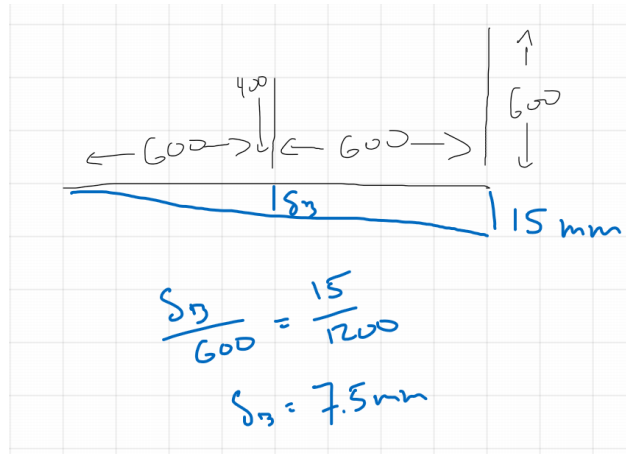
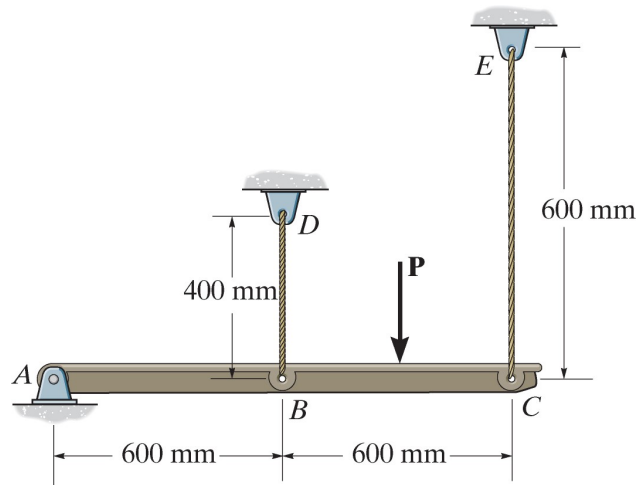


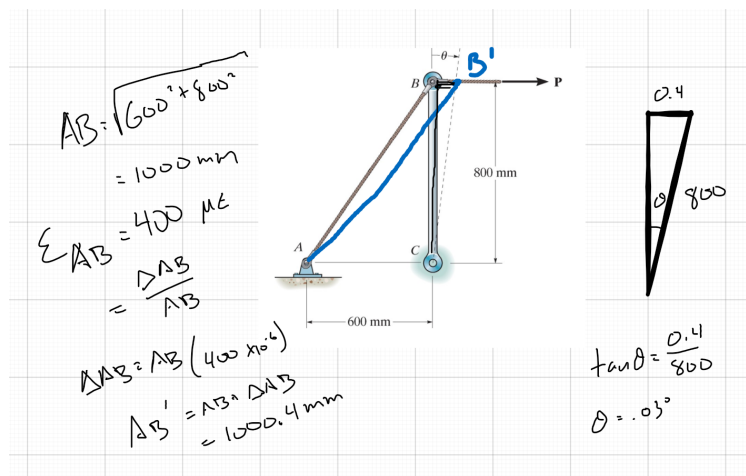
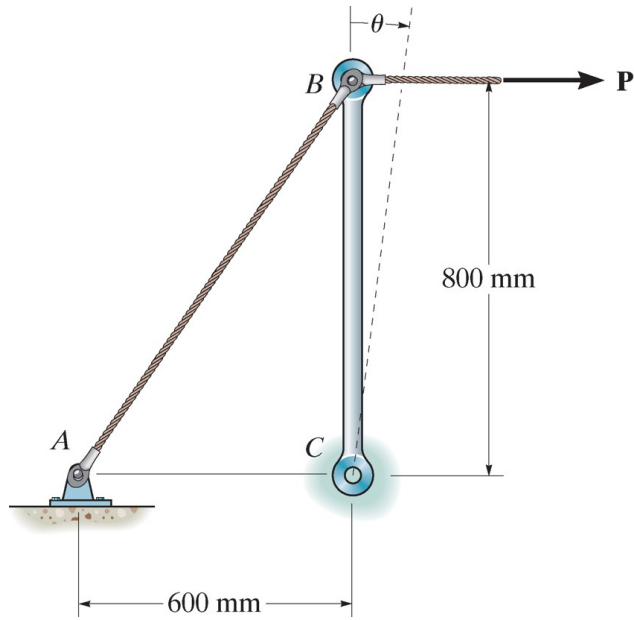
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Homework 2

