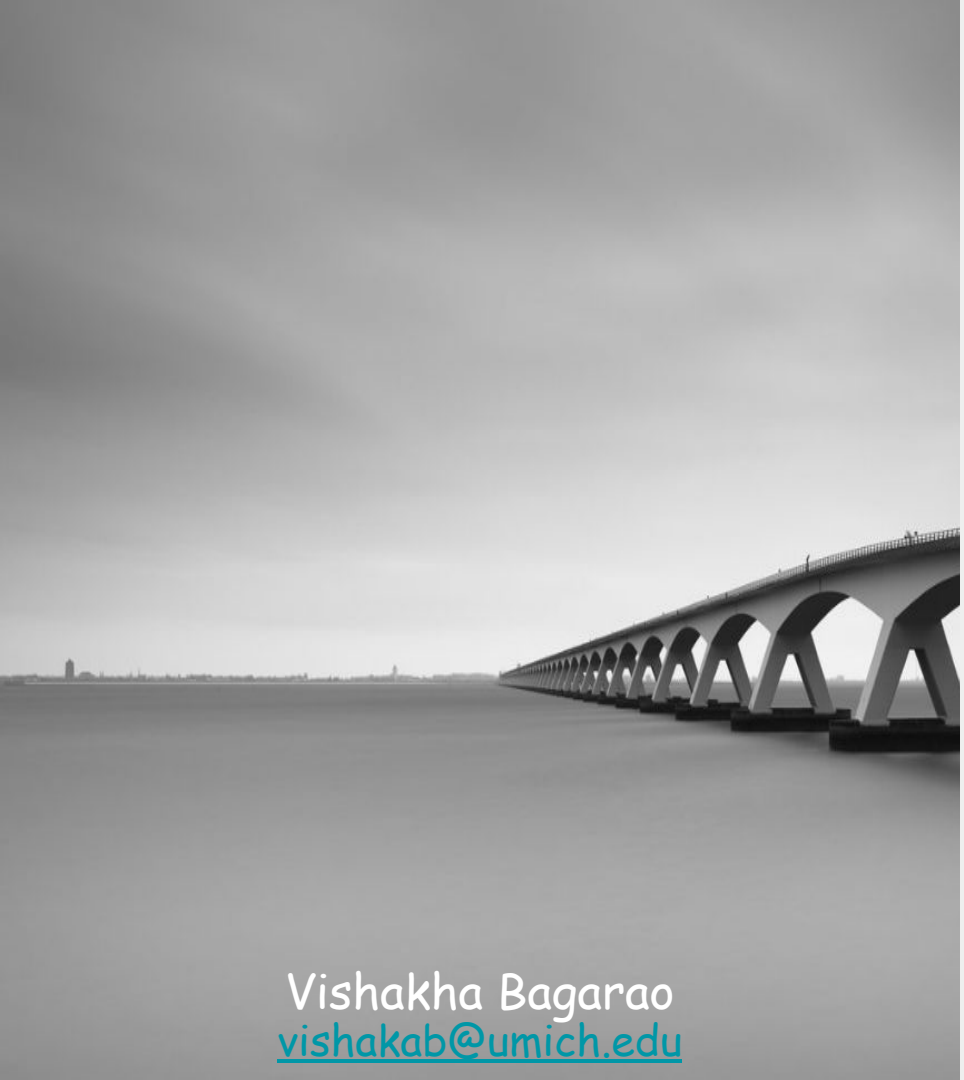
Arch 314- Structures I

Recitation 006

Vishakha Bagarao

1st Nov 2024



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- Lab 08- Elasticity

Elasticity

- Stress is the force applied to an object per unit area.
- Strain is the amount of deformation in the material, per unit length.
- Hooke's Law: Stress is proportional to strain.
- Young's Modulus, is obtained by dividing the stress by the strain present in the material. It is measure of the stiffness of the material. (Thomas Young, 1807).
- Deformation: Elastic deformation is when a material temporarily changes shape under force, but returns to its original shape once the force is removed.

