Stress Concentration Lab Instructions

This lab is a modified version of an at-home lab for students in the EGR 203 Mechanics of Materials course.

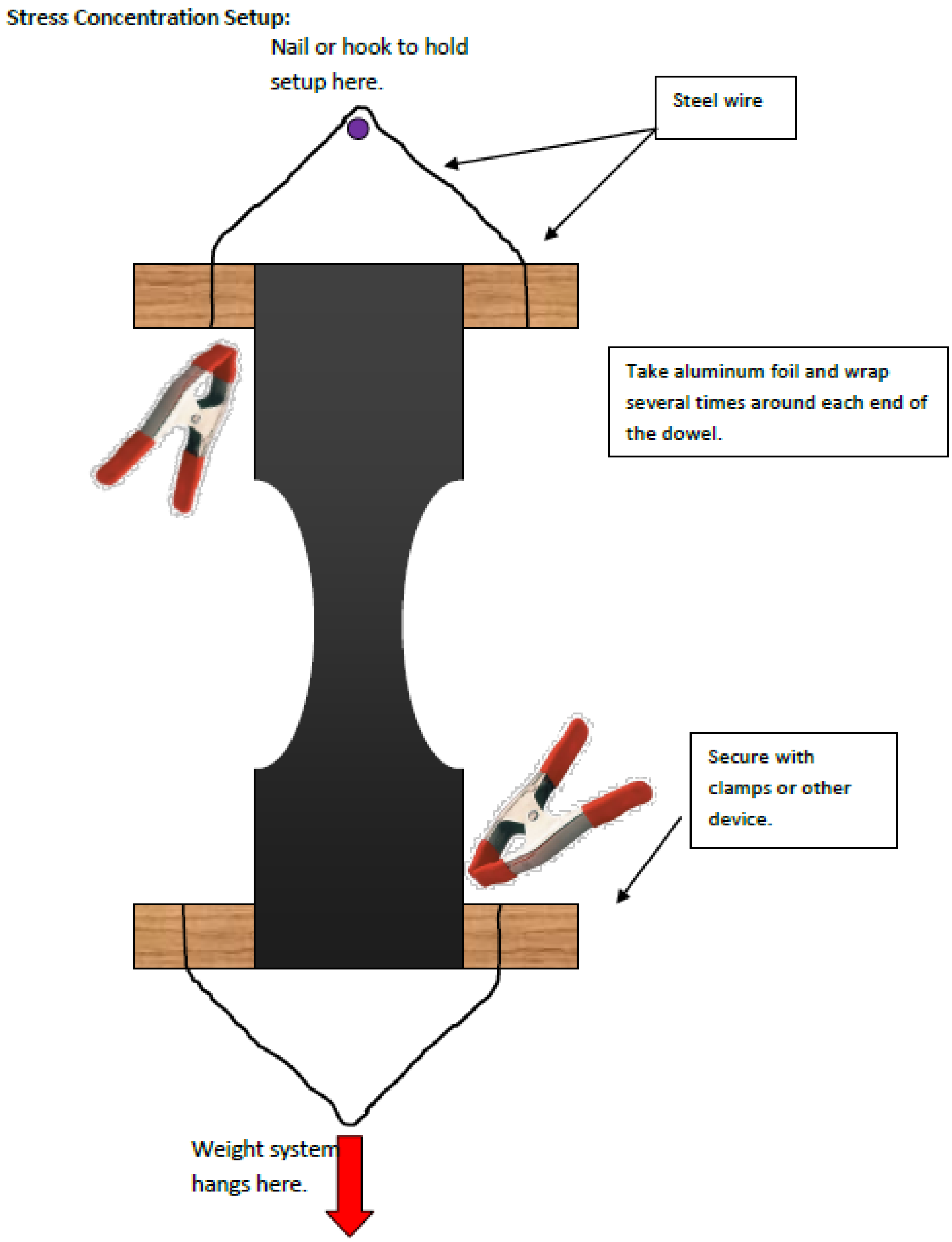
Try it yourself and compare your results with students in the class!

Set-Up

For this lab, you will need to create a stress concentration set-up with a weight system as shown in the picture. **Note** that you can replace the dowel and clamps with pencils and binder clips (or any other means you have) to securely attach the two ends of aluminum foil without creasing (see student example photos).

It is helpful to roll the ends of the foil around the dowels a few times to prevent slipping when you hang weights.

You will also need aluminum foil and a cup to hold the weights. Pennies and other coins are popular weights (you can look up the standard mass on the US Mint website) or water if you'd like. Just remember – water will spill all over when the foil breaks! Try that outside.



Template Instructions

Print out the template page and cut both templates out along the lines.

Place the templates over a sheet of aluminum foil (folded to be 2-ply thick generally yields better results) and mark with a pen or pencil.

Cut the foil to the same shape as the template.

Each of the shapes will be treated independently. Begin with the “dogbone” shaped foil. Wrap each end around the dowel/pencil and affix as shown below.

Procedure

1. Record the measurements for your cut foil in the table. You will need to know the smallest width and the thickness of your aluminum foil. Thickness is difficult to measure without digital calipers. If you don’t have digital calipers, then use a standard thickness of 0.016 mm. Don’t forget to multiply by 2 if you used a double thick foil!
2. Hang weights on your hanger until the aluminum foil breaks. Record the maximum weight (mass).

