EML 4230 Introduction to Composite Materials

Chapter 2 Macromechanical Analysis of a Lamina Maximum Stress Failure Theory

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Courtesy of the Textbook Mechanics of Composite Materials by Kaw

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## Strength Failure Theories for an Angle Lamina

- The failure theories are generally based on the normal and shear strengths of a unidirectional lamina.
- In the case of a unidirectional lamina, the five strength parameters are:
  - $\Box$  Longitudinal tensile strength  $(\sigma_1^T)_{ult}$
  - □ Longitudinal compressive strength  $(\sigma_1^C)_{ult}$
  - $\Box$  Transverse tensile strength  $(\sigma_2^T)_{\mu}$
  - □ Transverse compressive strength  $(\sigma_2^C)_{ult}$
  - $\square$  In-plane shear strength  $( au_{12})_{ult}$

**Maximum Stress Failure Theory** 

• The lamina is considered to be failed if:

$$-\left(\sigma_{1}^{C}\right)_{ult} \leq \sigma_{1} \leq \left(\sigma_{1}^{T}\right)_{ult}, \text{ or}$$
$$-\left(\sigma_{2}^{C}\right)_{ult} \leq \sigma_{2} \leq \left(\sigma_{2}^{T}\right)_{ult}, \text{ or}$$
$$-\left(\tau_{12}\right)_{ult} \leq \tau_{12} \leq \left(\tau_{12}\right)_{ult}$$

is violated.

- Note that all five strength parameters are positive numbers.
- Each component of stress does not interact with each other.



Off-axis loading in the x-direction

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## Solution

The ultimate strengths of a unidirectional Graphite/Epoxy lamina are:

$$(\sigma_1^T)_{ult} = 1500 \text{ MPa}, (\sigma_1^C)_{ult} = 1500 \text{ MPa}, (\sigma_2^T)_{ult} = 40 \text{ MPa}, (\sigma_2^C)_{ult} = 246 \text{ MPa}, (\tau_{12})_{ult} = 68 \text{ MPa}.$$

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