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سایت آموزش مهندسی مکانیک ایران

Modeling of Composite Tubes Using ANSYS

JEFF KAPKE

ME 450 Introduction to CAE

May 3, 2000

Submitted to: Professor H.U. Akay

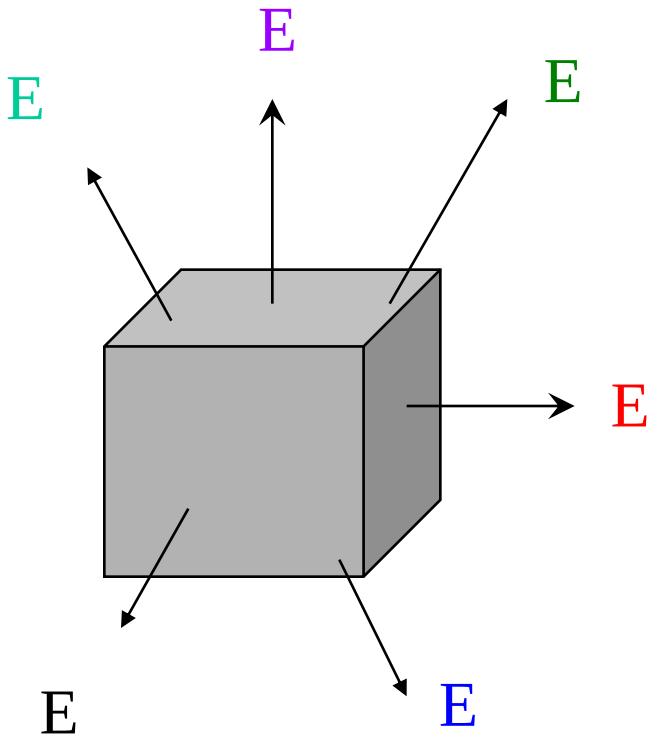
Uses for Composite Materials

- Aircraft
- Prosthetic Limbs
- Auto body
- Auto Frame
- Bridge Reinforcement
- Shafts and Rods
- Body Armour

Advantages of Composites

- Density of aluminum alloy approximately 2800 kg/m^3
- Density of carbon/epoxy approximately 1580 kg/m^3
- Tensile strength of aluminum alloy 7075-T6 is 570 MPa
- Tensile strength of carbon/epoxy 1830 MPa

Isotropic vs. Orthotropic



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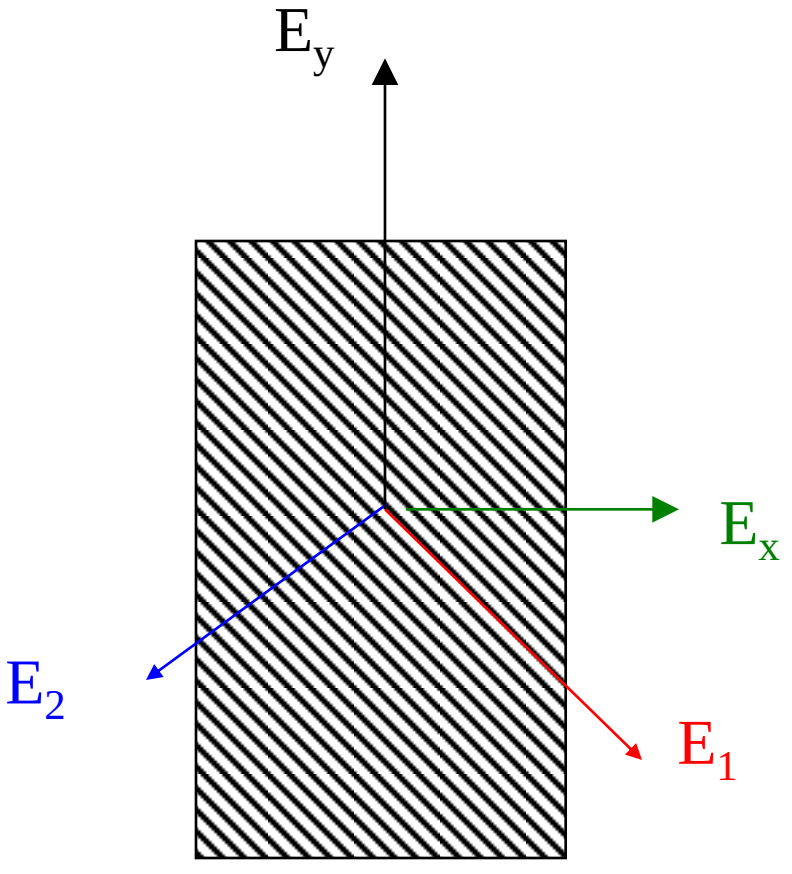
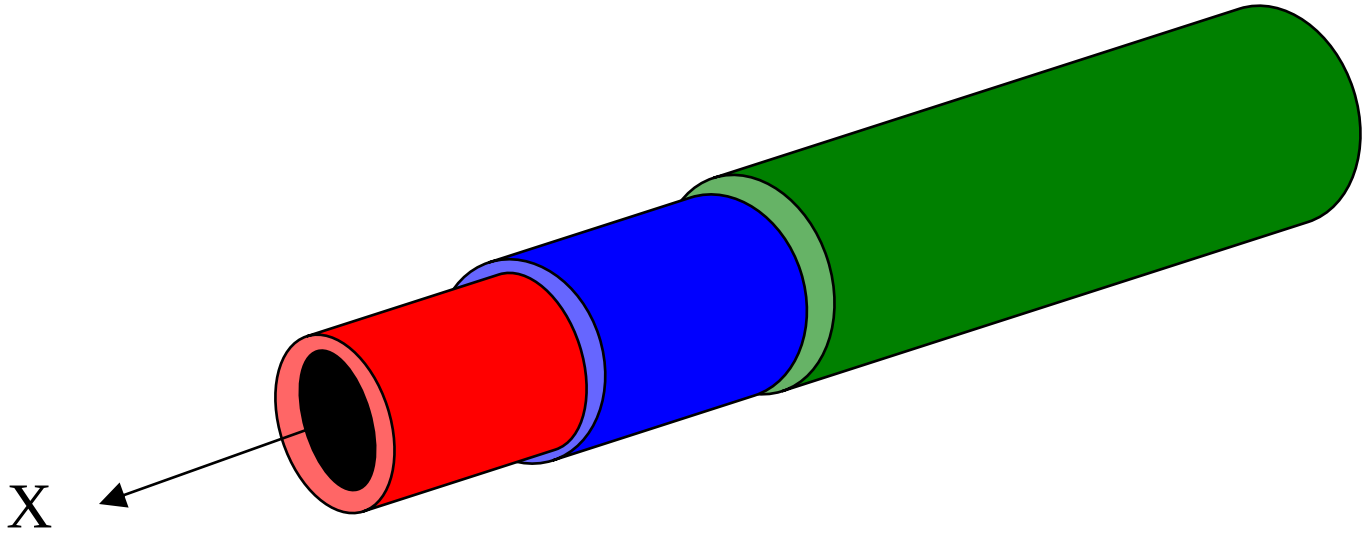