   You might need to do some math here. If you added pennies, for example, you will need to take the total mass of pennies (100 pennies) * 2.5 grams per penny = 250 grams. If you are thinking that grams are not a unit of weight – that’s correct! We’ll convert to a ‘real’ unit of weight in the calculations section. Just keep it in grams for now.

3. Repeat the experiment for the shape with the 90 degree cut.
4. Experiment with at least 3 of <u>your own</u> shapes made from aluminum foil.
5. For each shape record the relevant measurements (and take a photo!).

Data Table

Shape	Smallest Width [mm]	Total Thickness of foil* [mm]	Mass [g] (Hanging Weight)
Dogbone			
90 degree			

* use 2 * 0.016mm if you aren’t sure of the thickness of your foil.

Calculation Table

1. Copy your shape column from above
2. Convert from mass to force (a.k.a. weight)

$$Force[N] = \frac{mass[g] * 9.81[\frac{kNm}{s^2}]}{1000[\frac{g}{kg}]}$$

3. Determine the cross-sectional area at the smallest width

$$Area[mm^2] = width[mm] * thickness[mm]$$

4. Calculate the maximum stress that your foil withstood before failure.

$$Stress[MPa] = \frac{Force[N]}{Area[mm^2]}$$

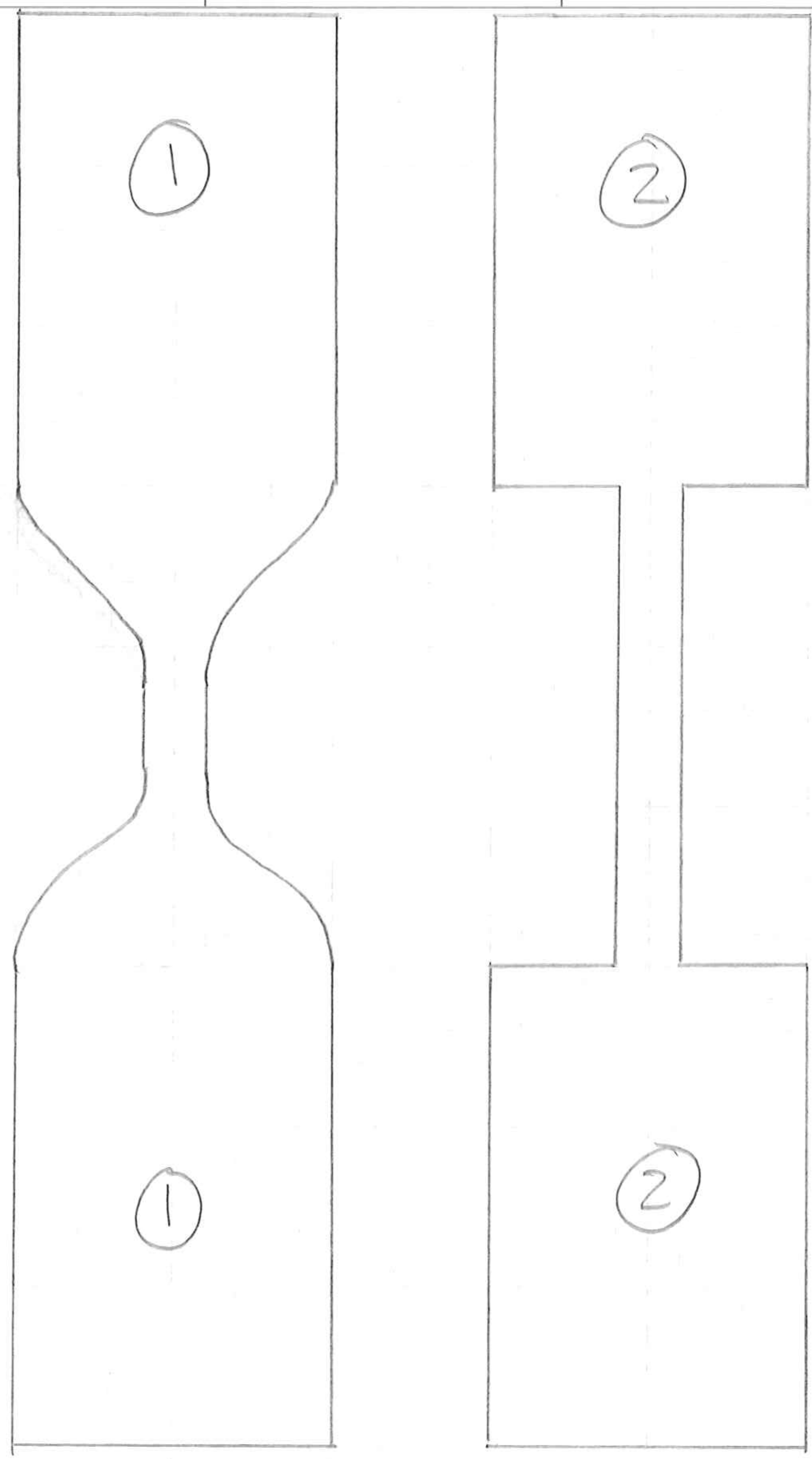
Shape	Force [N]	Cross sectional area at smallest width [mm²]	Stress [MPa]
Dogbone			
90 degree			

Results

Which shape was able to withstand the highest stress?

Can you explain why?

Do you see any of these shapes in engineered structures around you?


1
2
1
2