1. If the load shown causes the point C to displace 15 mm find the strain in the ropes BD and CE .

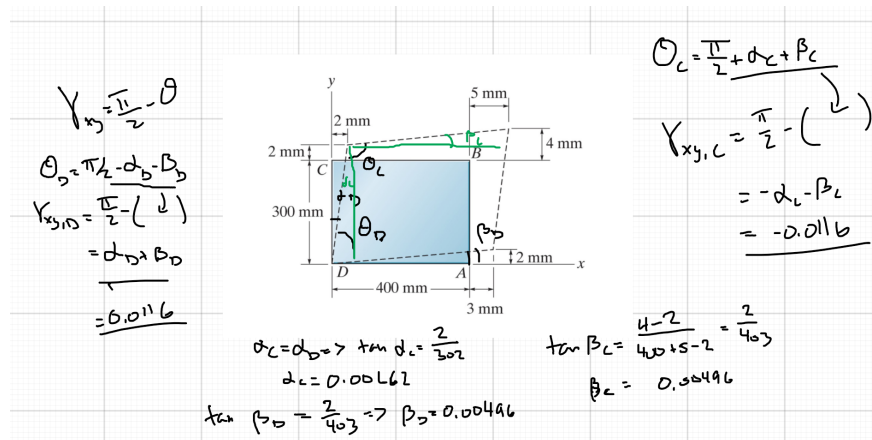
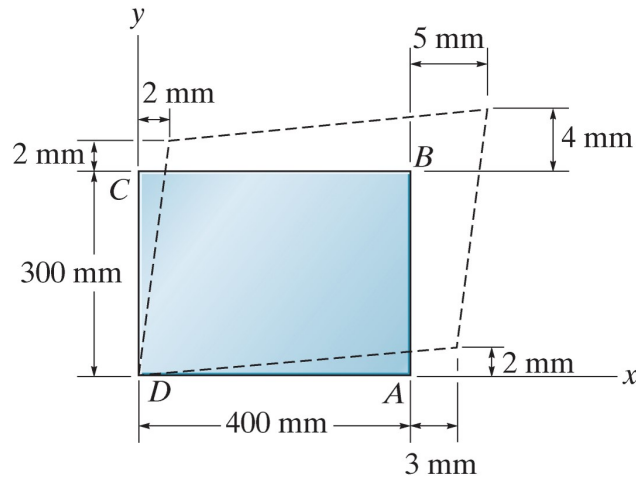


- We use similar triangles to find the displacement at B , $\delta_B = 7.5 \text{ mm}$
 - We can now find the strain in both ropes $\epsilon_{BD} = \frac{7.5}{400} = 0.0188$ and $\epsilon_{CE} = \frac{16}{600} = 0.025$
2. A flexible cable, AB , connects to a rigid member CB as part of an airplane control mechanism. A force as shown causes a strain in the cable of $400\mu\epsilon$, find the angle θ that the rigid member rotates due to this strain.