$E_x \neq E_y \neq E_1 \neq E_2$

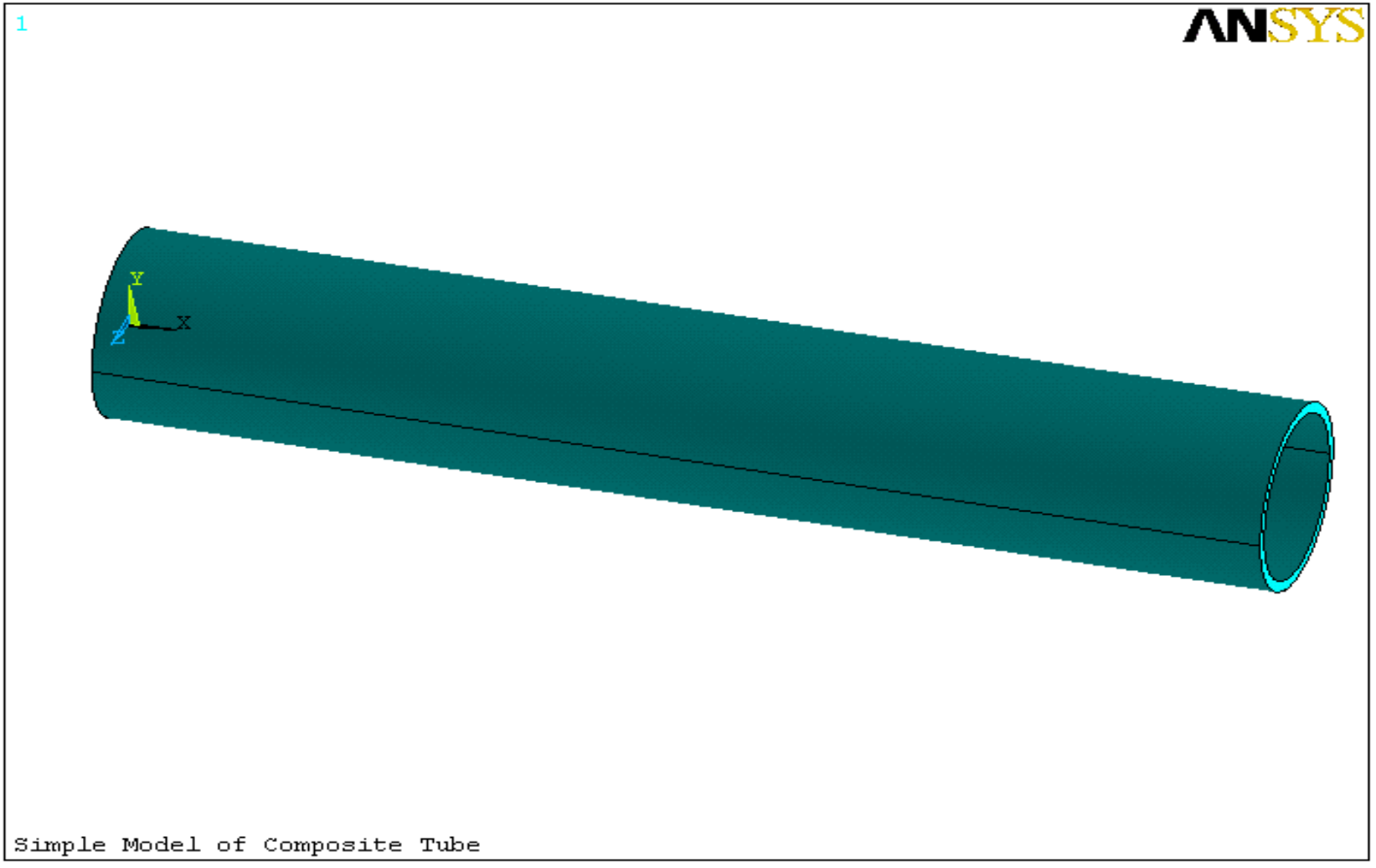
Fabrication

Layers of a Composite Tube



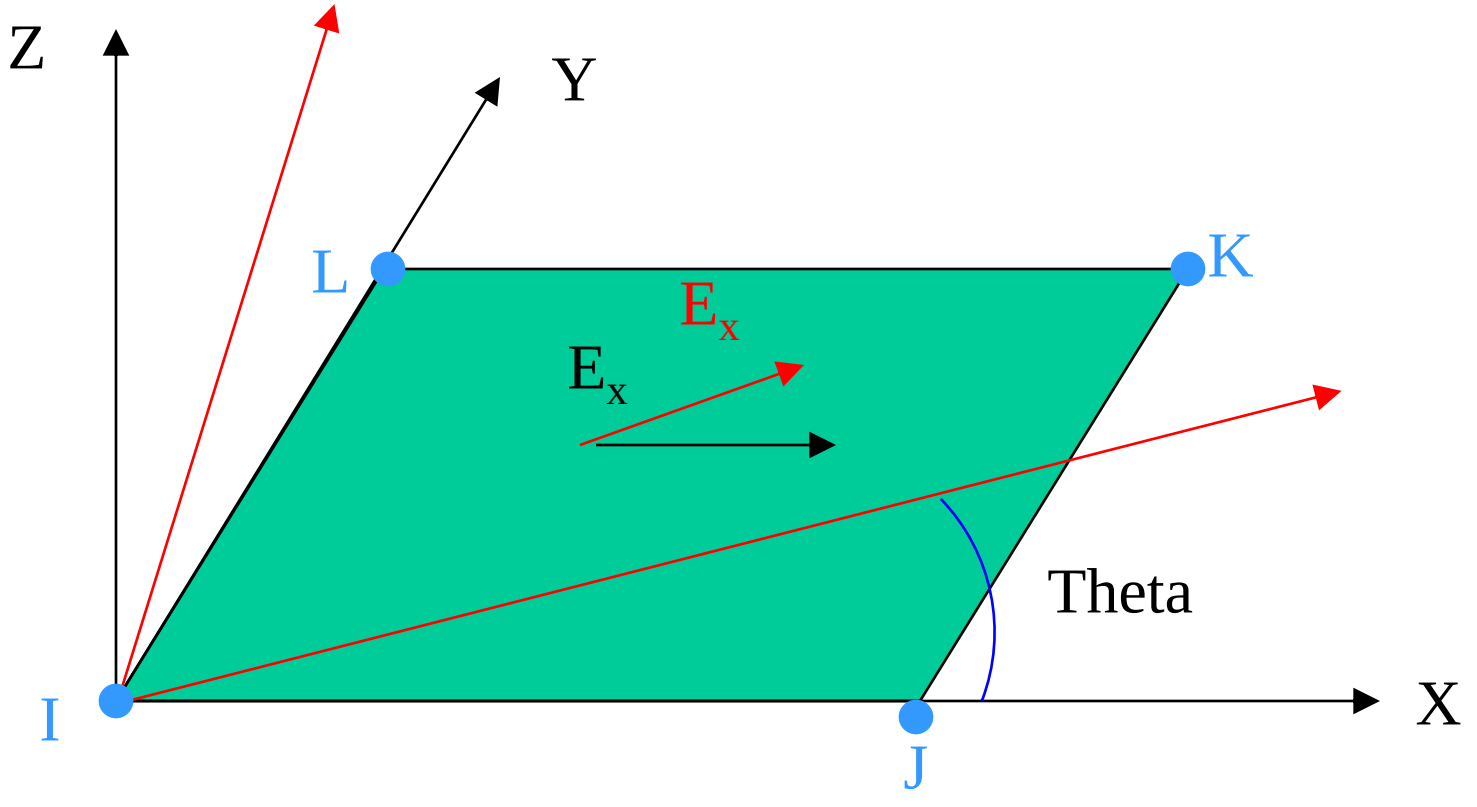
Each color represents a different fiber orientation and change in material properties relative to the Global Axis.

