Elasto-plastic analysis of delamination phenomena in laminated composites under thermal loads

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Abstract:

Metal matrix composites (MMC_s) represent a new generation of materials with a great number of property advantages compared to the conventional materials such as high stiffness-to-weight ratio, high strength-to-weight ratio, electrical and thermal conductivities. They also show a higher operating temperature and environmental resistance. These properties offer a wide range of application in missiles, aircrafts and other high-performance vehicles.

Using micromechanical FEM models, it has been shown that the singular nature of radial and hoop stress components at the fiber end is responsible for the fiber/matrix debonding and matrix cracking on the free surface of unidirectional fiber composites.

The contradiction to the "Shear-Lag" theory was then identified and adequately explained by a newly proposed theory widely known as the "Overlapping Hypothesis". It is noted that the Shear-Lag theory ignores the radial and hoop stress components at the fiber end.

In addition to the cracking phenomena inherent with unidirectional composites explained above, the delamination problem limits the working life of laminated composites. Many analytical, numerical as well as experimental studies have been performed to identify the main reasons for such a damaging problem and, though, some successful containing procedures have been proposed, the general solution is still too far to reach.

The main goal of the current study is to see whether the Overlapping Hypothesis could be used for explaining the delamination. This is being performed considering FEM micromechanical models along with unidirectional and cross-ply metal matrix laminates. Inelastic behavior of the composite constituents under thermal loads is included.

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