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سایت آموزش مهندسی مکانیک ایران



Modeling of Composite Tubes Using ANSYS

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ME 450 Introduction to CAE

May 3, 2000

Submitted to: Professor H.U. Akay

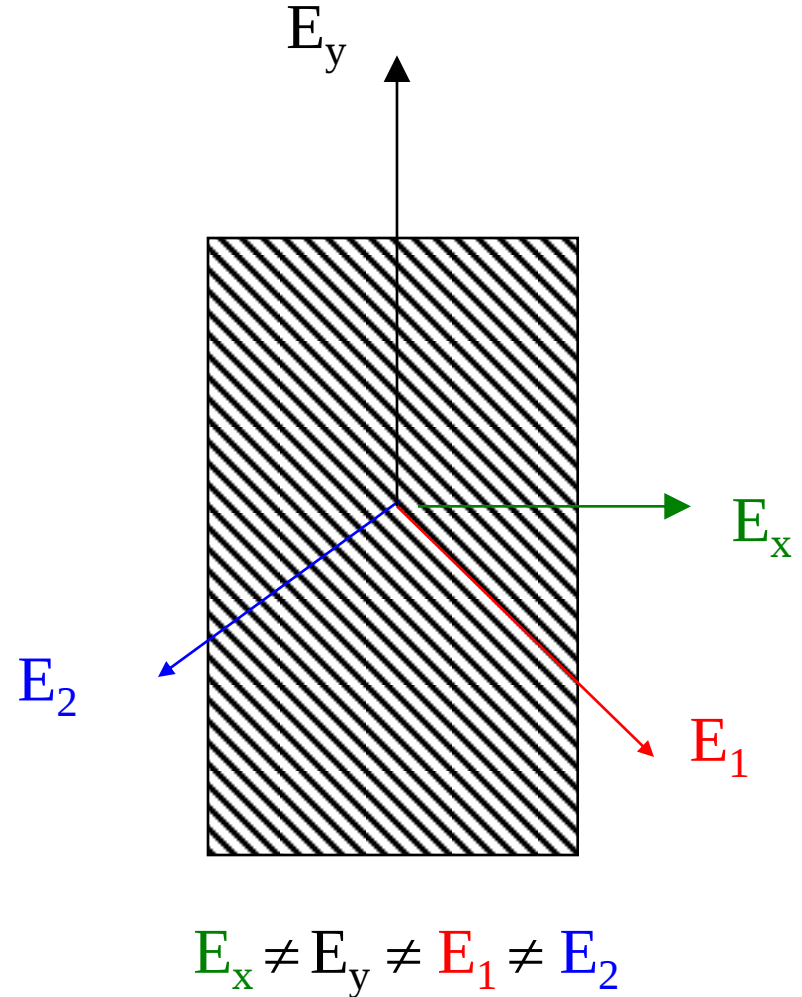
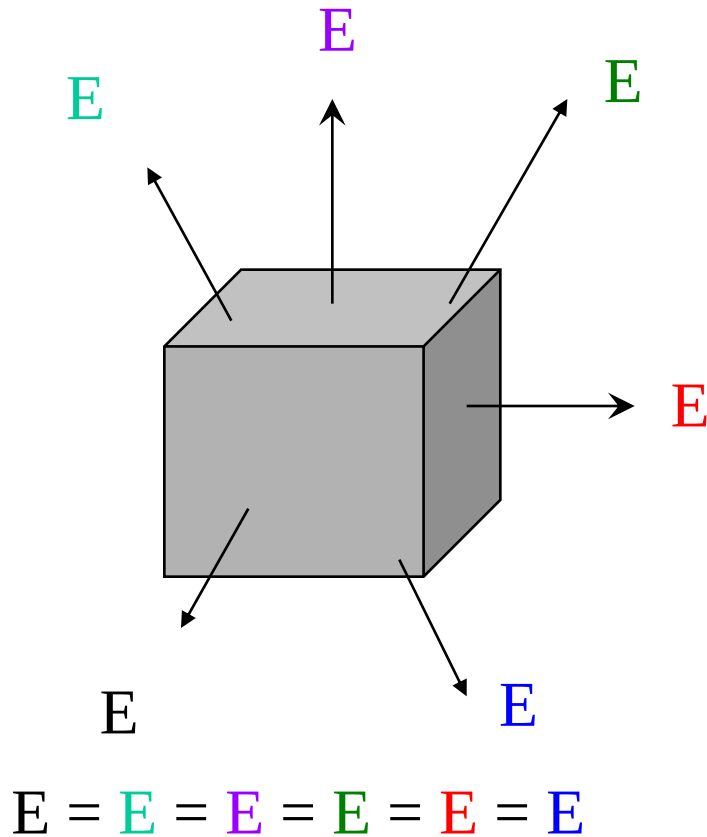
Uses for Composite Materials

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

Advantages of Composites

- Density of aluminum alloy approximately 2800 kg/m³
- Density of carbon/epoxy approximately 1580 kg/m³
- Tensile strength of aluminum alloy 7075-T6 is 570 MPa
- Tensile strength of carbon/epoxy 1830 MPa