Modeled Tube in ANSYS

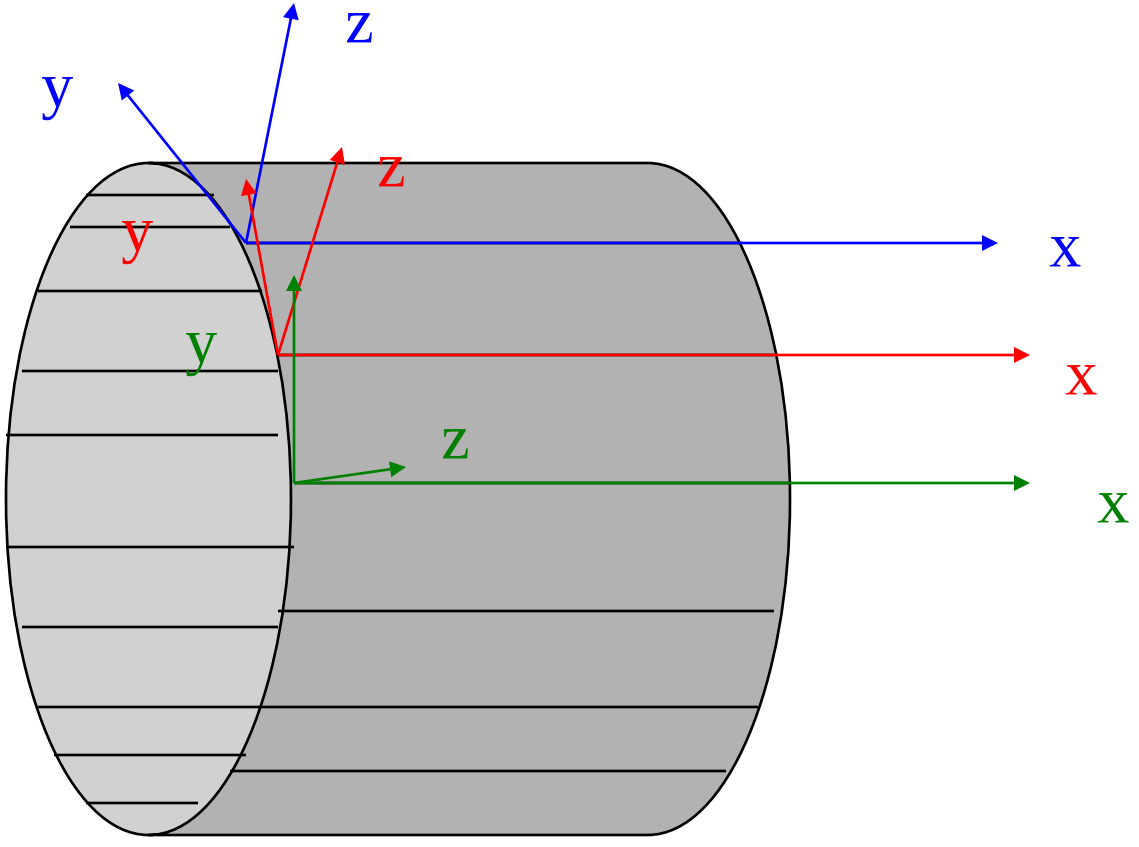


Element Coordinate System

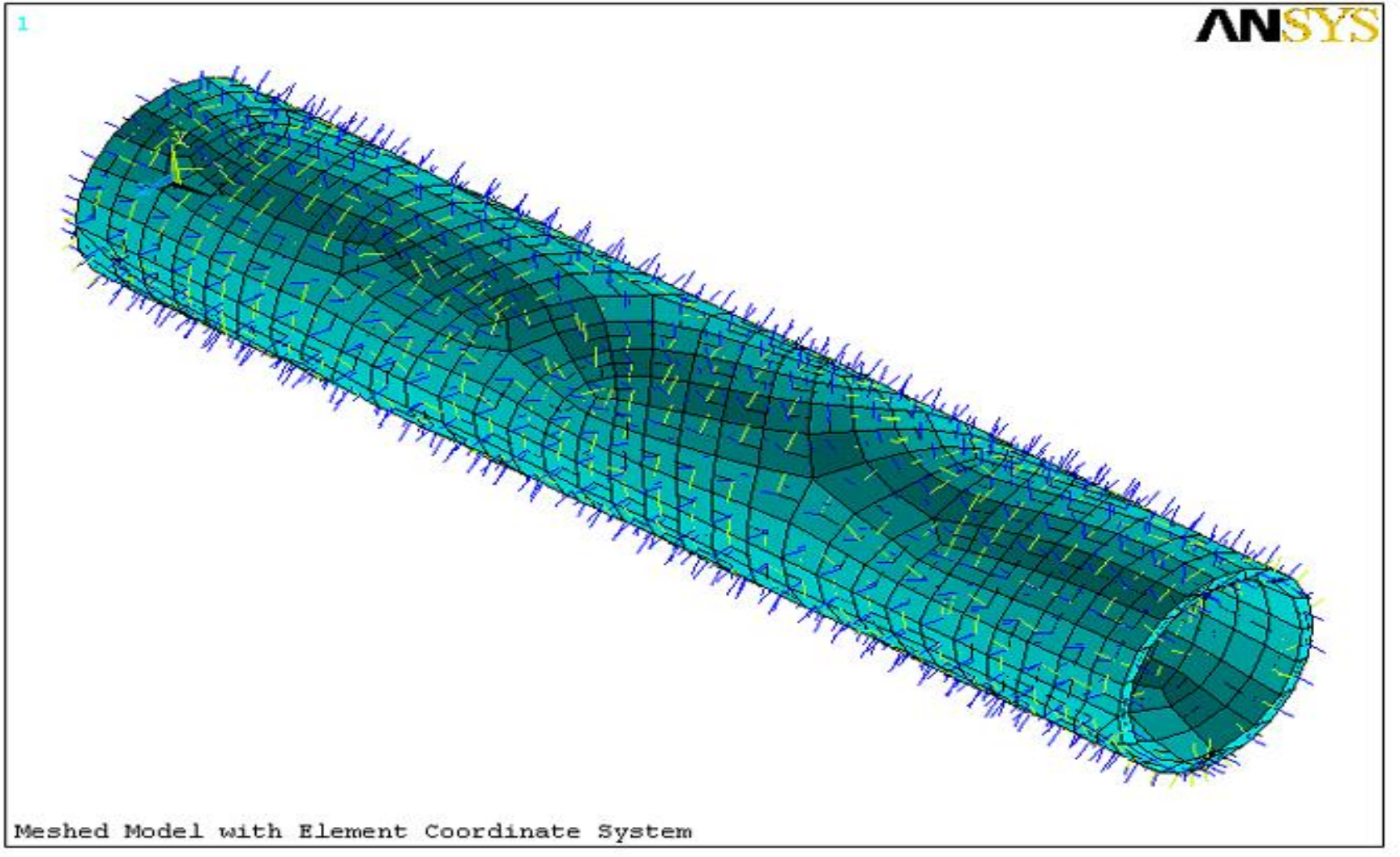
Shell 91 From ANSYS Element Library



ANSYS Coordinate System for Shell Element

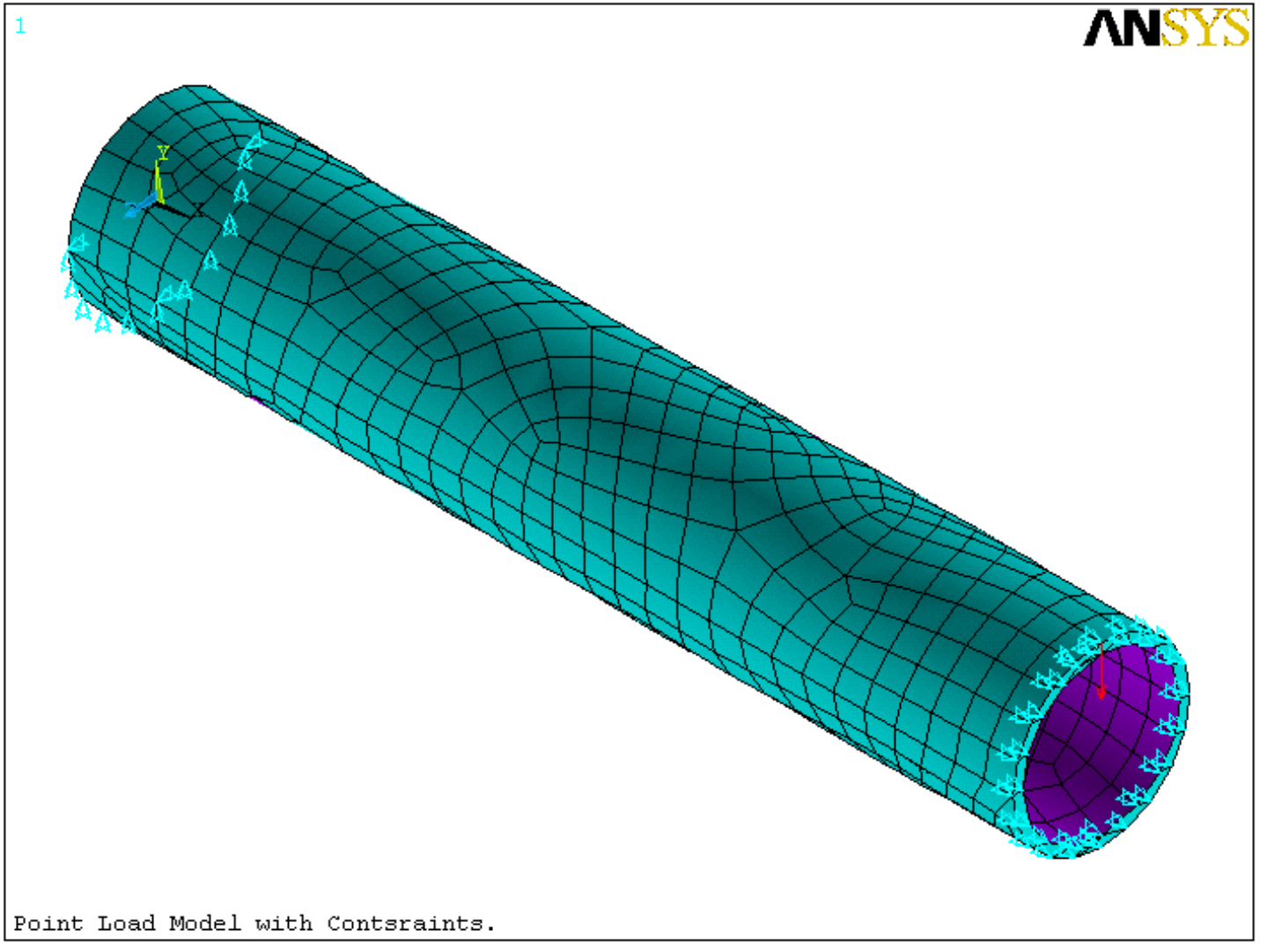


