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Dynamic Fracture of Nanocomposites and Response of Fiber Composite Panels to Shock Loading[1]

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This lecture will present studies on the response of novel engineering materials to extreme dynamic loadings. In particular, the talk will focus on the behavior of sandwich composite materials to shock loading and dynamic fracture of nano-composite materials. Results from an experimental study on the response of sandwich materials to controlled blast loading will be presented. In this study, a shock tube facility was utilized to apply blast loading to simply supported plates of E-glass vinyl ester/PVC foam sandwich composite materials. Pressure sensors were mounted at the end of the muzzle section of the shock tube to measure the incident pressure and the reflected pressure profiles during the experiment. A high speed digital camera was utilized to capture the real time side deformation of the materials, as well as the development and progression of damage. Macroscopic and microscopic examination was then implemented to study the post-mortem damage. Conclusions on the relative performance of sandwich composites under blast loadings will also be discussed. Results from an experimental investigation conducted to evaluate the mechanical properties of novel materials fabricated using nano sized particles in polymer matrix will also be presented. Unsaturated polyester resin specimens embedded with small loadings of nano sized particles of TiO2 and Al2O3 were fabricated using a direct ultrasonification method to study the effects of nanosized particles on nanocomposite fracture properties. The ultrasonification method employed produced nanocomposites with excellent particle dispersion as verified by TEM. Experiments were conducted to investigate the dynamic crack initiation and rapid crack propagation in theses particle reinforced materials. High-speed digital imaging was employed along with dynamic photoelasticity to obtain real time, full-field quantification of the stress field associated with the dynamic fracture process. Birefringent coatings were used to conduct the photoelastic studies due to the opaqueness of these materials. Dynamic fracture experiments were conducted with various specimen geometries to study the complete history of dynamic crack propagation from initiation to crack branching. Results from several of these experiments were compiled to establish a relationship between the dynamic stress intensity factor, KI, and the crack tip velocity, and the behavior of the nanocomposites is compared with that of the virgin polyester matrix. The specimens used in this study and the nano- particle distribution are also shown in the figure. Crack arrest toughness increased by 64% in the nanocomposite relative to the virgin polyester. Also, Crack propagation velocities in nanocomposites were found to be 50% greater than those in the virgin polyester.

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