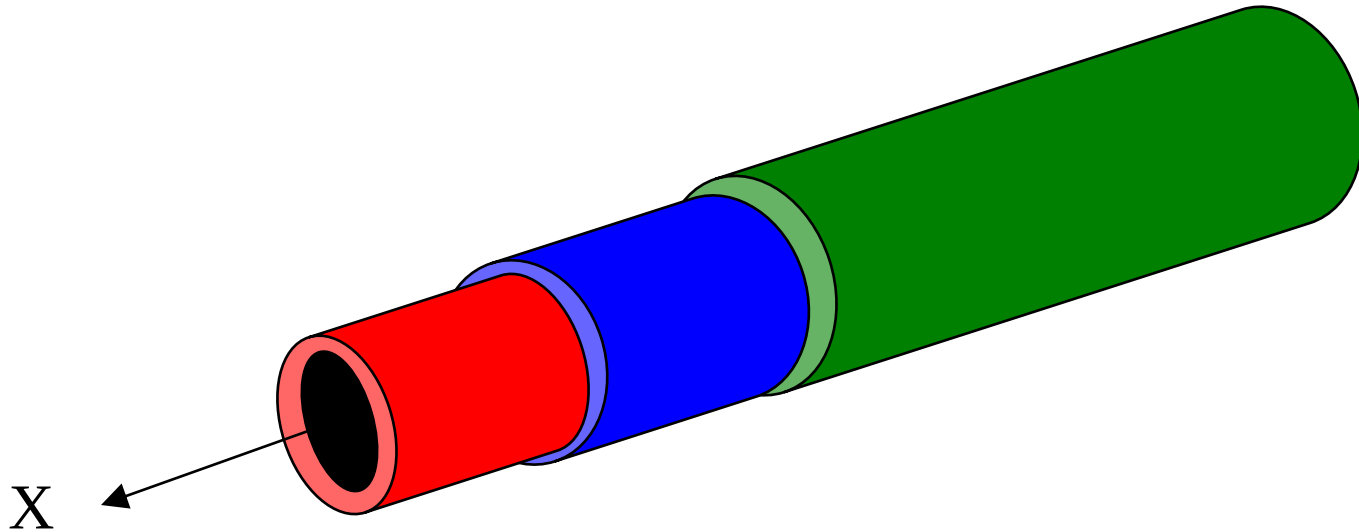
Isotropic vs. Orthotropic



Fabrication

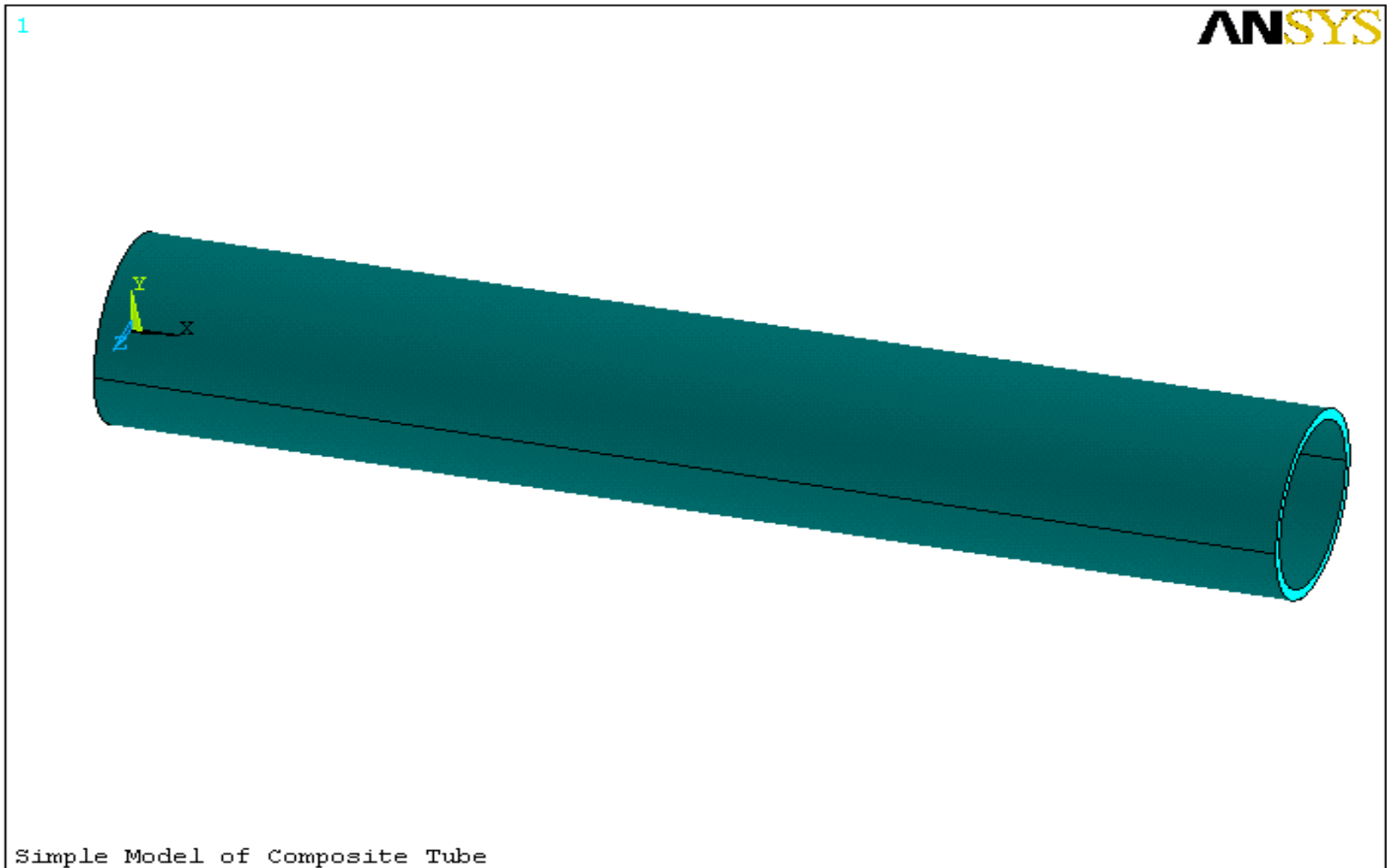


Layers of a Composite Tube



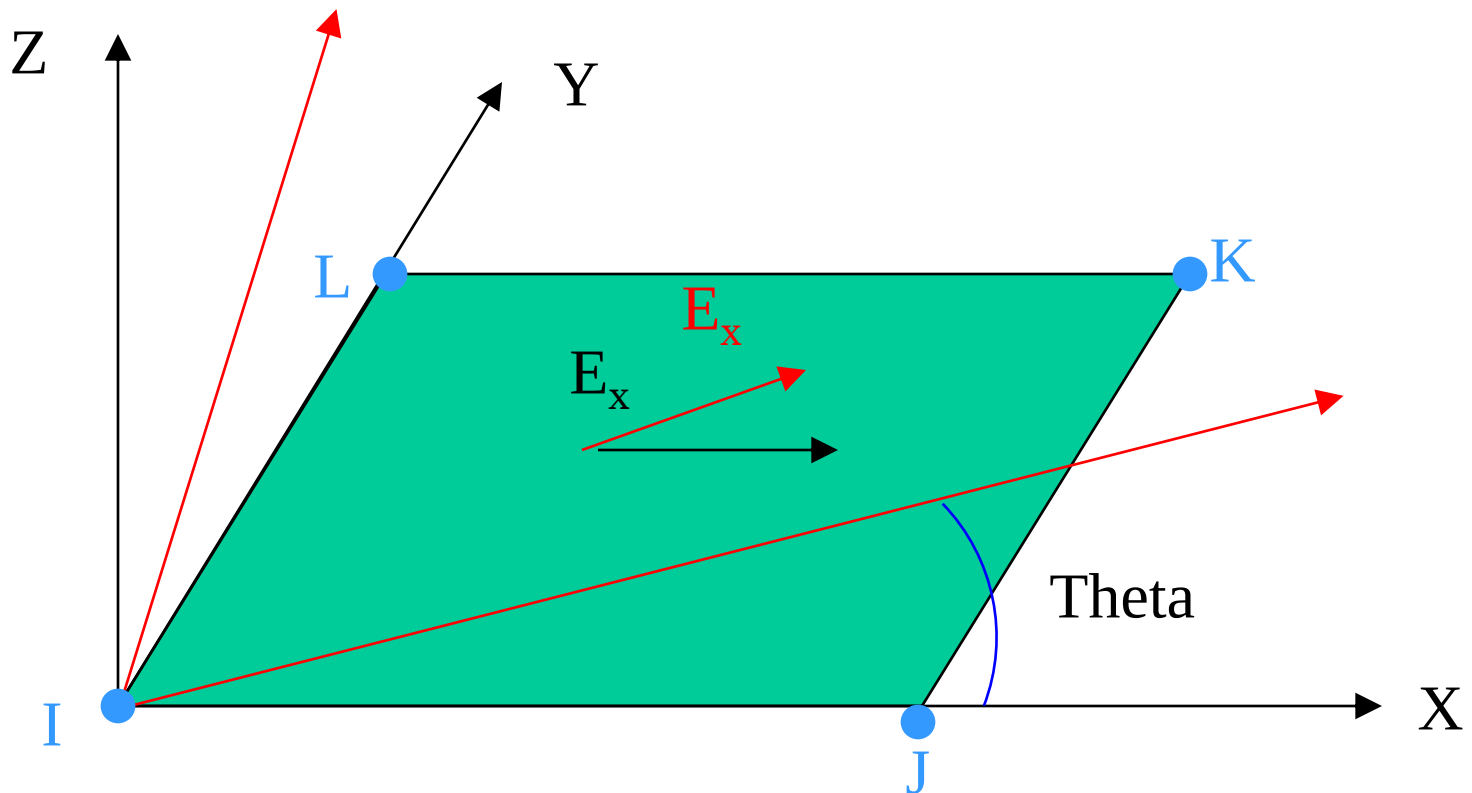
Each color represents a different fiber orientation and change in material properties relative to the Global Axis.