ANSYS Element Coordinate System



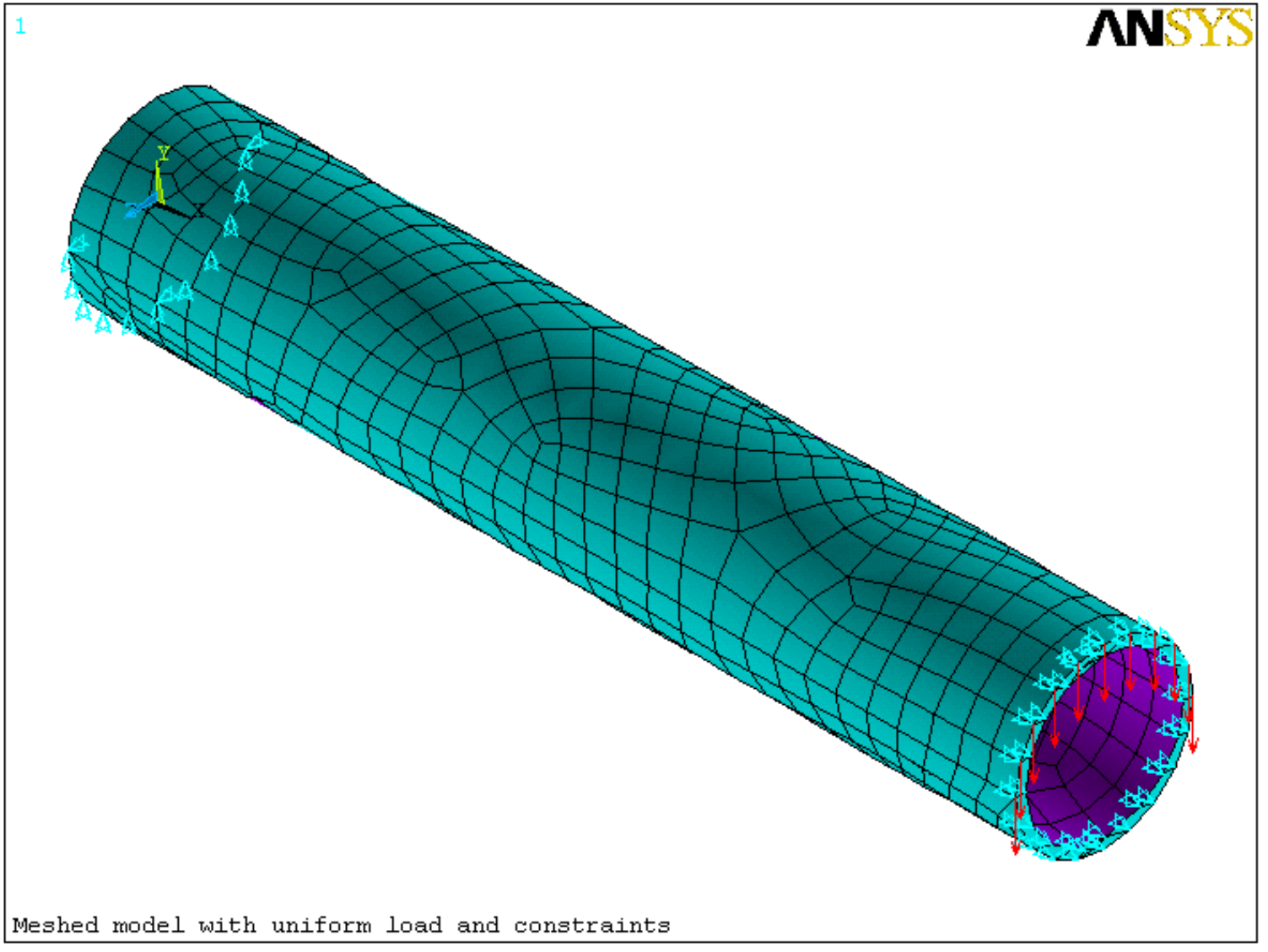
ANSYS Model Setup

Constrained with Point Load

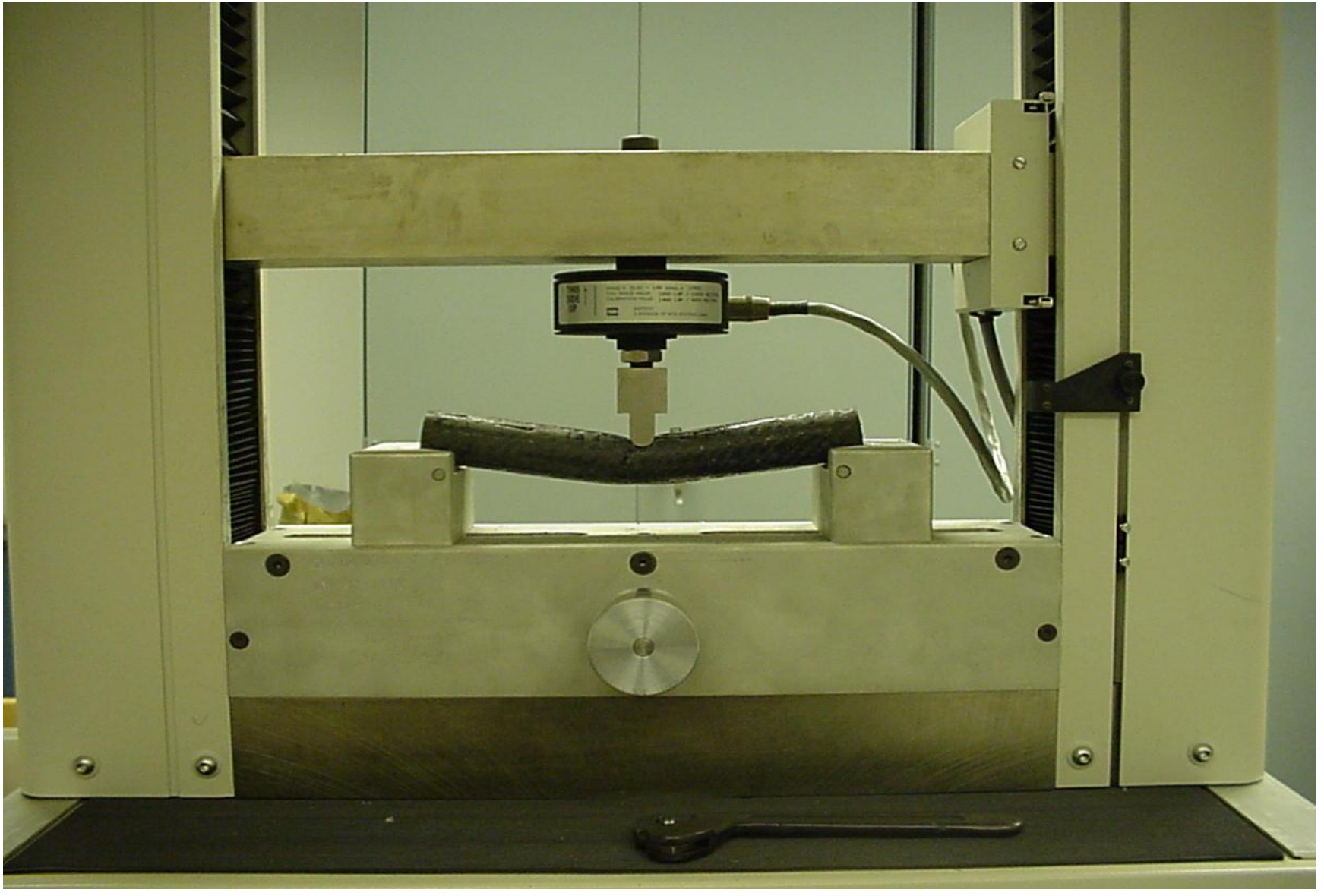


ANSYS Model Setup

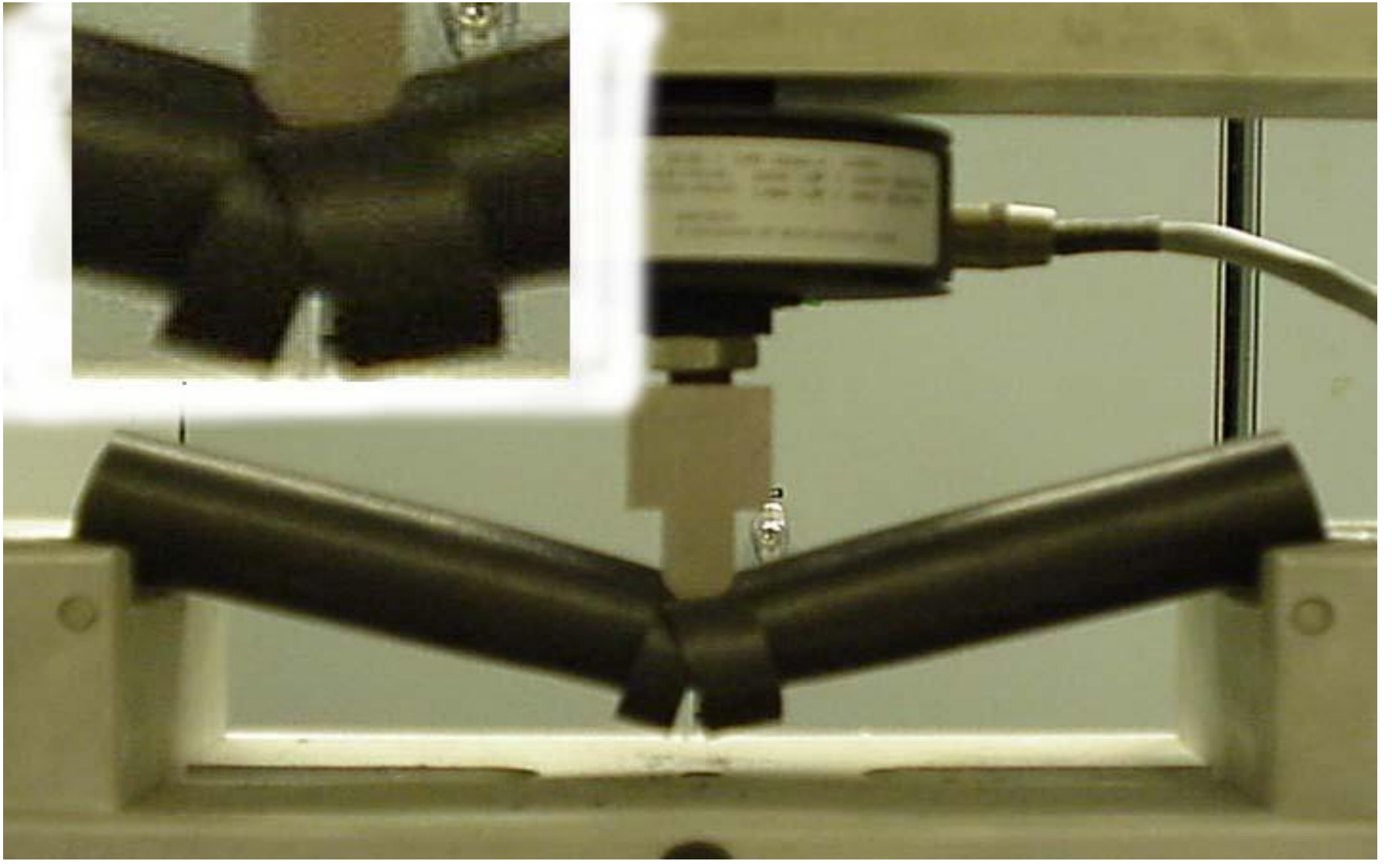