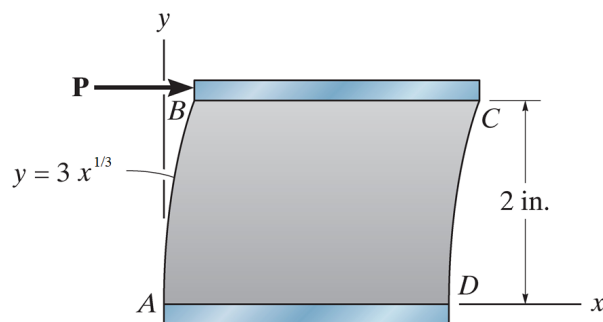


- We see that $\theta = 0.03^\circ$

3. Determine the shear strain, γ_{xy} at corners C and D for the plate shown.

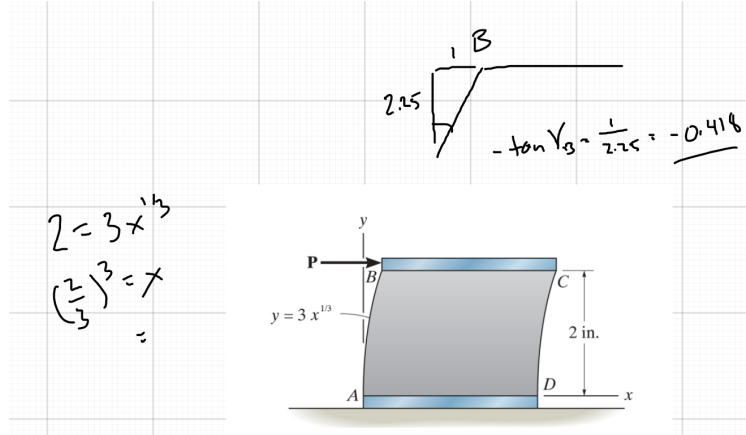


4. The polysulfone block is glued at its top and bottom to rigid plates. A tangential force applied to the top plate causes the sides to deform so that they are described by the equation $y = 3x^{1/3}$. Find the shear strain at corners A and B.



- Since we do not have straight lines, for this problem we need to consider the slope of the curved surface at the two points of interest, A and B.
- We can find these slopes using the derivative

- $y' = x^{-2/3}$
- The next thing we need to determine is the x-coordinate at B (when $y = 2$), we find $x = (2/3)^3 = 0.2963$
- Now we can substitute the two known values of x into the derivative, $y'(0) = \infty$, $y'(0.2963) = 2.25$.
- The slope at A is infinite, meaning a vertical line, which means $\gamma_{xy,A} = 0$
- The slope at B is 2.25, and we can find the associated angle $\gamma_{xy,B} = -0.418$



5. A tension test was performed on a steel specimen with a cross-sectional area of 0.5 in^2 and a gage length of 2 in. Plot the stress-strain diagram and find the modulus of elasticity, the yield stress, and the ultimate tensile strength.

Table 1: tensile test data

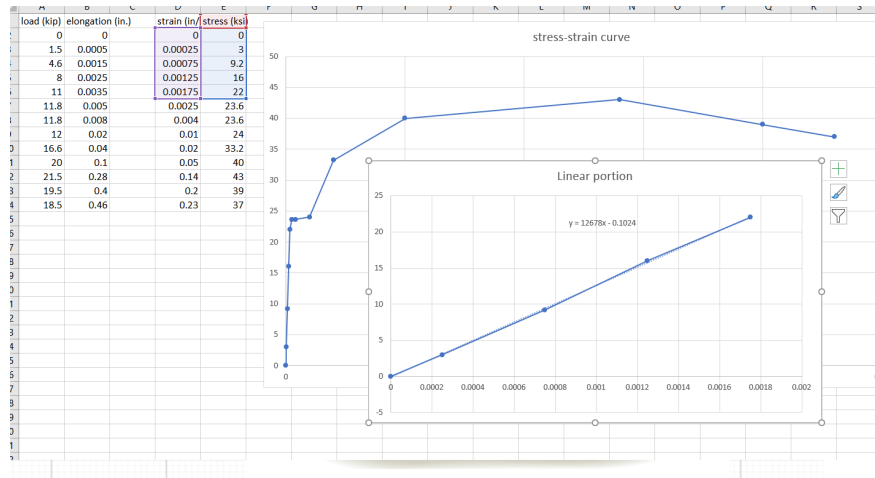
Load (kip)	Elongation (in)
0	0
1.50	0.0005
4.60	0.0015
8.00	0.0025
11.00	0.0035
11.80	0.0050
11.80	0.0080
12.00	0.0200
16.60	0.0400
20.00	0.1000
21.50	0.2800
19.50	0.4000
18.50	0.4600

Load (kip)	Elongation (in)
0	0
1.50	0.0005
4.60	0.0015
8.00	0.0025
11.00	0.0035
11.80	0.0050
11.80	0.0080
12.00	0.0200
16.60	0.0400
20.00	0.1000
21.50	0.2800
19.50	0.4000
18.50	0.4600