Modeled Tube in ANSYS

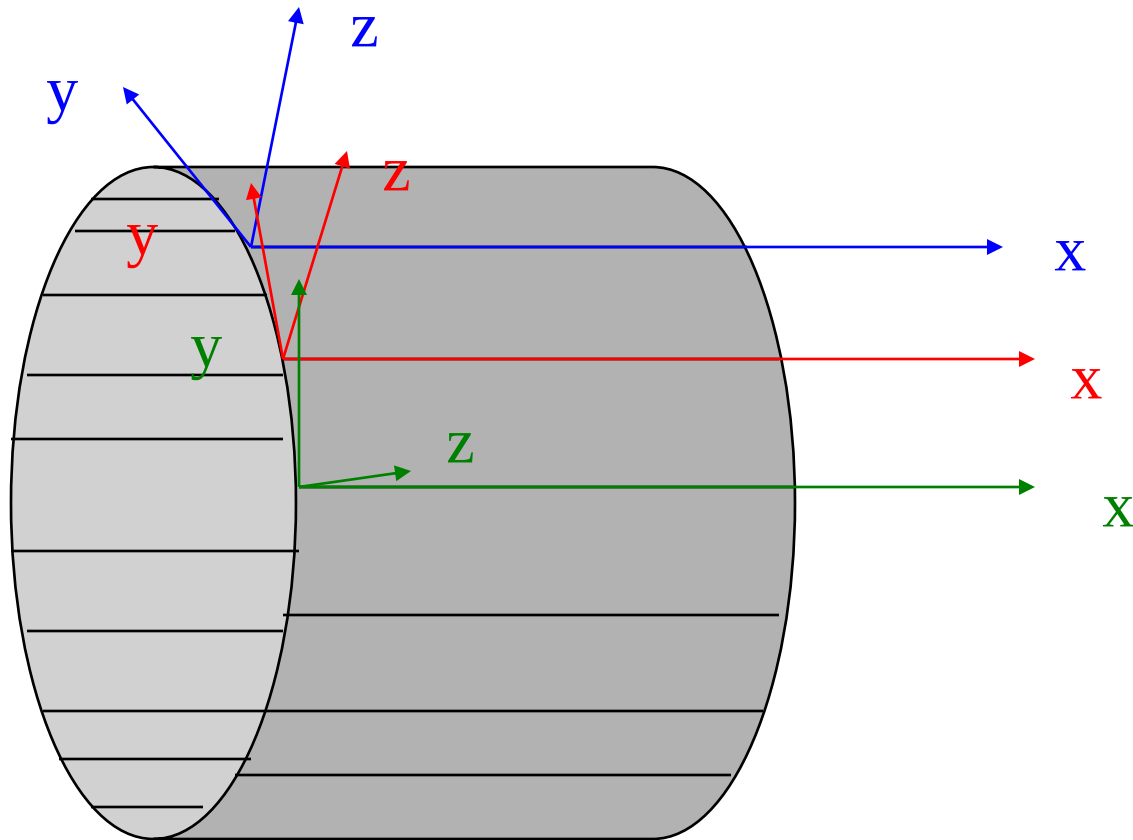


Element Coordinate System

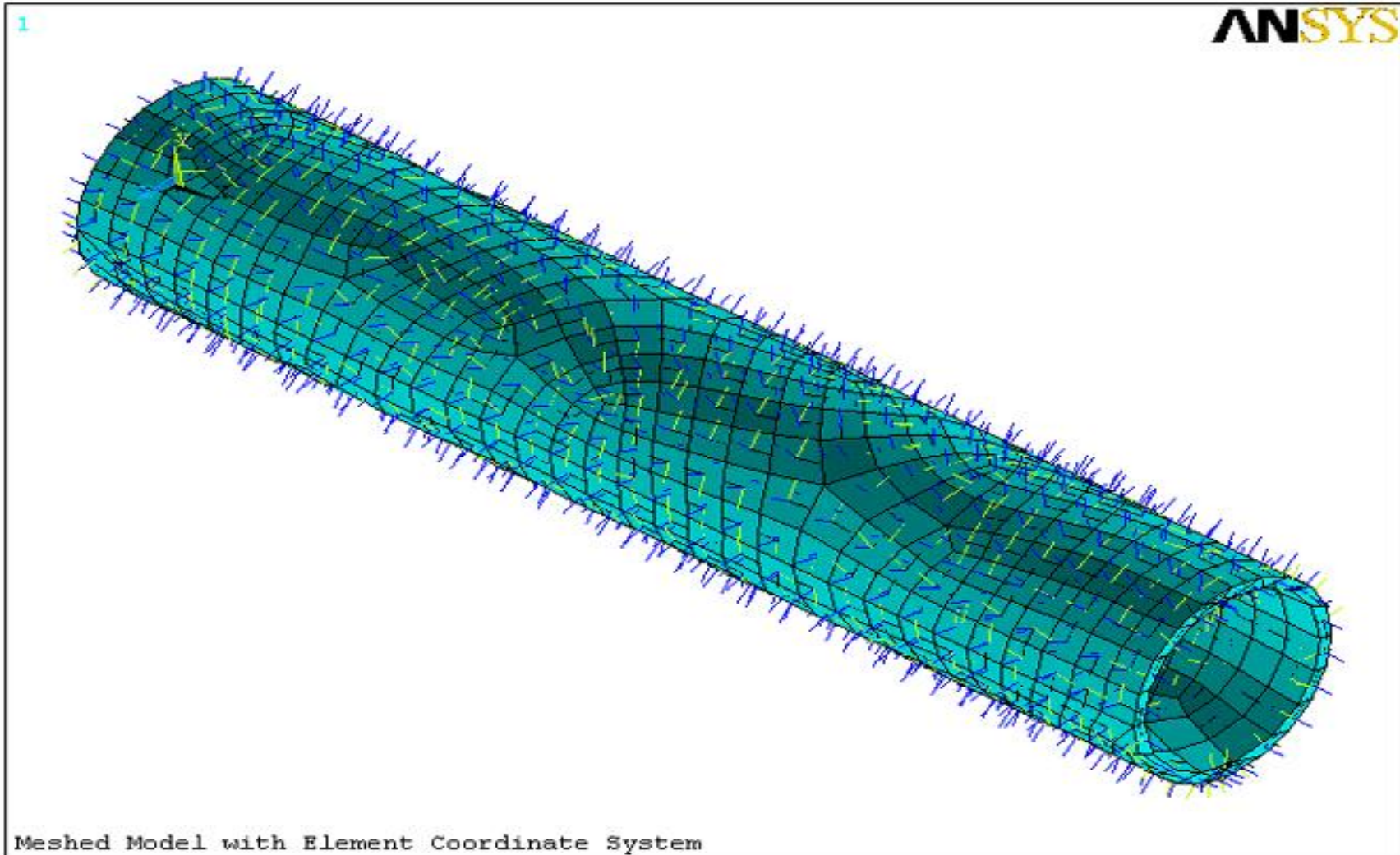
Shell 91 From ANSYS Element Library



ANSYS Coordinate System for Shell Element

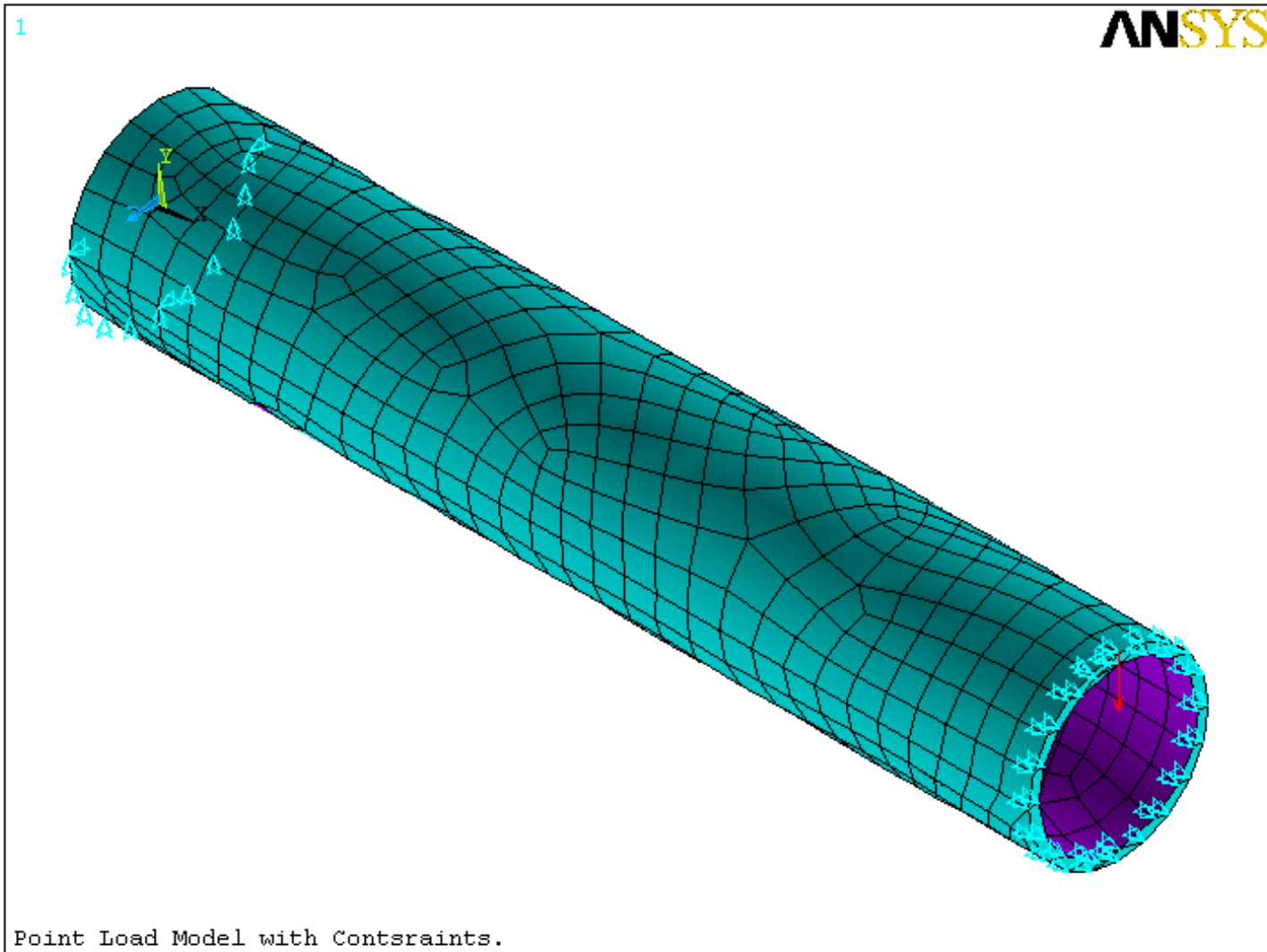


ANSYS Element Coordinate System



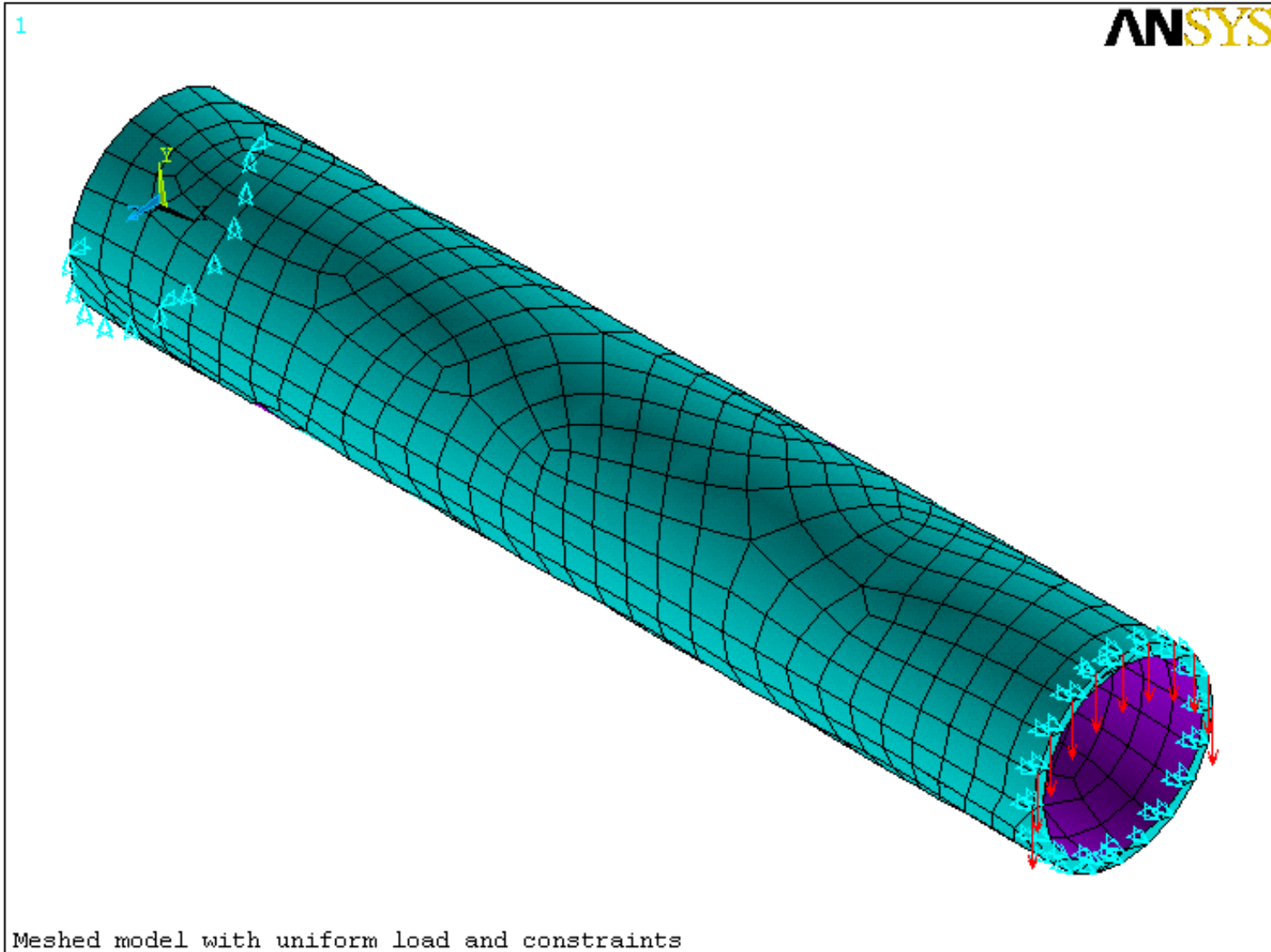