Constrained with Uniform Load



Real Test on Composite Tube

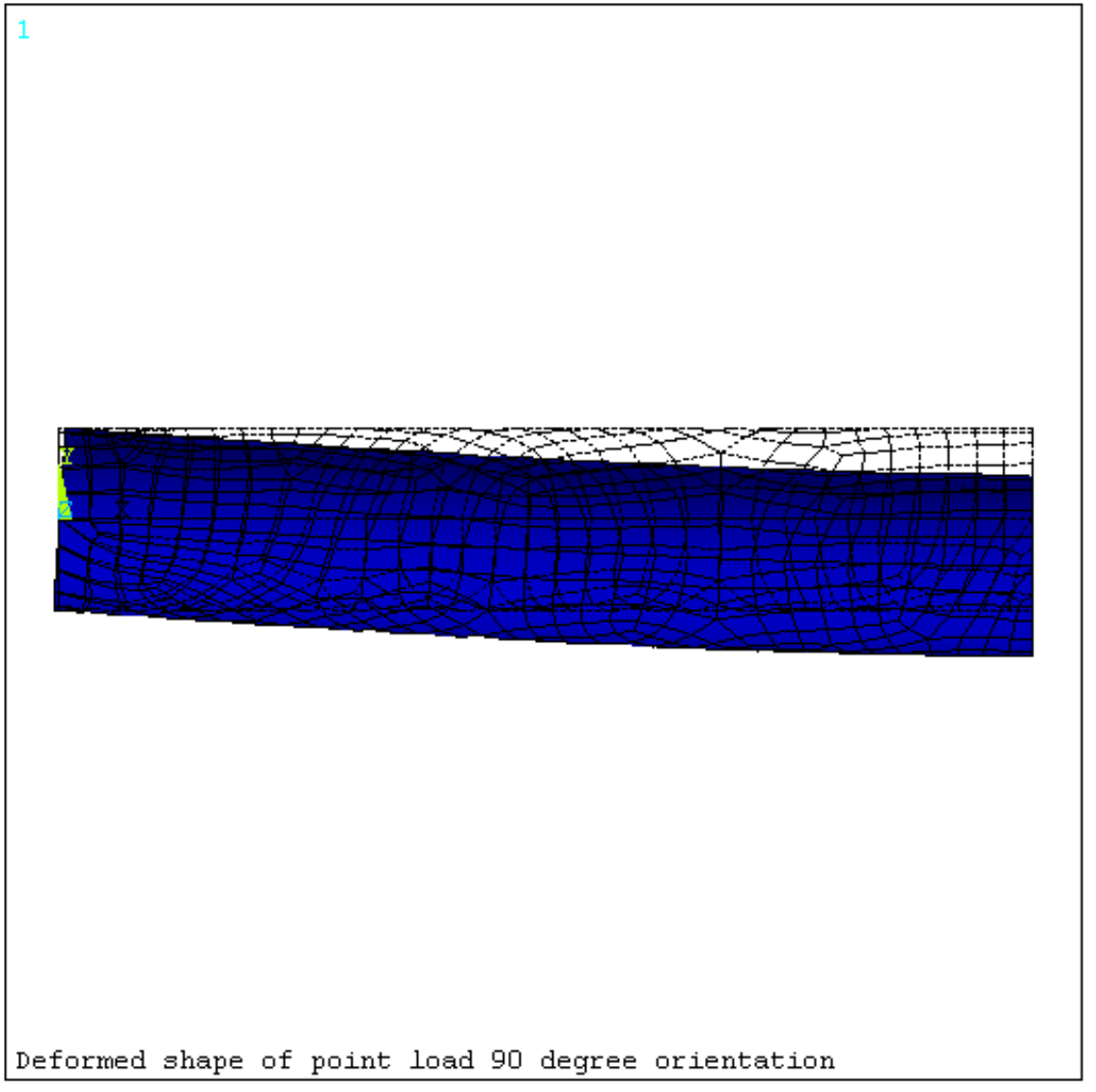


Filament Wound Tube



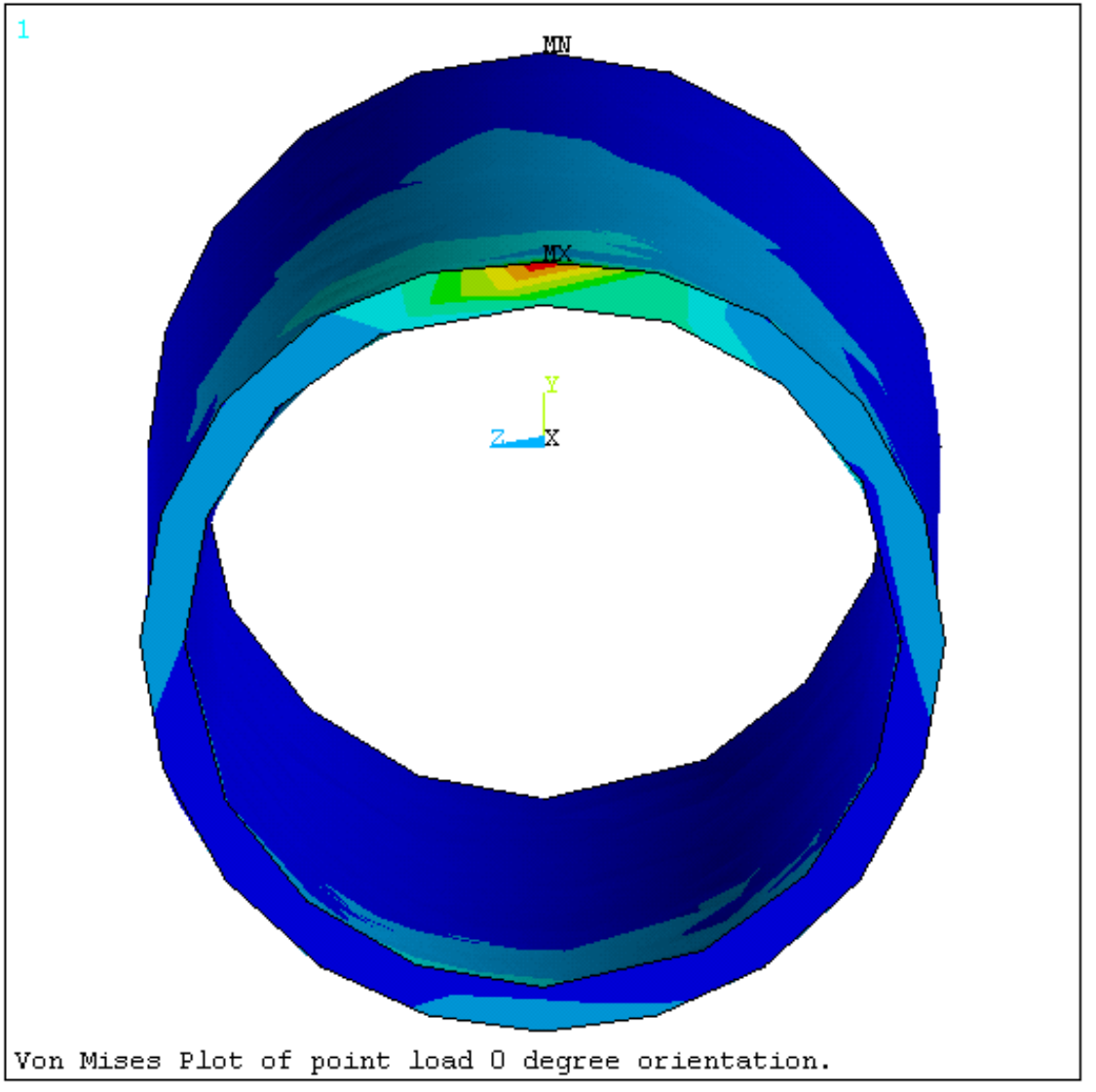
Deformed and Un-deformed

Point Load with 90^{o} Fiber Orientation