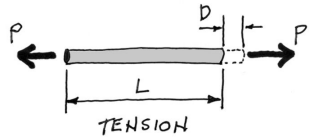
$$\sigma = \frac{P}{A}$$

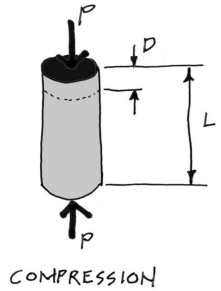
$$\varepsilon = \frac{D}{L}$$

$$\varepsilon \propto \sigma$$

$$\mathrm{E} = \frac{P/A}{D/L} = \frac{\sigma}{\varepsilon}$$

$$D = \frac{PL}{AE}$$

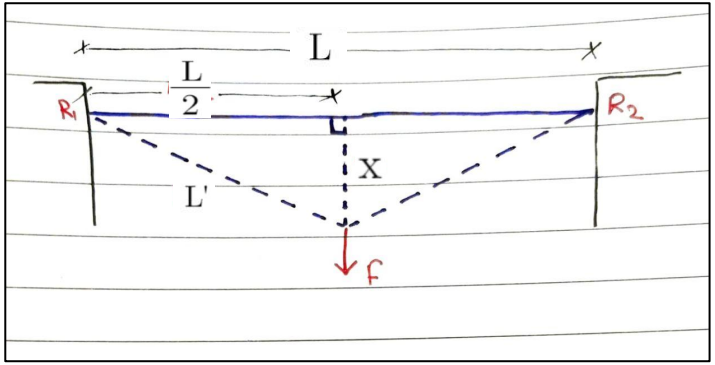




Elasticity:

- Final stretched length of the full cable : 2xL'

$$L' = \sqrt{\left(\frac{L}{2}\right)^2 + (x)^2}$$



- Deformation of full cable: D

$$D = 2L' - L$$

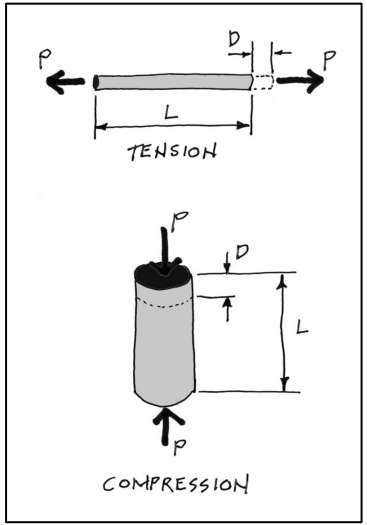
- Stress and Strain in the cable

$$\sigma \propto \varepsilon \qquad \sigma = \frac{P}{A} \qquad \varepsilon = \frac{D}{L}$$

- Young's Modulus: E

$$E = \frac{\sigma}{\varepsilon} = \frac{P/A}{D/L} = \frac{PxL}{AxD}$$

$$P = \frac{ExAxD}{L}$$



Problem Set 10

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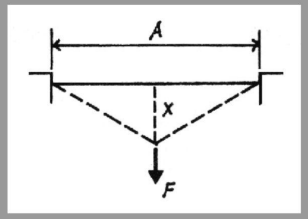
10. Elastic Deformation

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: 3 -1- -2-

Span: A	36 FT
Sag: x	1.24137931 FT
Cable Area	0.8 IN^2
Young's Modulus: E	25439 KSI

#	Question	Your Response	Correct Answer	Score
1	Final stretched length of the full cable	36.0855 FT	36.0855 FT	5
2	Deformation D of full cable	0.08551 FT	0.0855108 FT	5
3	Force in the stretched cable	48.3402 KIPS	48.3402 KIPS	5
4	Horizontal component of the force in the cable	48.2257 KIPS	48.2257 KIPS	5
5	Vertical component of the force in the cable	3.32569 KIPS	3.32591 KIPS	5
6	Total force F applied to cable	6.65139 KIPS	6.65182 KIPS	5
7	Stress in the cable	60.4253 KSI	60.4253 KSI	5
8	Strain of the cable	0.002375 IN/IN	0.0023753 IN/IN	5

