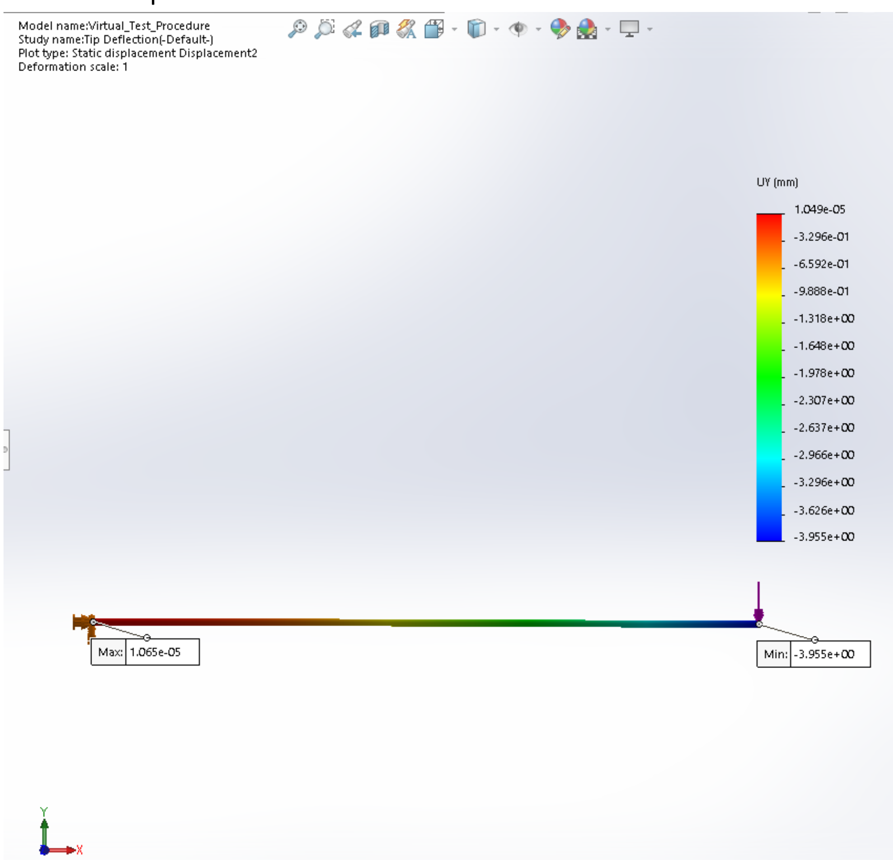
1 Deflection Under Transverse Tip Load

1. Why would a transverse tip load test be a more practical test than tensile elongation test to get an Elastic Modulus estimate of a 12mm metal rod without specialized equipment?
   Due to the size of the metal rod the pull on each end would affect the rod as a whole more than the transverse tip load. If the rod was longer then the tensile elongation test would do well.

2. As long as we stay within the realm of small deformations:
   a. What effect will doubling the load have on δ?
      The displacement would double
   b. What effect will doubling the length of the rod have on δ?
      the displacement would be multiplied by 8.
3. Insert a screenshot of the default stress plot generated showing the beam deformation under transverse tip load.



4. What is your applied load (in N) and the value of your largest magnitude transverse displacement (in mm)?

Applied Load	1	N
Transverse Tip Displacement	3.995	mm

5. Give the following section properties and equations:

	SolidWorks Value	Analytical Value	Units (SI)	Analytical equation of radius
Area	113.10	113	mm^2	Pi*r^2
Polar MOI (J)	2035.75	2035.75	mm^4	(Pi*r^4)/2
Area MOI (I)	1017.88	1017.88	mm^4	(Pi*r^4)/2

6. Solve for E using the information given and obtained. Give your value here in GPa.

Lab 2 Calc.

$\delta = \frac{PL^3}{3EI}$ $L = \cancel{1100}$ 1100 mm $\delta = -3.955$ mm $= 0.003955$

$I = I_{zz} = 1017.88\ mm^4$ $P = 1\ N$

$E = \frac{PL^3}{3\delta I} = \frac{(1N)(1100\ mm)^3}{3(3.955\ mm)(1017.88\ mm^4)}$

$E = 110208.155\ \frac{N}{mm^2} \cdot \left(\frac{1000\ mm}{1\ m}\right)^2$

$E = 1.1 \cdot 10^{11}\ \frac{N}{m^2}$ $1.10208 \cdot 10^{11}$

$\theta = \frac{TL}{JG}$ $T = .99\ N \cdot m$ $L = 1100\ mm$

$J = \frac{\pi \cdot 6^2}{2}$ $\theta = .01372$

$= \cancel{2.0357}$ $2035\ mm^4$ $1.\cancel{272}$

$G = \frac{TL}{J\theta}$ Displacement $6.332 \cdot 10^{-2}$ mm

$r = .06$ mm $\theta = D/r$

$G = \frac{E}{2(1+\nu)}$ $1+\nu = \frac{E}{2G}$ $\nu = \frac{E}{2G} - 1$

$G = \frac{(.99\ N \cdot m)(1.1\ m)}{\left(2035\ mm^4 \cdot \left(\frac{1\ m}{1000\ mm}\right)^4\right)(.01372)}$

.37

$G = 4 \cdot 10^{10}$

$\boxed{G = 3.89 \cdot 10^{10}\ N/m^2}$

$\nu = .413$

$E = \frac{PL}{A\delta}$ $\delta = 9.726 \cdot 10^{-2}$ mm $L = 1.1$ m

$P = 1100\ N$ $A = 113.1\ mm^2$

$E = \frac{(1100\ N)(1.1\ m)}{\left(113.1\ mm^2 \cdot \frac{}{1000^2}\right)\left(9.726 \cdot 10^{-2}\ mm \cdot \frac{}{1000}\right)} = 1.0999 \cdot 10^{11}$

2 TORSION TEST

1. Without specialized equipment, why couldn't we just measure the Poisson Ratio directly (by applying tension to the rod and measuring change in diameter)?
   We would not do this because the material could plastically deform and then the Poisson ratio could not be calculated from a tension test.
2. To get our angular deflection in radians, we divided displacement of an edge node by the rod radius. What are two restrictions do we need to put on when we can use this simple equation?
   a. Small deformation assumption
   b. Has to be the deformation at the end of the rod
3. What was your applied torque, maximum linear displacement, and maximum angular displacement in the units given?

Applied Torque	0.99	N.m
Max Linear Displacement	8.232e-2	mm
Max Angular Displacement	0.1372	radians

4. Compare the values obtained using your virtual tests with the values listed under Material Properties in the table below:

	Calculated	Listed in SW	% difference	Units (SI)
Elastic Modulus	1.1e11	1.102e11	0.18	N/M^2
Shear Modulus	3.89e10	4e10	2.75	N/M^2
Poisson Ratio	.413	.37	11.62	N/A

3 TENSILE ELONGATION

1. What value did you get for the elongation of the rod (in mm)?

	Simulation	Analytical	Units
Elongation (delta)	9.726e-2	9.726e-2	N/M^2

2. Is this a value you could measure accurately with a ruler?
   This is not a value that you could measuring with a ruler. You could use a dial caliper maybe or something more precise.