Modeling of Mechanical Properties of Glass Fiber Overwrapped Field Coils

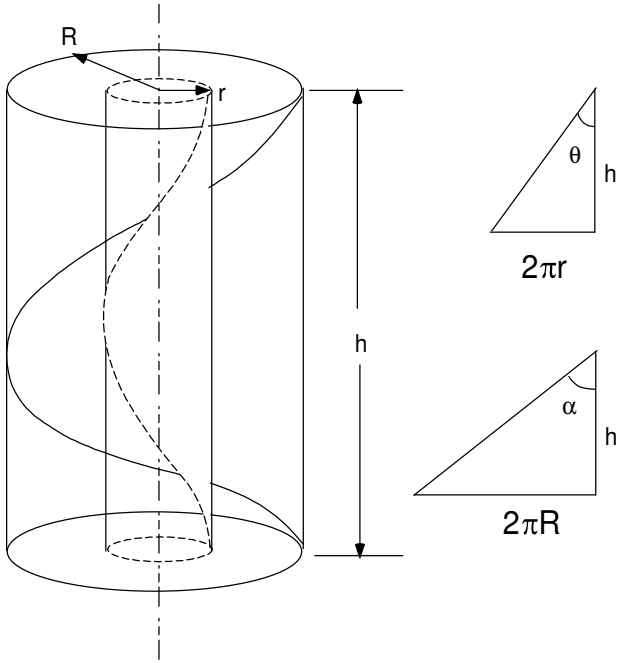
Issues

- Elastic parameters are not consistent with experimental results
- Need better understanding of the failure mechanisms
- Analytical modeling will help optimize the design

Need to know

- Specific information on the twist and geometry of the conductors
- Properties as a function of temperature
- Layup sequence
- Volume fraction

Elastic parameters of twisted conductors

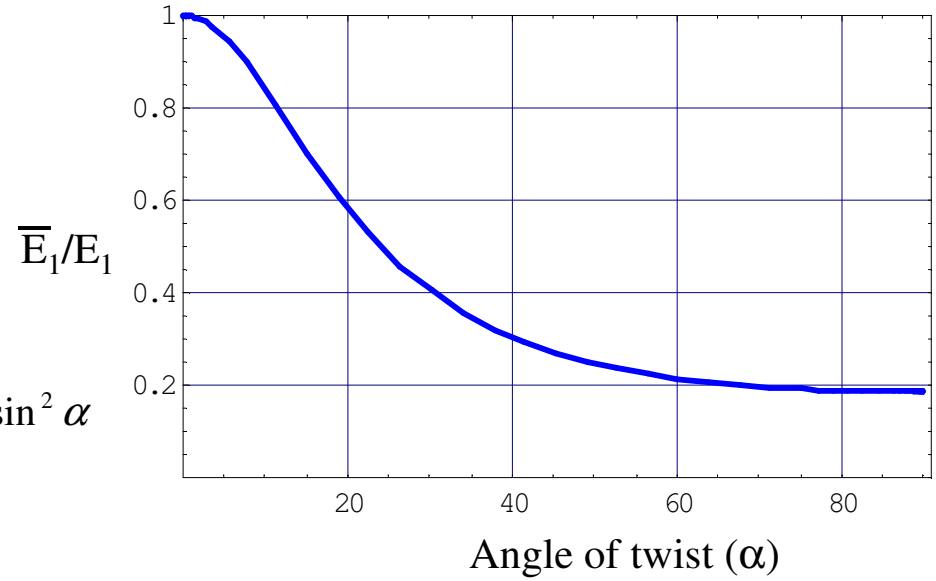


- Epoxy impregnated conductor acts as a composite material with orthotropic properties
- Elastic parameters of twisted conductors are different from that of perfectly oriented ones
- Angle of twist varies from zero in the center to a maximum at the outermost layer
- Highly anisotropic

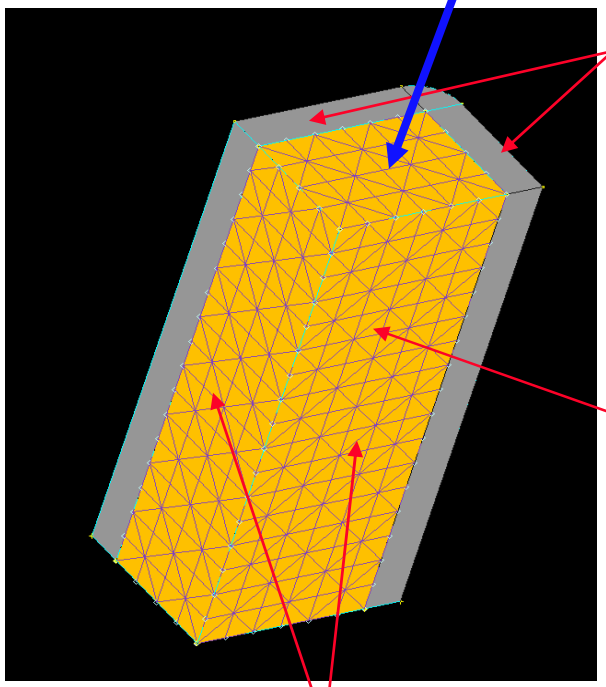
$$S_{11}=\frac{1}{E_1};S_{22}=\frac{1}{E_2};S_{66}=\frac{1}{G_{12}};S_{12}=-\frac{\nu_{12}}{E_1}$$

$$S_{11}^{a}=S_{11}\cos^4\alpha+S_{22}\sin^4\alpha+(2S_{12}+S_{66})\cos^2\alpha\sin^2\alpha$$

$$\overline{E_1}=\frac{1}{S_{11}^{a}}$$



FEA model and failure analysis



Objectives

1. Correlate modulus of the specimen with test results
2. FEA model will incorporate the glass/kapton overwrap as composite shell
3. Understand failure mechanisms in the conductors as well as in the insulation
4. Predict failure
5. Recommend geometry and layup changes to optimize properties