Overview

In the aerospace industry, many of the design allowables for composite materials are based upon assuming the presence of damage or flaws Of critical importance is the ability to (a) develop design concepts to maximize damage resistance and damage tolerance, (b) predict performance degradation with damage, (c) detect damage, and (d) effectively repair structure if appropriate This session includes four papers which contribute to furthering our understanding in each of these four areas

The first paper, "Damage Tolerance of Three-Dimensional Braided Commingled PEEK/Carbon Composites" by Hua, Chu, and Ko discusses a technique for reducing impact damage through the use of three-dimensional (3-D) braided composite structures Improved impact damage resistance results in an effective increase in damage tolerance over two-dimensional laminate structures impacted under the same conditions Open hole tensile and compressive residual strength is lower than that of a laminated structure, although the relative strength loss is better with 3-D braided structure

Tan and Kim's paper "Damage Accumulation and Fracture of Notched Composite Laminates Under Tensile and Compressive Loading" is especially interesting because it includes compressive as well as tensile loadings The characteristic length of damage at the tip of a notch is a critical parameter in many analytical models for predicting residual strength with damage Tan and Kim show that the characteristic length of accumulated notch-tip damage is a constant for a given laminate if the damage characteristics are the same under different types of loading and varies if the damage characteristics vary

Zhang and Sandor in "Advances in Thermographic Stress Analysis and Evaluation of Damage in Composites" present some experimental and analytical work on fibrous composite laminates They show that, for laboratory specimens under cyclic loading, changes in the thermal signature in the region of the crack tip reflect damage accumulation They developed a theory and method for calibrating changes in the thermal signature to detect and quantify damage growth in some monolithic composite laminates

Finally, Siener in "Stress Field Sensitivity of a Composite Patch Repair as a Result of Varying Patch Thickness" presents his work on stress analysis of a variable thickness repair patch Siener uses finite element modeling to obtain qualitative evaluations of the relative effectiveness of several patch designs and compares the results with experimental data He concludes that a simple linear finite element modeling approach is inadequate for predicting the behavior of variable thickness repair patches He also shows how plies reoriented into the principal stress direction can increase patch effectiveness and thus reduce patch thickness, except where the second principal stress is nearly as large as the first principal stress

The technology necessary to establish acceptable levels of defects for the design and testing of composite structures that have such expected flaws and damage is provided by improving composite material damage tolerance through the use of 3-D braiding, monitoring damage accumulation and fracture of notched composites, and being able to detect, quantify, and predict damage growth by thermographic stress analysis Once the damage occurs or the flaws are discovered, a method of designing repairs for them is presented