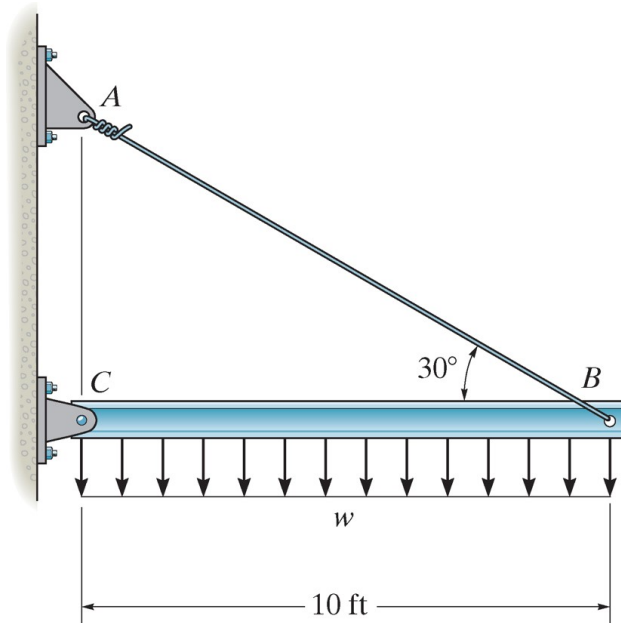
- My solution for this problem was performed in Excel, stress and strain were calculated from the load and elongation, then a best-fit line in the linear region

was used to find E and σ_Y , the ultimate tensile strength is the highest stress found.

- $E = 13 \text{ Msi}$, $\sigma_Y = 23.6 \text{ ksi}$, $\sigma_{ult} = 43 \text{ ksi}$

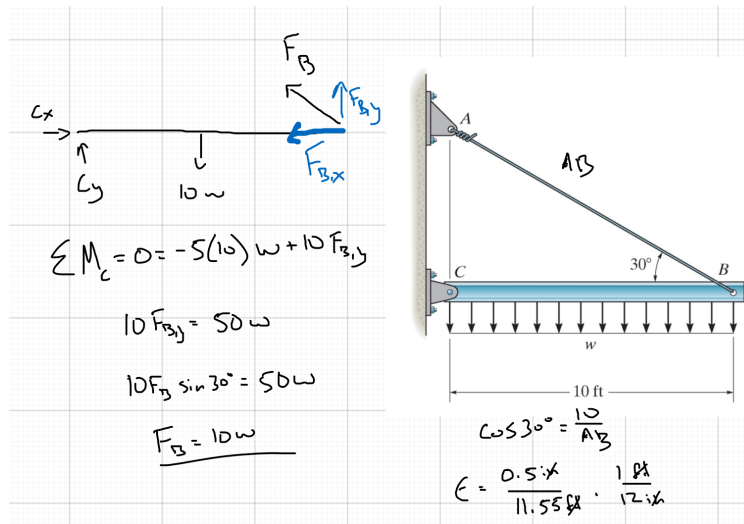


6. The rigid beam shown is supported by a pin at C and an A-36 steel wire AB . If the wire diameter is 0.25 in determine what the load w is when B is displaced 0.50 in downward.

