Sandwich Structures

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Sandwich panels made of stiff face sheets and compliant low density core materials result in high stiffness lightweight structures. Over the last few years, the science and technology of sandwich structures and materials has gained an impressive momentum, and the use of such structures and materials in a variety of products covering the range from sporting goods to satellites is on the increase. There is a lot of interest in sandwich structures particularly in applications related to aerospace, energy, and marine technologies. Advances in materials processing and fabrication techniques including digital manufacturing are leading to novel applications. As the range of applications expands, particularly in the area of marine structures such as high speed craft and structures resistant to blast loading, there is increased need to understand the behavior of sandwich structures under a wide range of loading conditions and environments. This poses special challenges to experimental mechanics in characterizing the loading and deformation and failure response of sandwich structures.

The International Conference on Sandwich Structures has served as a premier venue over the last two decades for periodically bringing together researchers to discuss progress in this area. The 9th International Conference on Sandwich Structures (ICSS-9) sponsored by the Office of Naval

Research, was held on the campus of the California Institute of Technology (Caltech), Pasadena, California, July, 2010. The overall objective of the ICSS-9 was to provide a forum for the presentation and discussion of the latest research and technology on all aspects of sandwich structures and materials. The conference covered a wide range of topics including dynamic effects, experimental aspects, modeling and simulation, fracture, fatigue, instabilities, materials, processing, manufacturing, and applications of sandwich structures. The global interest in these topics was reflected in participation of more than 120 researchers from 20 countries. The papers in this volume represent leading contributions from presentations at ICSS-9 with emphasis on experimental mechanics of marine sandwich structures. The papers are organized into topical areas of mechanical properties, impact damage, air and underwater blast performance, and hull slamming of sandwich structures.

The characterization of mechanical properties of sandwich structures poses special challenges due to their heterogeneity and considerable mismatch in properties between core and face sheet. Furthermore, sandwich structures are finding increasing applications in the sea water environment and extremes of low and high temperatures. There is also a critical need for knowledge of properties for design and analysis of applications employing sandwich structures. Zhang, Dulieu-Barton, Fruehmann, and Thomsen discuss a new methodology using digital image correlation (DIC) for measuring material properties of polymeric foam core materials at elevated temperatures. They have focused on measuring the compressive and tensile moduli and Poisson's ratio of the foam in an accurate manner by correcting for the non-uniform strain distribution across the specimen. Aviles, Carlsson, and May-Pat present a shear-corrected formulation for the sandwich twist specimen and have validated this new approach using experiments. This

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approach accounts for the shear stiffness of the core and is especially important for low density cores. Siriruk, Penumadu, and Sharma present a detailed study of the combined effect of seawater and low temperatures on the behavior of foam cores and overall behavior of sandwich structures. They provide an extensive study of the fracture behavior under complex loading conditions and harsh environmental conditions.

Sandwich structures can experience low velocity impact both during manufacturing of marine craft and during service. It is imperative to characterize and develop models to predict the damage caused by such impact. Daniel, Abot, Schubel, and Luo provide a comprehensive assessment and review of damage tolerance of composite sandwich structures with various core materials subjected to low velocity impact. They use spring-mass and energy balance models to compare with the experimental measurements and finite element simulations to capture the full response of the panel indentation.

The high speed naval marine craft can be subjected to air blast and underwater explosive loading. Relatively little is known concerning the blast resistance of sandwich structures and effective strategies to mitigate the blast effects. Shukla and Wang discuss the performance of pre-compressed sandwich panels subjected to blast loading. They use a shock tube to generate blast loading, and 3D DIC and high speed photography to measure the transient deformation of the deforming sandwich structures. Arora, Hooper, and Dear present detailed methodologies for studying the dynamic structural response of sandwich structures and composite tubes. They have conducted field experiments together with high speed instrumentation to study the effects of air blast and underwater explosive loading. They use DIC and high speed photography

to obtain the 3D transient response of large panels of sandwich structures subjected to air blast. Avachat and Zhou analyze the response of sandwich structures subjected to underwater blast loading. They provide insights to the effect of various material parameters on energy dissipation and transient deformation, which could lead to optimization of structural design.

High speed marine craft made of sandwich structures are subjected to highly transient periodic loading in the form of hull slamming and infrequent high amplitude wave impact. Battley and Allen present a novel method for studying slamming of sandwich panels on water. They have developed an instrumented servo-hydraulic machine for studying the interaction due to the impact of the hull of a marine craft on water surface. They provide insights regarding the response of sandwich panels under hull slamming conditions. Silva and Ravichandran discuss the development of a mechanical slamming simulator for emulating the loading due to hull slamming. They describe the use of simultaneous DIC and infrared thermography to study damage evolution in sandwich structures under repeated hull slamming using thermoelastic stress analysis.

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