

Overview

Considerable progress continues to be made on issues related to the behavior of composites subjected to compression—the most complicated of the loadings to understand because of the large number of possible responses and their interactions. The three papers in this section reflect the areas in which the composites community is conducting research related to compressive behavior: analysis of the basic phenomena, extensions of basic test methodology, and applications to structural concerns.

In the paper on “The Influence of Fiber Waviness on the Compressive Behavior of Unidirectional Continuous Fiber Composites,” Highsmith, Davis, and Helms search for an explanation for the sometimes “disappointing” behavior of composites in compression. They look at phenomena associated with fiber waviness, matrix nonlinearity, and free surface effects. A micromechanical model is developed to consider sinusoidal waviness of the fibers, and an experimental technique is developed to measure fiber waviness. Their results indicate that this can be an important effect, particularly when consideration is given to matrix nonlinearity. Further work such as this is necessary for the composites community to attain a working understanding of the physical phenomena at work in compressive response.

Leaving the micromechanical view and taking a global view of a composite structure, Portanova, Poe, and Whitcomb address the “Open Hole and Postimpact Compressive Fatigue of Stitched and Unstitched Carbon-Epoxy Composites.” This issue of impact and subsequent response is of particular importance in composite structures as the propagation of delamination caused by impact can severely reduce compressive load-carrying capacity. The work by these three authors shows that stitching can increase the postimpact response by keeping the delamination damage localized to the initial damage region. The authors also show that the stitching does not cause a discernible decrease in unimpacted fatigue strength, a concern caused by the “holes/inclusions” created in the stitching process. Techniques such as stitching may hold the key to increasing design allowables in composites subjected to compression.

The final paper deals with “A Method for Evaluating the High Strain Rate Compressive Properties of Composite Materials.” While many authors have dealt with quasistatic conditions, Montiel and Williams have devised a method to test composites under compression at strain rates up to 8 s^{-1} . The properties at these rates are important for a number of considerations, including certain loading conditions and impact events. The authors show that the strength of the material can be reduced by a substantial factor at these high strain rate loadings. These factors need to be taken into account in design considerations where such strain rates may be encountered.

The three papers in this session are all worth reading as they help to advance our state of knowledge concerning the response of composite materials and their structures to compressive loading.