Current Score: 40 / 40

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#1. Final stretched length of the full cable. (2L')

$$L' = \sqrt{\left(\frac{A}{2}\right)^2 + x^2} \quad \text{...[By pythagorean thm]}$$

$$= \sqrt{\left(\frac{36}{2}\right)^2 + (1.24137931)^2}$$

$$\therefore L' = 18.0427554 \text{ FT} //$$

Final stretched length of the full cable $= 2L'$

$$= 2 \times 18.0427554$$

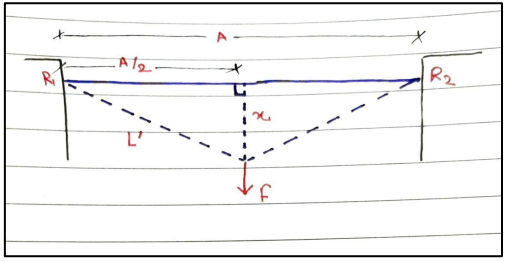
$$\therefore 2L' = 36.0855 \text{ FT}$$

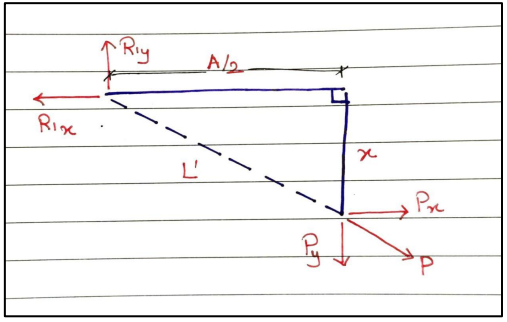
#2. Deformation of full cable. (D).

$$D = 2L' - A$$

$$= 36.0855 - 36$$

$$\therefore D = 0.0855 \text{ FT}$$





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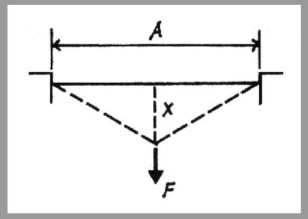

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#3. force in the stretched cable (P)

$$P = \frac{\text{Cable area} \times D \times E}{\text{Span: A.}}$$

$$= \frac{0.8 \times 0.0855 \times 25439}{36}$$

$$\left[\frac{in^2 \times ft \times \frac{KIPS}{in^2}}{ft} = KIPS \right]$$

$$\therefore P = 48.34 \text{ KIPS.}$$

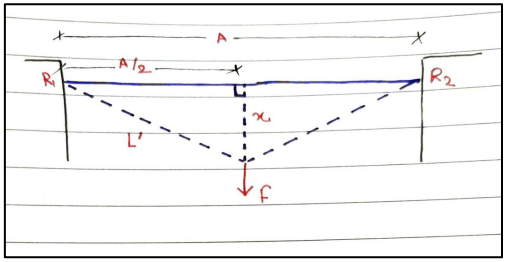
#4. Horizontal component of the force in the cable.

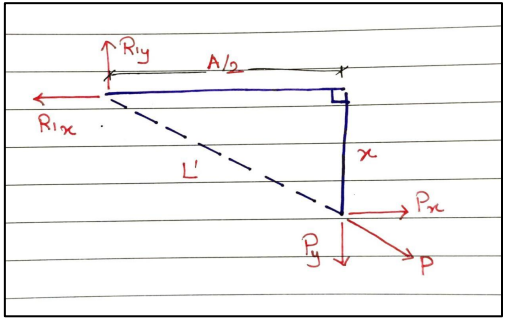
P_x

$$\frac{P_x}{A/2} = \frac{P}{L'}$$

$$\therefore P_x = \frac{48.34 \times 18}{18.04276}$$

$$\therefore P_x = 48.225 \text{ KIPS.}$$





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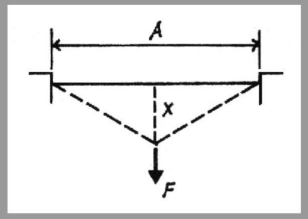

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#5. Vertical component of the force in the cable: P_y

$$\frac{P_y}{x} = \frac{P}{L'}$$

$$\therefore P_y = \frac{48.34 \times 1.2414}{18.04276}$$

$$\therefore P_y = 3.3259 \text{ KIPS}$$

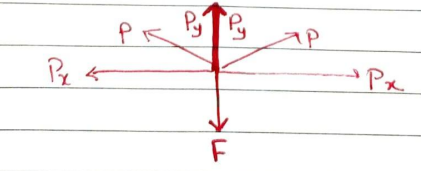
#6. Total force applied to the cable: F.

