



## SECOND-ORDER FAILURE CRITERIA IN LAMINATE INCLUDING THE EFFECT OF SHEAR STRESS

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**Summary:** Second-order failure criteria in stress field are recommended for the analysis of unidirectional and multidirectional composite materials. Such an approach is easy to use because the coefficients of failure criteria represent the components of stress tensors. Equations and introduced transformations can be successfully used. The combination of experimental results and numerical results received in the software package Matlab proved to be very productive. As known five out of six components of strength tensor necessary for defining failure criteria are easy to determine, while the sixth component is very difficult to determine. The criteria of boundary behavior of the material, based on tensor-polynomial functional, differ in the manner of determining the interaction components of strength tensor. Numerical results have considerably contributed in this respect, because, based on the obtained characteristics of the material. The laminate is modeled by first-order deformation theory. The paper observes the possibility of failure in each laminate layer for various loading values and ratio of shear stress to shear strength of the material.

**Keywords:** Second-order failure criteria; Failure envelope; Shear stress; Laminates; Stress tensor

### 1. THEORETICAL ASSUMPTIONS

At the classical deformation theory for the supposed displacement field the perpendicular stress  $\sigma_{zz}$ , shear stresses  $\tau_{xz}$ ,  $\tau_{yz}$  as well as deformations  $\varepsilon_{zz}$ ,  $\gamma_{xz}$ ,  $\gamma_{yz}$  are neglected. The shortcomings of the mentioned theory have partially been removed by the first order shear deformation theory. For the supposed displacement field given in [1] vector components of the linear deformation can be presented as:

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