ICCM-16ABSTRACT

Invited to be a plenary lecture

Recent Advances in Marine Composites Research

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Marine structures operate in severe environments, and are designed to withstand complex multi-axial loading conditions, including highly dynamic loadings. The unique and hostile marine environment, with the presence of sea water and moisture, temperature extremes, time-dependent three-dimensional loading due to wave slamming and high sea states, hydrostatic pressure, and other factors, gives rise to significant challenges for designers of composite marine structures. Additional requirements on Naval structures include the ability to withstand extreme dynamic loading, due to weapons impact, or to air or underwater explosions.

The Solid Mechanics Research Program of the Office of Naval Research (ONR) provides the scientific basis for the effective design of affordable and reliable Naval structures, and for the assessment of structural integrity. The major focus is on mechanics of marine composite materials and composite sandwich structures. The program deals with understanding and modelling the physical processes involved in the response of glass-fiber and carbon-fiber reinforced composite materials and composite sandwich structures to static, cyclic, and dynamic, multi-axial loading conditions, in severe environments (in the presence of sea water, moisture, temperature extremes, and hydrostatic pressure). The establishment of these models, with predictive capabilities, require multi-scale, multi-physics analysis. Avenues for enhancing the performance of marine composite structures through the introduction of nanoparticles (and nanotubes), and through the incorporation of novel design concepts, are also being explored. Research on multifunctional composites seeks to enhance performance through the incorporation of additional beneficial attributes, without compromising on the mechanical properties.

Recent achievements of the leading researchers in mechanics of composite materials and sandwich structures, supported by the ONR Solid Mechanics Program, will be summarized. These include research related to durability: sea water effects on interfaces (fiber/matrix, face-sheet/core); accelerated testing for long term durability; time-temperature dependent long term fatigue strength; post-impact fatigue behavior; tension, compression and shear fatigue of foam core materials; and comparative studies of effects of sea and fresh water. Research on dynamic effects include: dynamic constitutive equations and strain rate effects; dynamic response of nanocomposites; impact response and ballistic penetration; effect of blast/shock loading; interaction of multiple delaminations; progressive damage models; fluid-sandwich structure interaction effects; hydroelastic response under slamming loads; and concepts for mitigation of damage. Special Sessions on Marine Composites, Durability, and Dynamic Failure, include (approximately) two dozen papers based on ONR supported research.