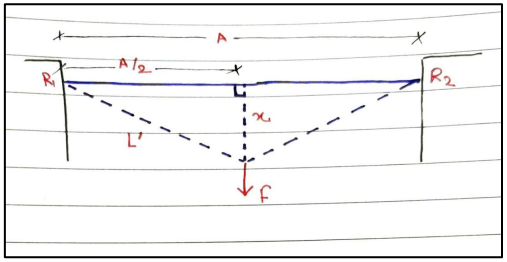
$$\Sigma F_y = 2 \times P_y - F = 0$$

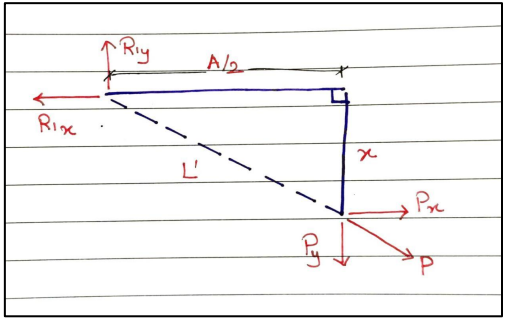
$$\therefore F = 2 \times P_y$$

$$= 2 \times 3.3259$$

$$\therefore F = 6.6518 \text{ KIPS}$$







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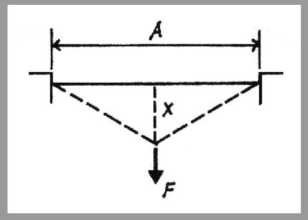

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7. Stress in the cable: σ

$$\sigma = \frac{P}{\text{Area}} = \frac{\text{Force}}{\text{Area}}$$

$$= \frac{48.34}{0.8} \qquad \left[\frac{\text{KIPS}}{\text{in}^2} = \text{KSI}\right]$$

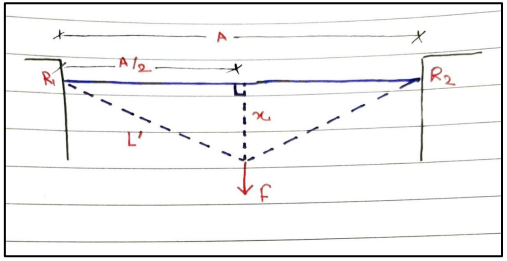
$$\therefore \sigma = 60.425 \text{ KSI}$$

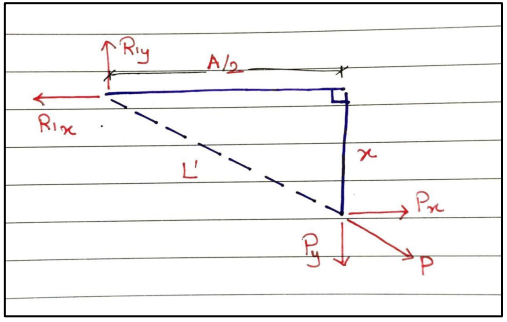
8. Strain of the cable: ε

$$\varepsilon = \frac{D}{L} = \frac{\text{Deformation}}{\text{original length.}}$$

$$= \frac{0.0855}{36} \qquad \left[\frac{\text{ft}}{\text{ft}} = \frac{\text{in}}{\text{in}} = \frac{\text{m}}{\text{m}} = \frac{\text{cm}}{\text{cm}}\right]$$

$$\therefore \varepsilon = 0.002375 \text{ in/in}$$





Lab 08 Elasticity

Structures I
Arch 314

Name 1 _____
Name 2 _____
Name 3 _____

Elasticity

Description

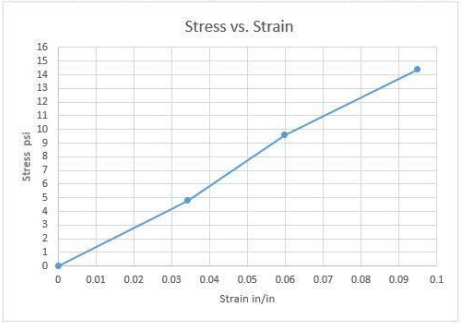
This project uses Hooke's Law to find the elastic modulus of a material.

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.

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 (ε=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/ε.



Due

During recitation