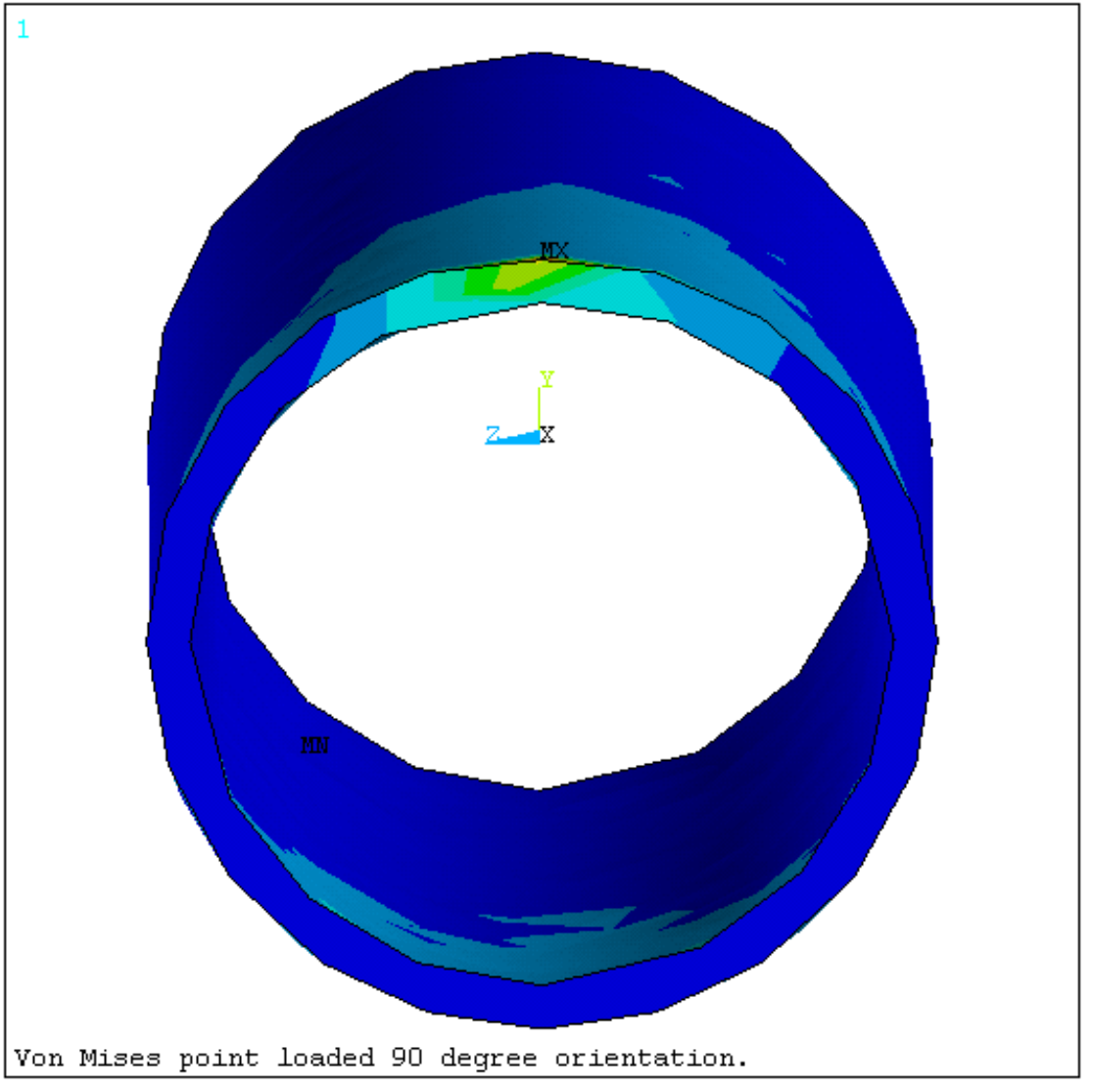


Von Mises Plot

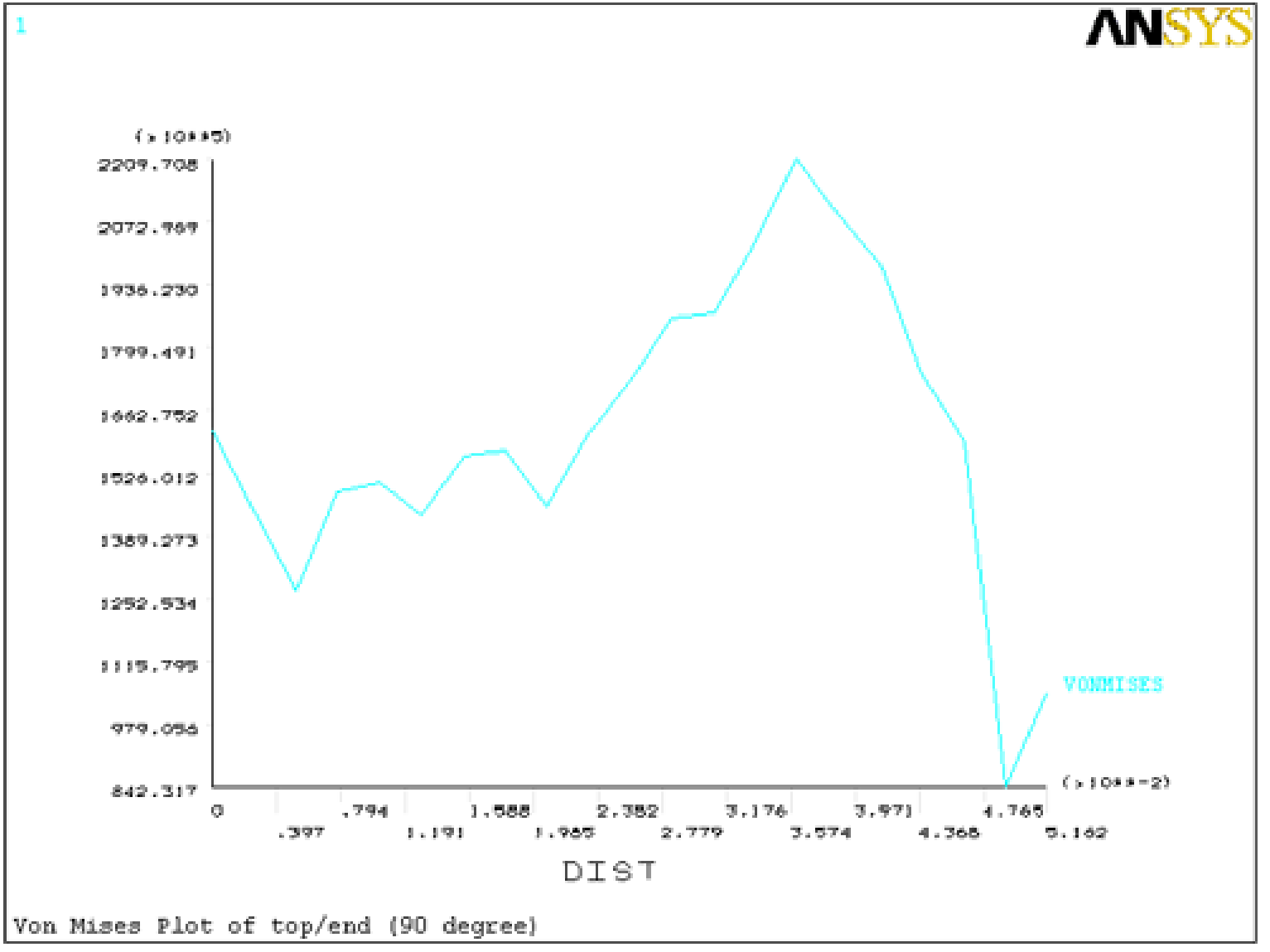
Point Load 0º Orientation



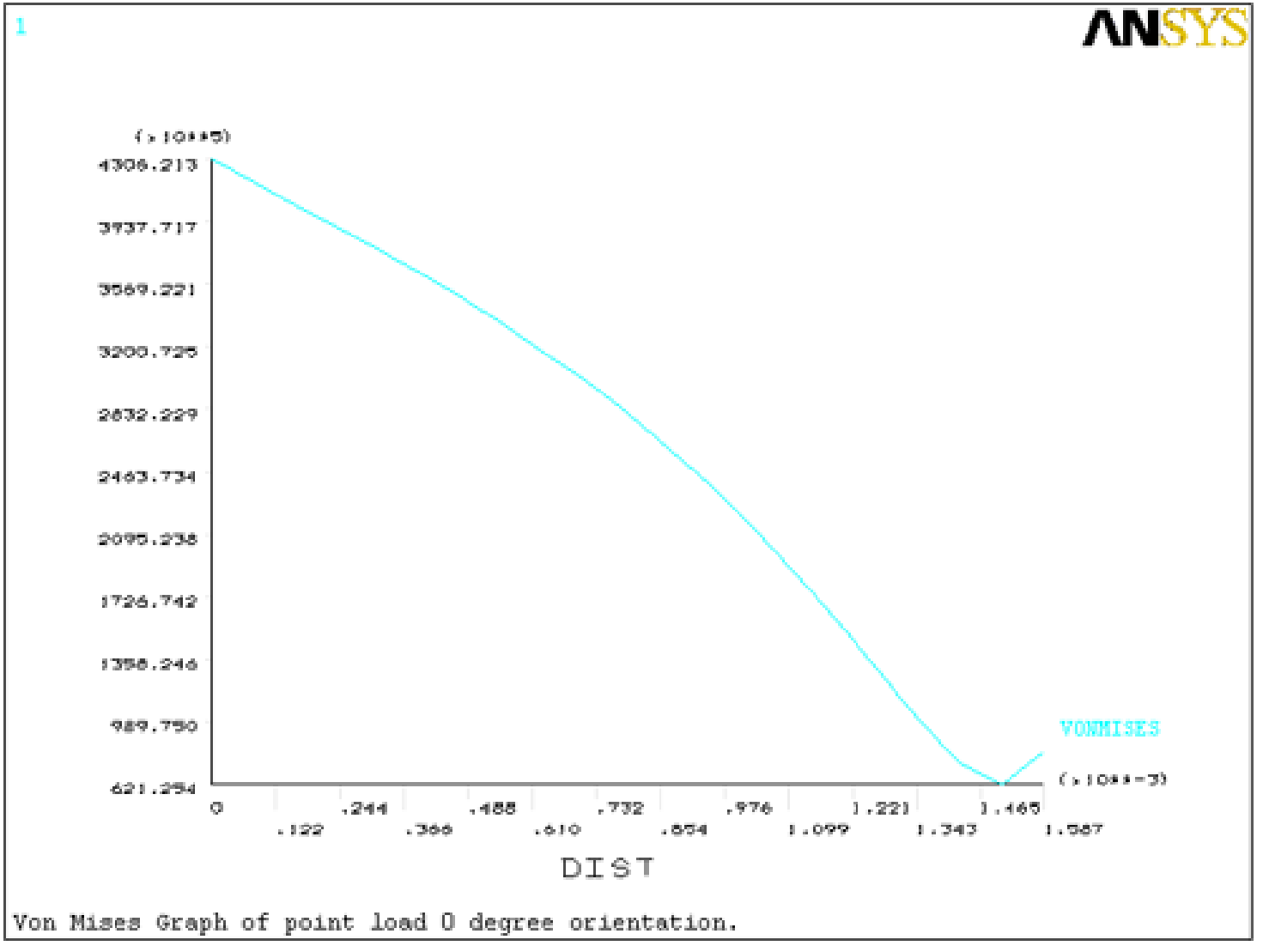
Von Mises Plot
Point Load/90^{o} Orientation



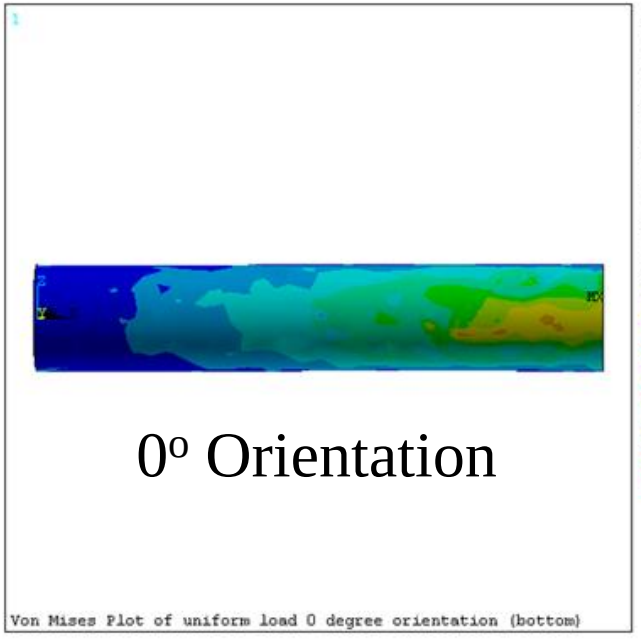
