The 3 Point Bending Test
Finding PLA's Elastic Modulus

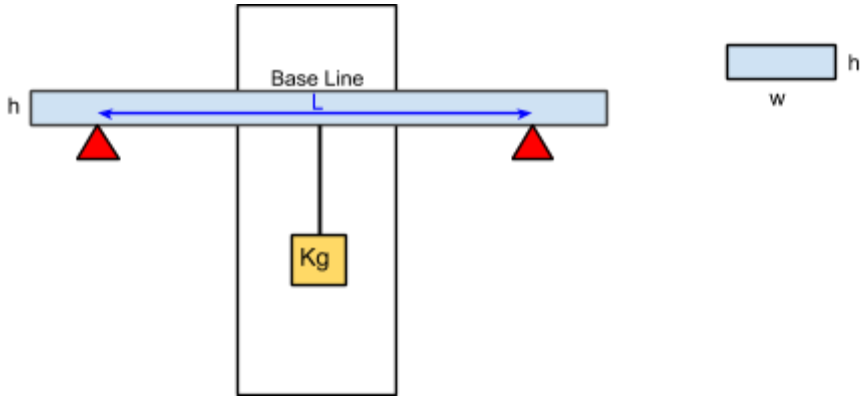
Objective:

The makerbot has been used in past student projects and certainly many more to come. In order to use this resource to its full potential it is important to understand the structural limitations of PLA. This experiment is designed to find one of the most important material properties of PLA, its elastic modulus. The elastic modulus will allow us to determine just how stiff the material is.

Materials:

* Rectangular PLA Beam, dimensions L=220 mm x W=10 mm x H=5 mm
* Triangular supports (2)
* Hanging weight set with weight hanger
* Vernier calipers (mm)
* Ruler (cm)
* Level
* String
* Blank paper

Basic Set-up:



General Procedure:

1. Print out a rectangular beam of the above dimensions.
2. Measure the beam's length with a ruler (cm).
3. Mark the center point along the length with a permanent marker.
4. At this point measure and record the beam's height and width using vernier calipers (mm).
5. Measure 1.5 cm from both ends of the beam and place a mark with permanent marker.
6. Measure and record the length (L) between the two outer marks with a ruler (cm).
7. Cut a short piece of string and tie a loop at both ends.
8. Place the beam through one of the loops and onto the two triangular supports.
9. Be sure that the outer supports are aligned with your marks.
10. Tape a blank sheet of paper to a level and place it parallel to the beam.
11. Draw a line where the top of the beam sits, this will be your base for measuring.
12. Add a weight hanger to the other loop and begin to add weight.
13. During this process make sure the string is aligned with your center mark.
14. Once the correct amount of weight is added mark the top of the beam's new position.
15. Be sure to record the mass used at each point in the chart below.
16. Continue to add increasing amounts of weight while marking each new position.
17. Carefully remove all weights and retrieve the paper.
18. Measure and record the distance between the base line and each deflection line (mm).

Data:

Beam Dimensions- L = _____ w= _____ h= _____

Beam Color- _____

Beam Fill Direction- _____

Mass (g)	F , Force (N)	δ , Deflection (mm)	Elastic Modulus (GPa)

Calculations:

To calculate force, divide mass used in grams by 1000 then multiply by 9.81.

Example: 1050 g = (1050/1000) * 9.81 = 10.3 N.

To calculate Elastic Modulus use the following equation after converting all values to SI (N,m,s).

$$E = \frac{FL^3}{4wh^3\delta}$$

The value calculated for E will be a very large amount of pascals. Dividing this number by 10^9 with put the value in GPa giving a much more manageable number. (3 sigfigs)

E average = _____

Since there is no well known value for PLA's elastic modulus true percent error cannot be evaluated. To test how accurate this experimental value is, calculate the amount of deflection for an unused amount of weight using the following equation, then test the prediction.

$$\delta = \frac{FL^3}{4wh^3E(experimental)}$$

Mass (g)	F, Force (N)	δ Calculated (mm)	δ Measured (mm)	% Error

% Error average = _____