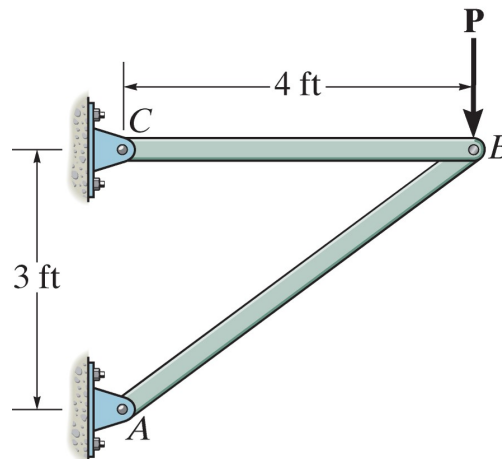


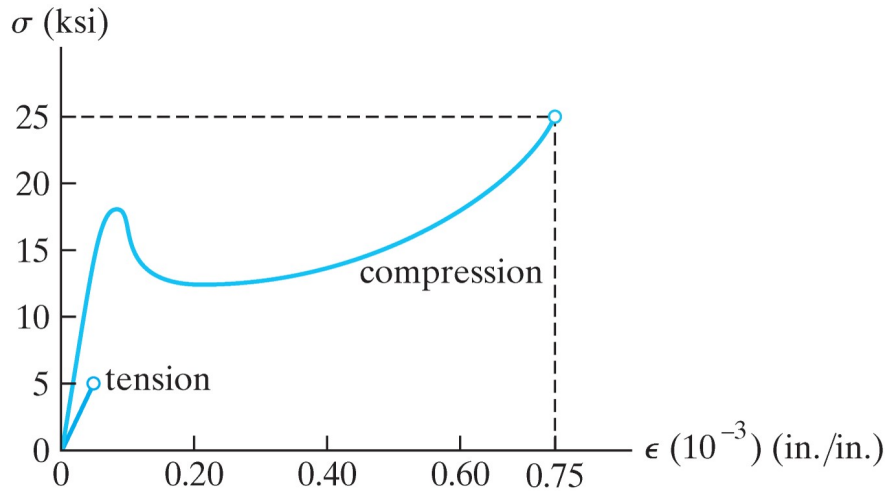
- Since the beam is "rigid" the displacement at B will be entirely due to stretch of the wire.
- We can look up E for A-36 steel in the back cover of the text, $E = 29.0 \text{ Msi}$
- For $\Delta L = 0.5 \text{ in}$ we know that $\epsilon = 0.5/12/11.55 = 0.00361$

- Using Hook's Law we know that $\sigma = E\epsilon = 29.0 \text{ Msi} \cdot 0.00361$ which gives $\sigma = 104.6 \text{ ksi}$, which for the given diameter means a force of 5.14 kip
- Using statics we can relate the force in the wire to the distributed load

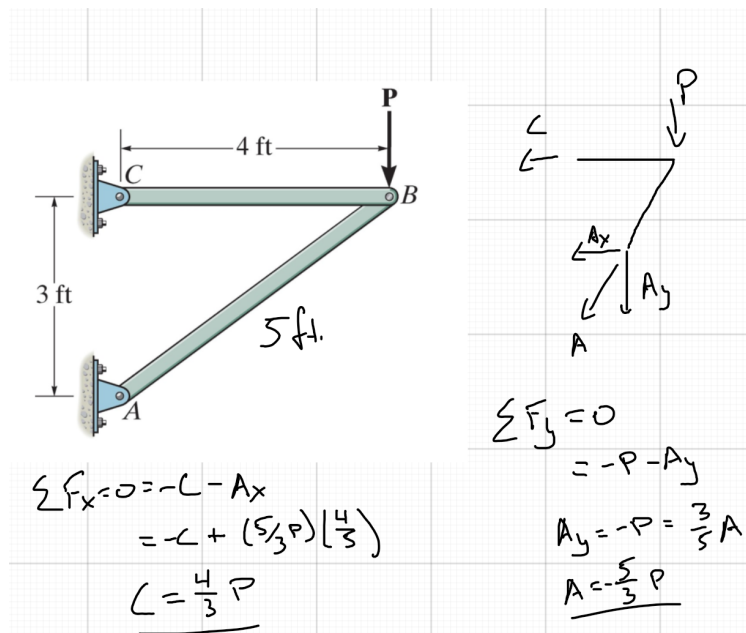


- since $F_B = 5.14 \text{ kip} = 10w$ we know that $w = 514 \text{ lb/ft}$
7. The two bars shown are made from the material given in the stress-strain diagram shown. Find the cross-sectional area of each bar such that they fail under the same load P . Neglect any effects from buckling, consider only tensile and compressive failure.





- We start by doing some statics to determine whether a bar is in tension or compression. Notice that since all forces/reactions occur at pins at the end, these are both 2-force members, so all reaction forces need to act along the axis of the bars



- We see that for a positive P that AB is in compression while BC is in tension. This means that AB will fail at 25 ksi and BC will fail at 5 ksi
- We can now find the areas such that the load P will cause failure in both
- We will find both areas in terms of the unknown load P
- $A_{AB} = 5P/3/25 = \frac{1}{15}P$ where P is in k-lb.
- $A_{BC} = 4P/3/5 = \frac{4}{15}P$ where P is in k-lb., we see that BC needs an area 4 times the size of AB .

8. Dr. Smith made a rubber band gun for his son. If the gun is 9 in long, compare the strain in 0.5 in, 1 in, and 2 in diameter rubber bands when stretched over the barrel of the gun.
- If the rubber bands are perfectly flexible, and we treat them as folding into nearly a straight line, then their initial length is one-half their circumference
 - The final length will be the length of the rubber band gun, this gives strains of 10.5, 4.7, 1.9
 - Rubber deforms much more than most engineering materials (steel, aluminum, wood) and thus has much higher strain values than we are used to seeing