Von Mises Graph of 90º/Hoop Orientation



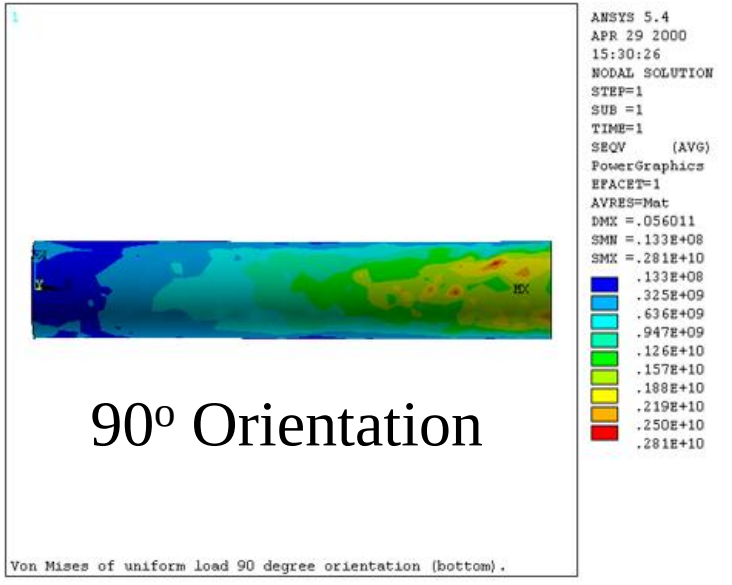
Von Mises Graph of 0º/Longitudinal Orientation



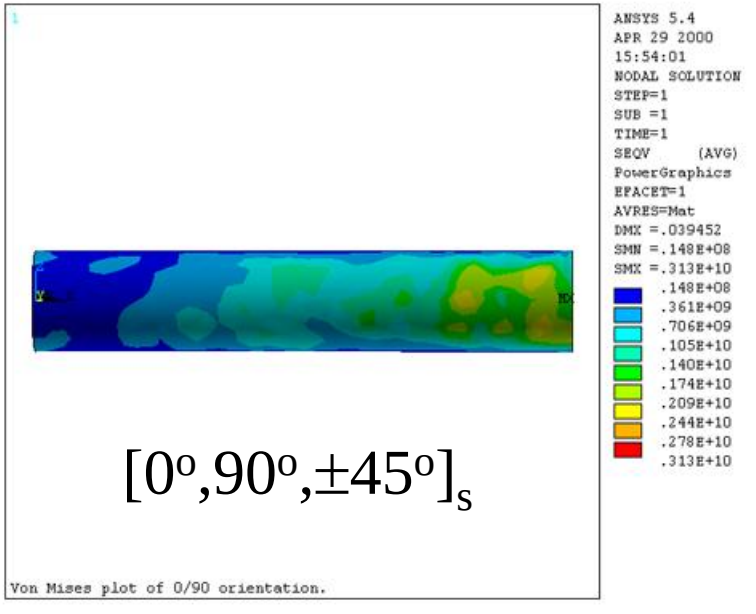
Von Mises Plots of Uniform Loading with Different Orientations