ANSYS Model Setup

Constrained with Point Load

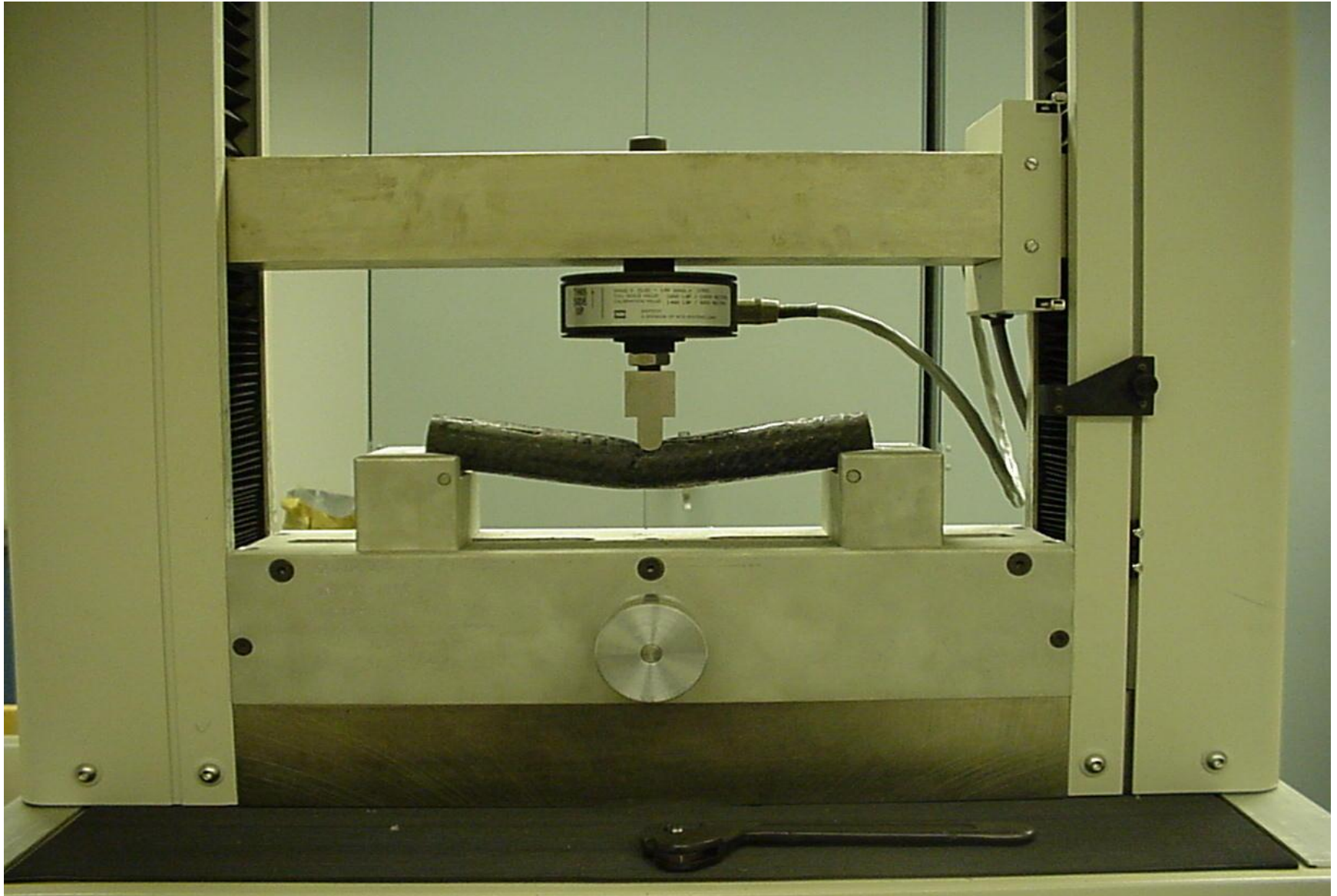


ANSYS Model Setup

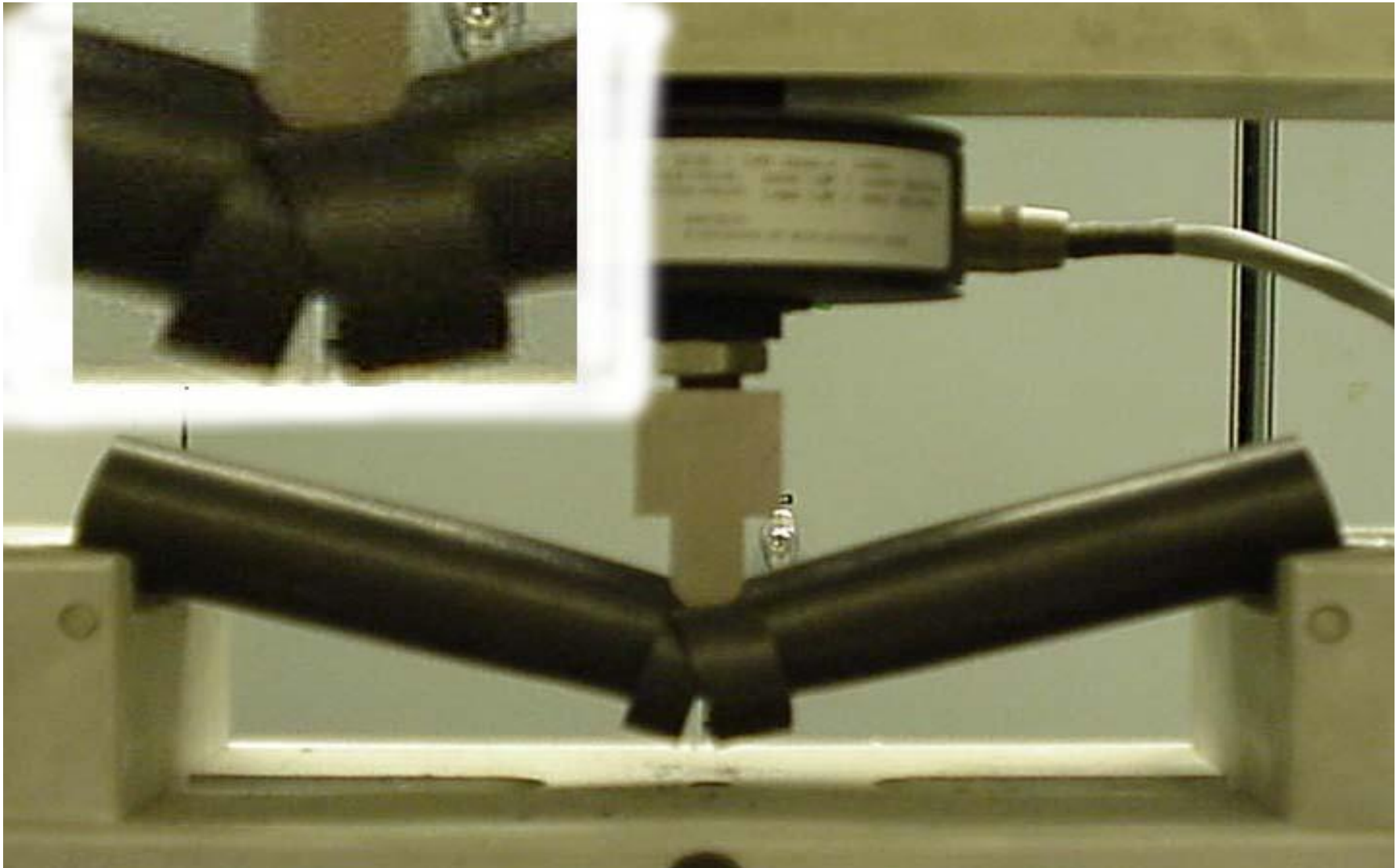
Constrained with Uniform Load



Real Test on Composite Tube

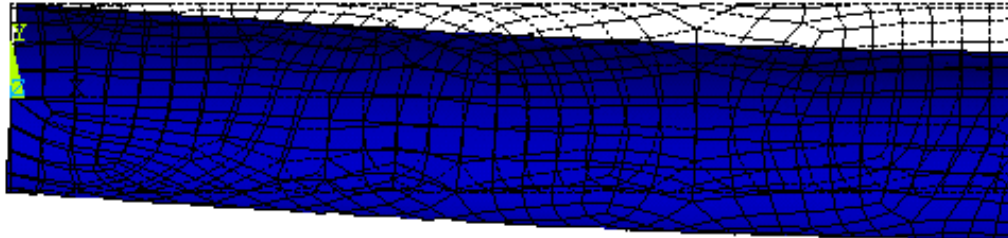


Filament Wound Tube



