Composites for Marine Structures – Challenges and Recent Advances

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Abstract

Composite materials are being used increasingly in Naval structures due to many advantages. These applications challenge ship designers and naval architects, in view of the unique marine environment, with the presence of sea water and moisture, varying temperatures, hydrostatic pressure, and time-dependent three-dimensional loading due to wave slamming and other factors. In addition, Naval structures are required to withstand extreme dynamic loading during combat situations, due to weapons impact, or to air or underwater explosions. The major factors governing the design of future Naval structures include: Affordability, Combat Effectiveness, Survivability, Reliability, Durability, and Structural Integrity. The Solid Mechanics Program at the Office of Naval Research provides the scientific basis for the effective design of affordable Naval structures utilizing composites and composite sandwich construction. It deals with the response of glass fiber and carbon fiber reinforced composites and composite sandwich structures to static, cyclic, and dynamic multi-axial loading conditions in severe environments. An overview will be provided of this Navy unique research program, with a discussion of its objectives, research issues, recent accomplishments, and future directions. Topics discussed will include: failure modes and failure criteria (3D); delamination growth under fatigue loading; dynamic constitutive behavior; dynamic failure modes; intersonic crack growth; the effect of moisture and sea water absorption; coupling effects between sea water absorption and mechanical fatigue; failure modes in sandwich structures; and impact damage in sandwich structures. The use of innovative experimental techniques for the real-time assesment of damage and failure will also be discussed. Concepts for enhancing the mechanical properties of composites through the use of nanocomposites will be described. Directions of future research will be discussed.