0^o Orientation



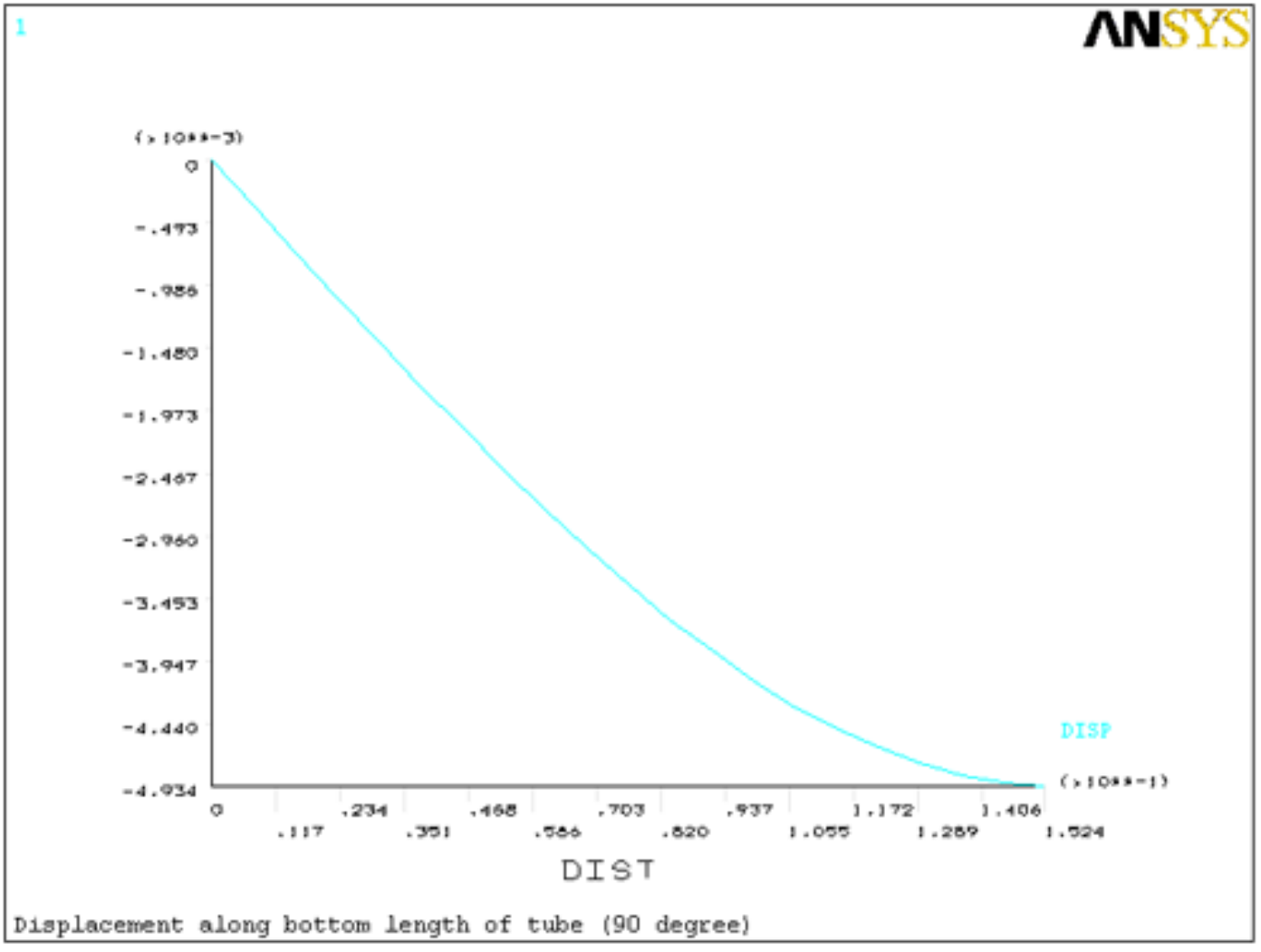
90^o Orientation



$[0^o,90^o,\pm45^o]_s$

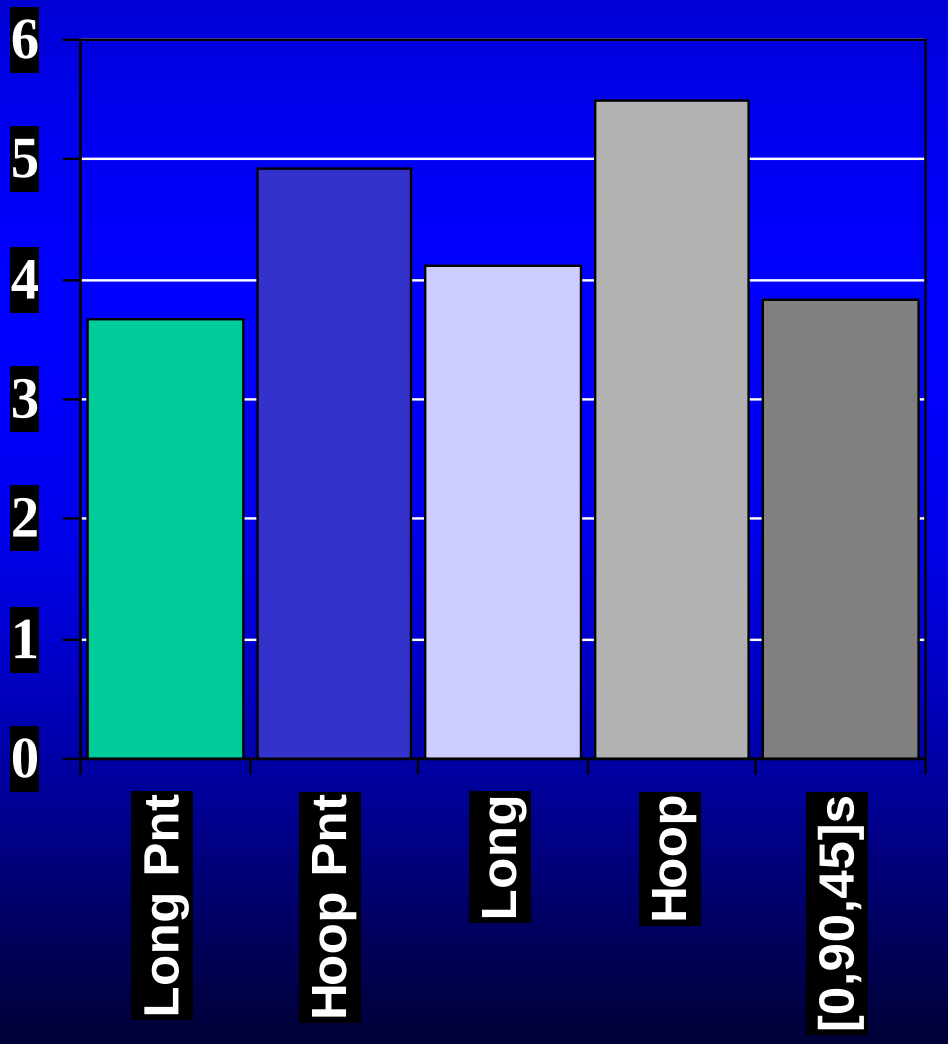
Displacement of Point Loaded 90º/Hoop Orientation

(Maximum Displacement 4.934mm)



Displacement Related to Orientation

- Uniformly loaded hoop has greatest displacement.
- Combination of layers decreases displacement.
- Displacement related to stiffness.



Results of Changing Orientation

- Hoop or 90^{o} orientation is strong under transverse loading.
- Longitudinal or 0^{o} orientation is stiffer in bending.
- Combination of orientations increases stiffness and strength.

Difficulties with ANSYS

- Creating model is not straight forward and simple.
- Meshtool does not recognize that all element axis should coincide within each layer.
- ANSYS is too powerful for simple problems.

Advantages of ANSYS

- Changing material properties or layer orientation is simple.
- Many different orientations can be analyzed in a short amount of time.
- ANSYS can predict results before fabricating composite sample.
- Complex geometries can be modeled and evaluated easily.

New Ideas

- Analyze tube in torsion.
- Apply moment instead of load.
- Test as a pressure vessel.
- Model unique geometries and compare results.
- Model a beam or flat plate and compare with actual results.