Deformed and Un-deformed Point Load with 90° Fiber Orientation

1



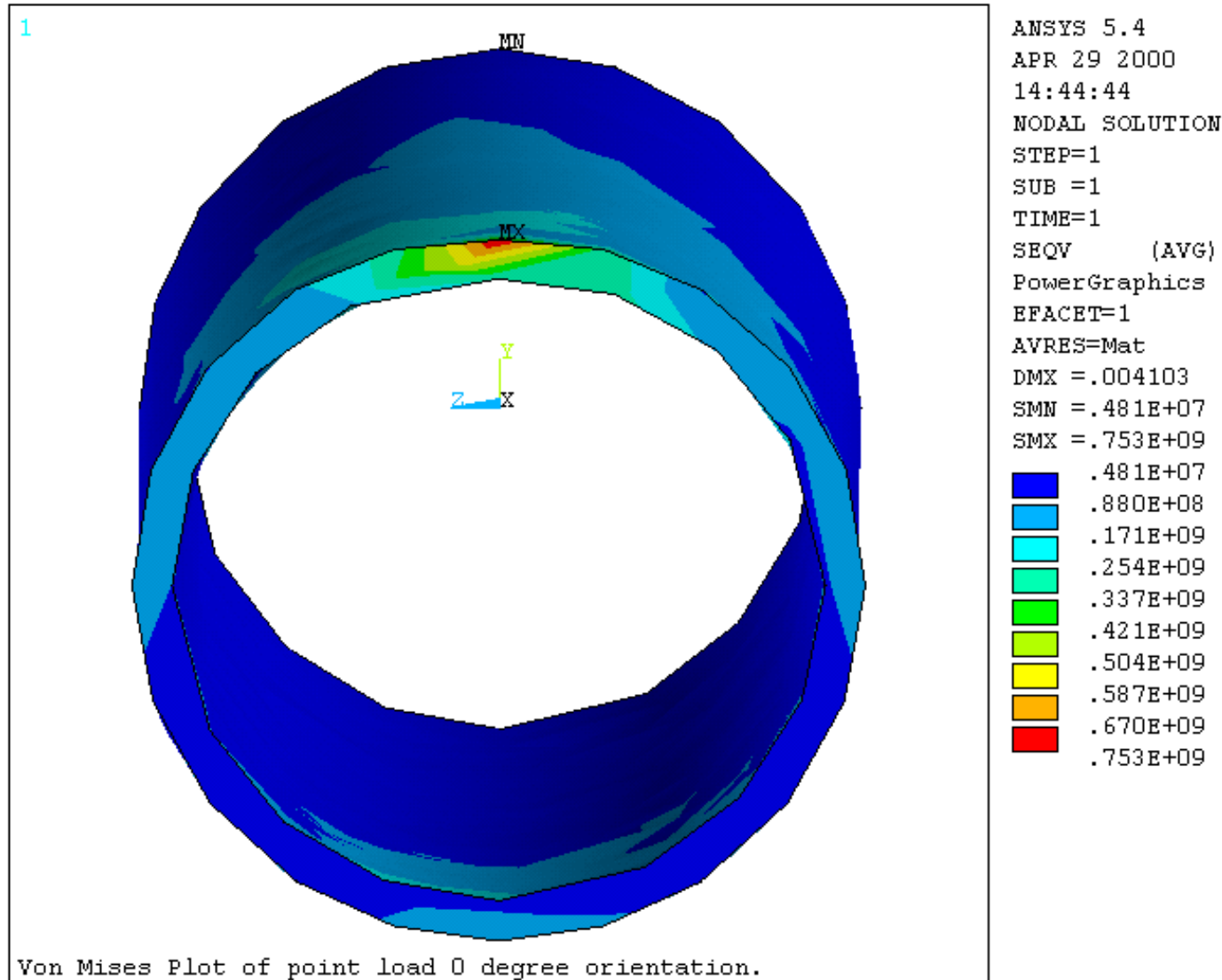
```
ANSYS 5.4  
APR 29 2000  
13:57:09  
DISPLACEMENT  
STEP=1  
SUB =1  
TIME=1  
PowerGraphics  
EFACET=1  
AVRES=Mat  
DMX =.005292
```

```
DSCA=1.44  
ZV =1  
DIST=.084337  
XF =.07573  
YF =-.003573  
ZF =-.916E-04  
Z-BUFFER
```

Deformed shape of point load 90 degree orientation

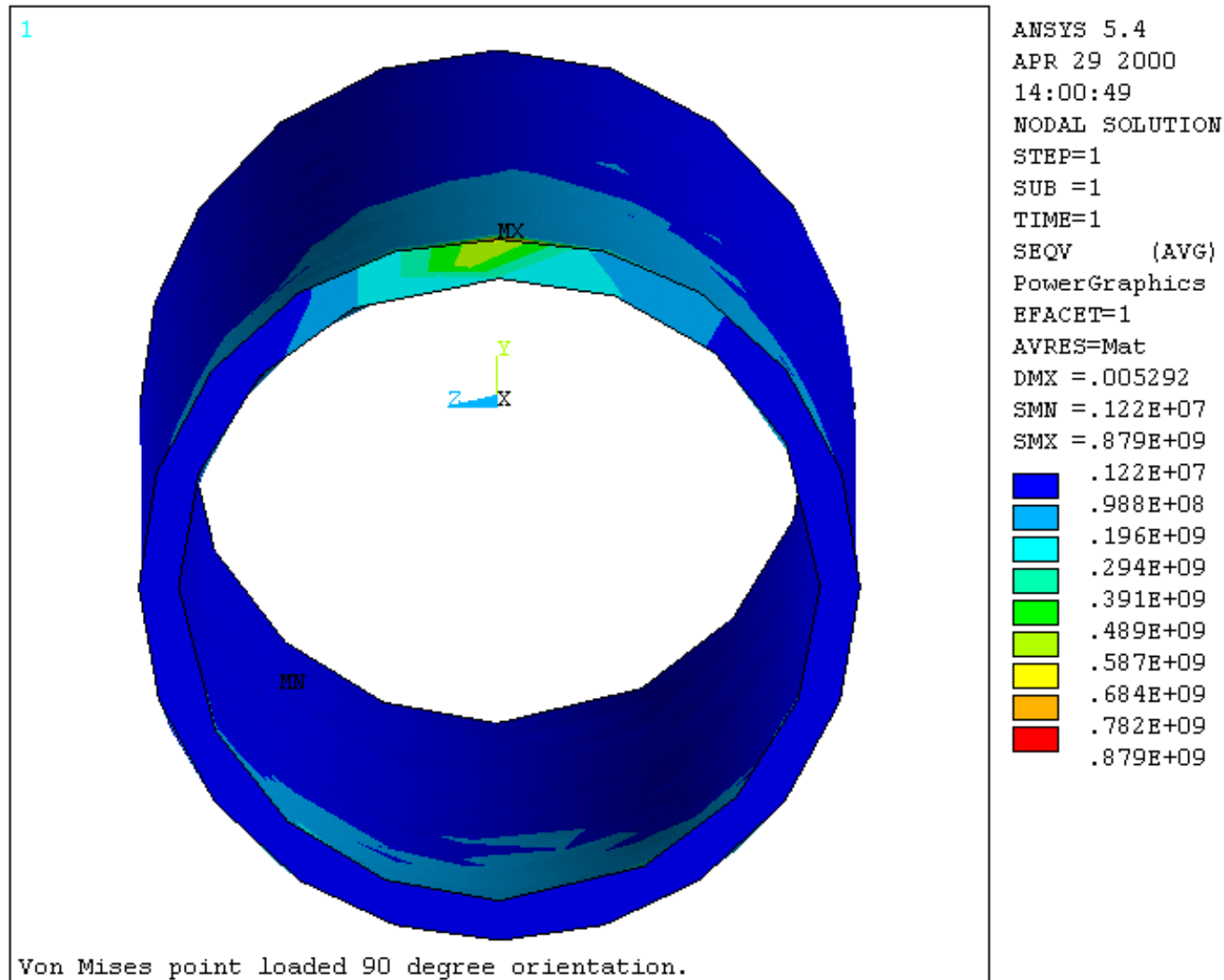
Von Mises Plot

Point Load 0° Orientation

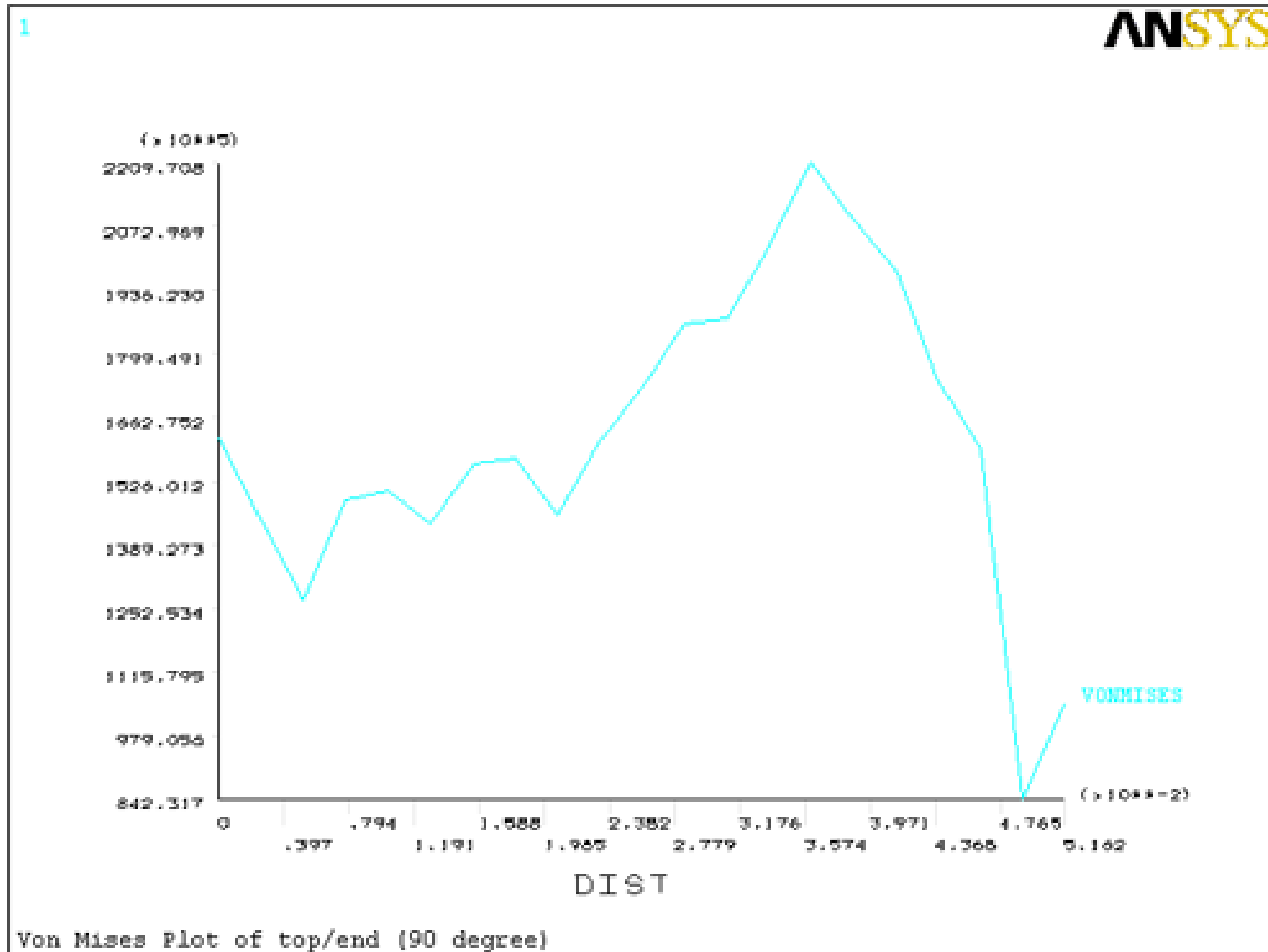


Von Mises Plot

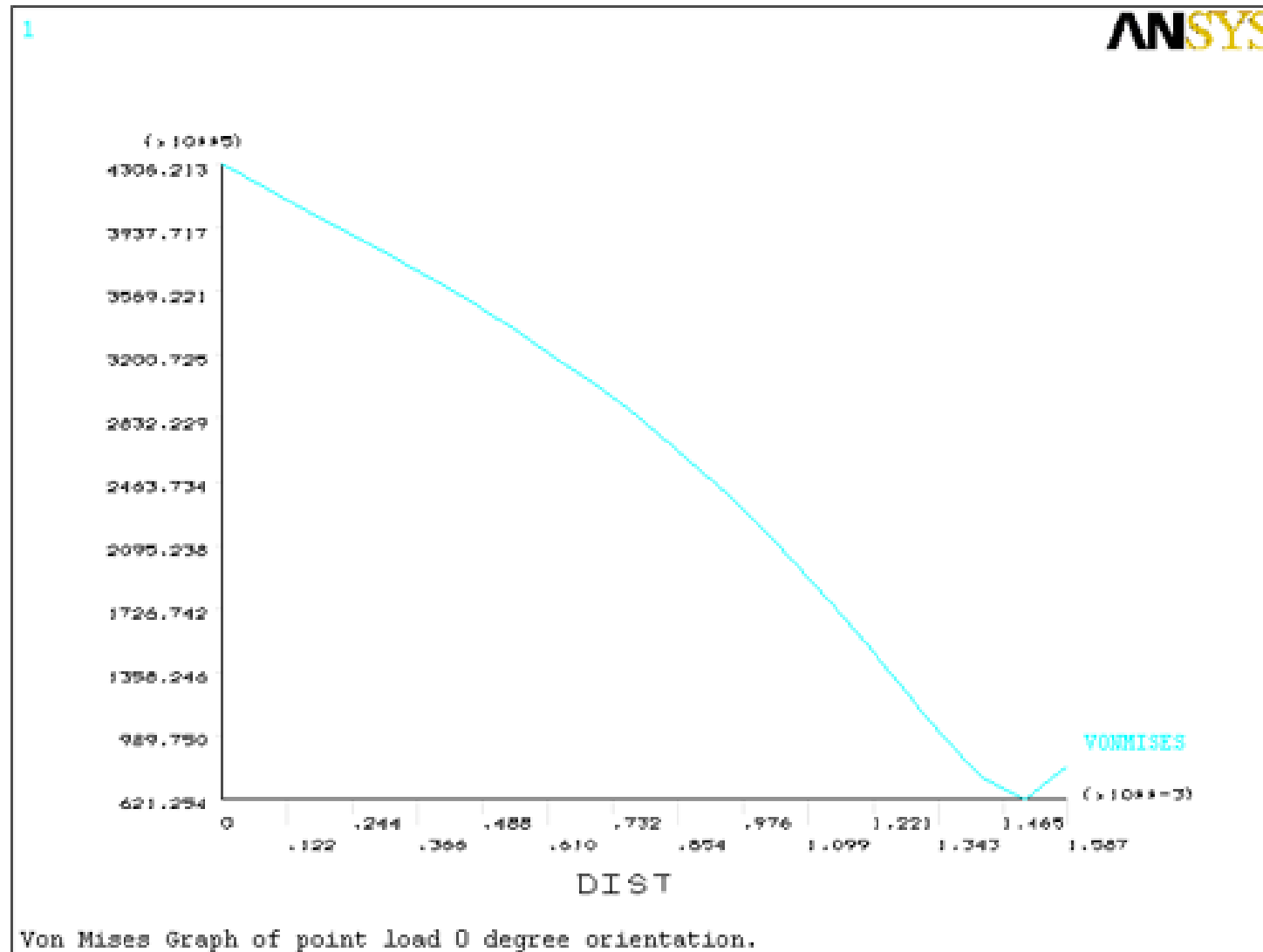
Point Load/90° Orientation



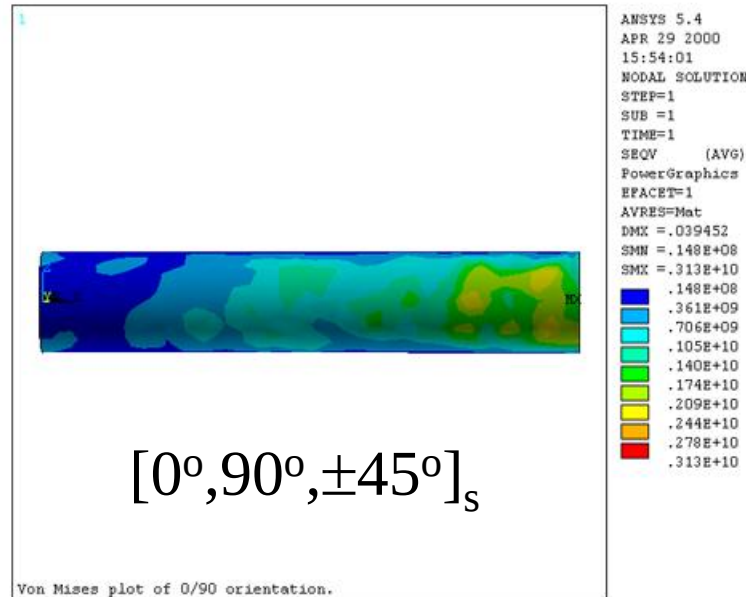
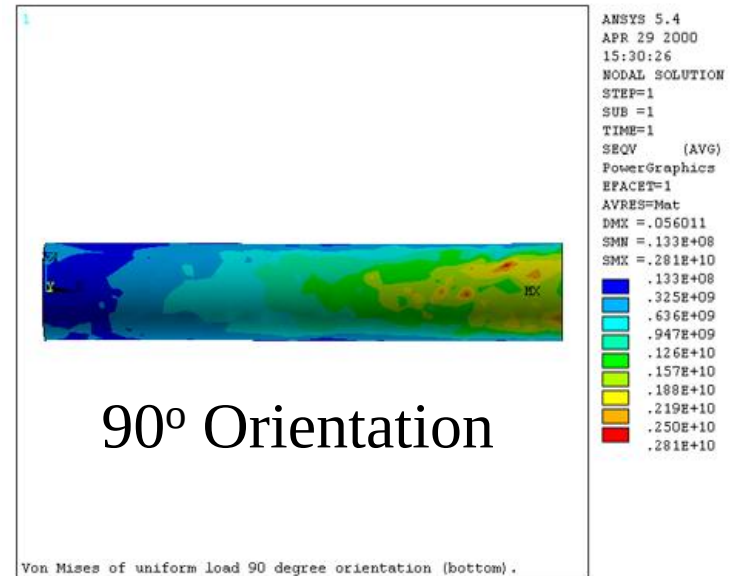
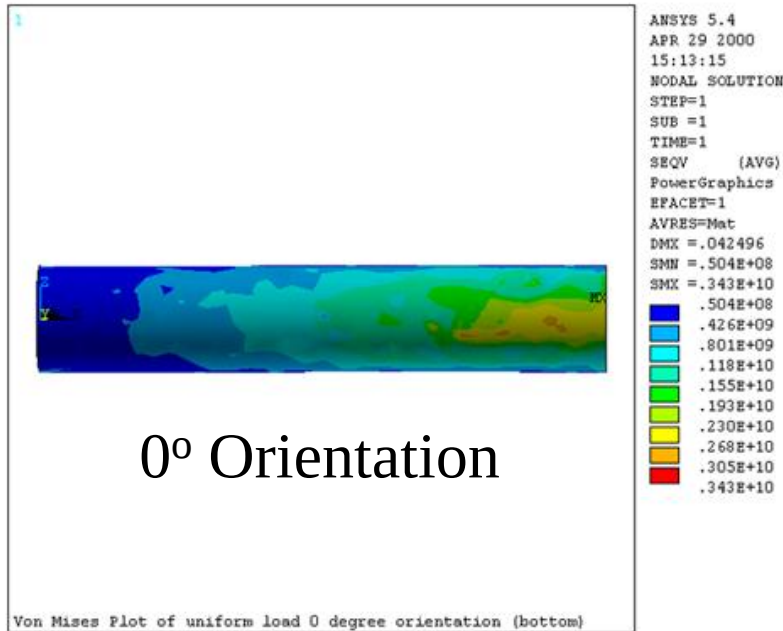
Von Mises Graph of 90°/Hoop Orientation



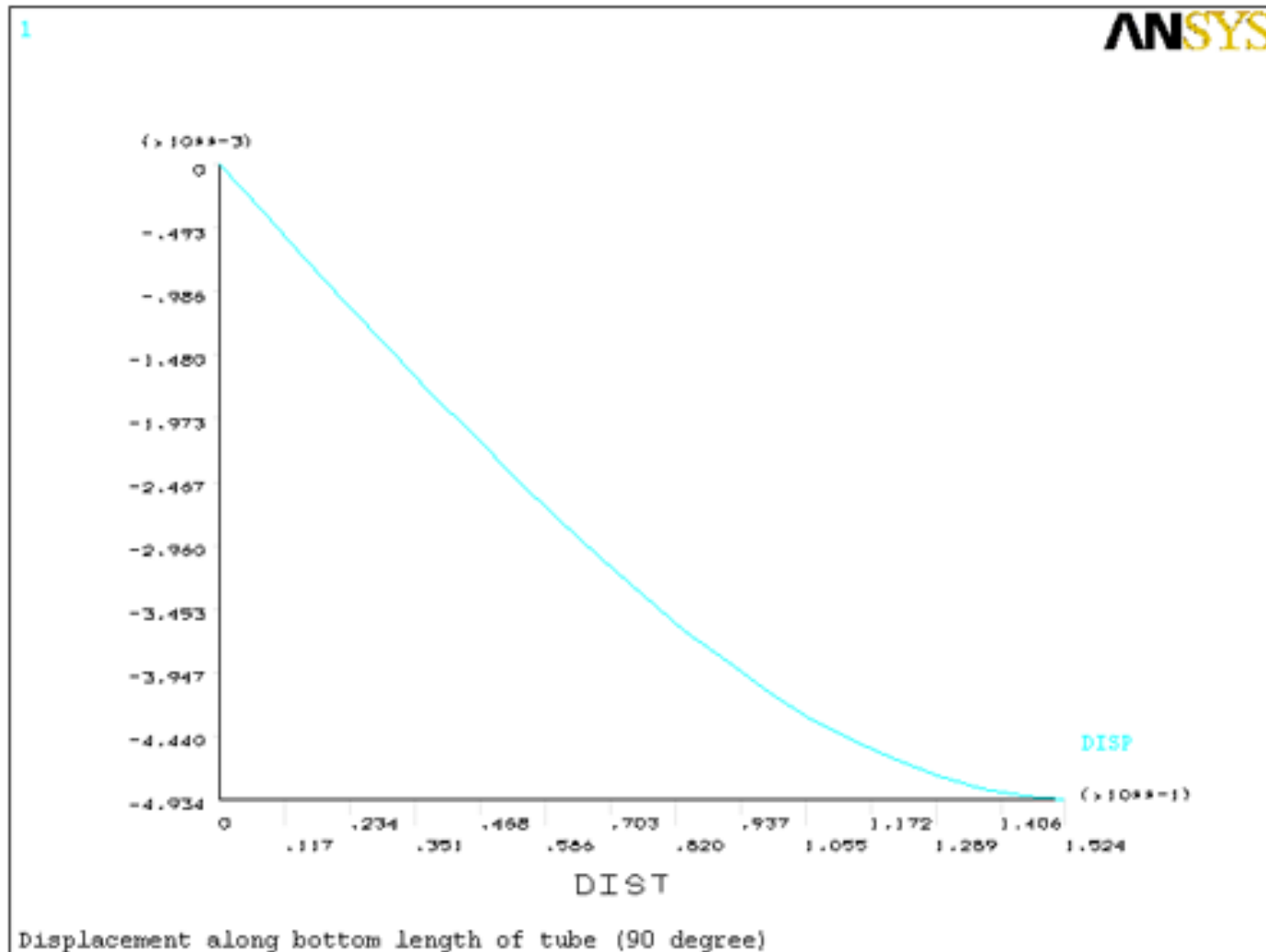
Von Mises Graph of 0°/Longitudinal Orientation



Von Mises Plots of Uniform Loading with Different Orientations

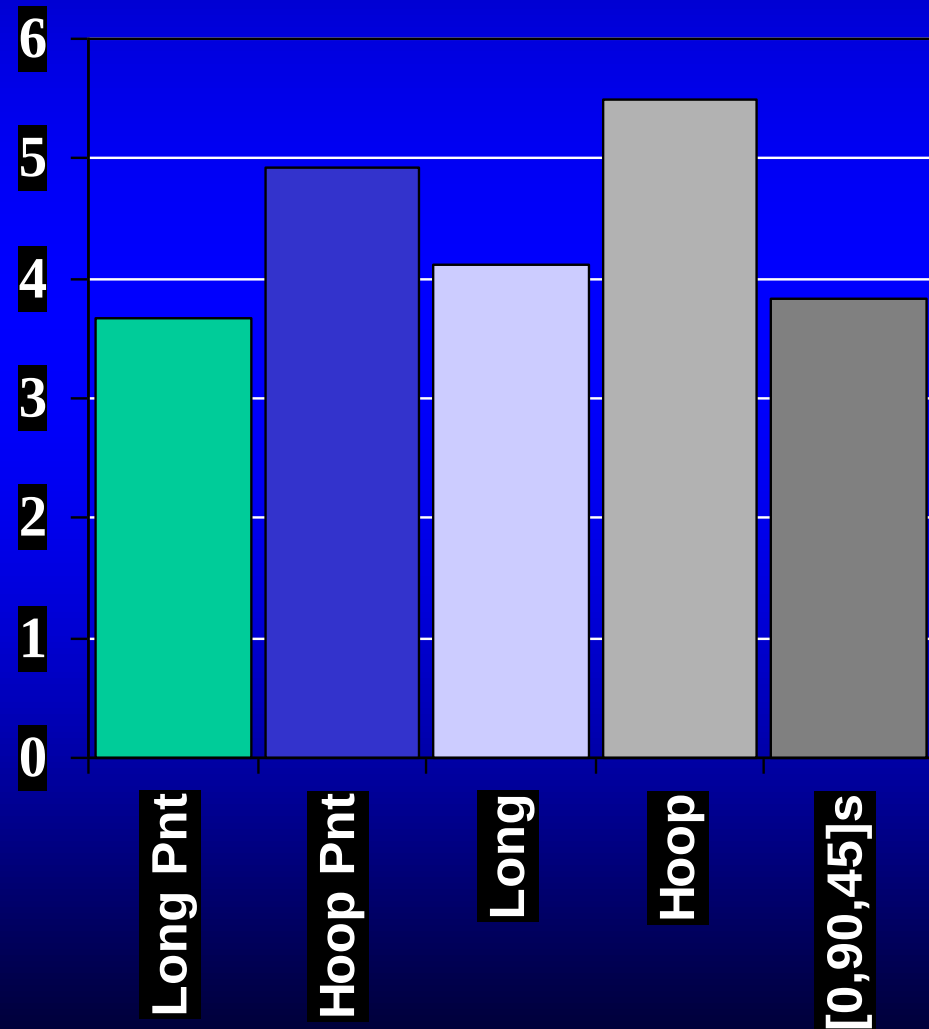


Displacement of Point Loaded 90°/Hoop Orientation (Maximum Displacement 4.934mm)



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° orientation is strong under transverse loading.
- Longitudinal or 0° 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.