Plenary

Performance of Ship Structures Under Extreme Environments - ONR Related Research Thrust Areas

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The Solid Mechanics Research Program of the Office of Naval Research (ONR) provides the scientific basis for the effective design and utilization of affordable and reliable naval structures operating in severe environments. These structures are designed to withstand complex multi-axial loading conditions, including highly transient loads. The analysis of these structures requires the incorporation of the effects of sea water and moisture, temperature extremes, time-dependent three-dimensional loading, high sea states, hydrostatic pressure, and other factors.

The current research focus is on mechanics of marine composite materials and composite sandwich structures. The program deals with understanding of, and establishing physically based models for, 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. The establishment of these models, with predictive capabilities, requires 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.

Some recent research accomplishments will be summarized. Examples include: effect of sea water on composites, combined effect of sea water and temperature extremes, enhancement of mechanical properties through incorporation of nanoparticles, utilization of carbon nanotubes for in-situ sensing of damage, establishment of three-dimensional static/dynamic failure criteria, mechanical behavior of syntactic foams, dynamic response of composite structures with fluid-structure interaction, low velocity impact and shock response, and hull slamming effects.

The presentation will include a discussion of future directions of research in mechanics of marine composites for affordable naval structures with enhanced performance and reduced life-cycle costs. Areas of increased emphasis include: structure/fluid interactions; shock, blast, and implosion effects; and coupled effects of sea water, temperature extremes, and highly dynamic loading.

Dr. Rajapakse is currently Program Manager, Solid Mechanics, Office of Naval Research. He earned his B.Sc. (Mathematics) from University of Ceylon (Sri Lanka), M.S. (Mathematics) from Stanford University, and Ph.D. (Applied Mechanics) from Stanford University. He has been elected FELLOW of four technical societies: American Society of Mechanical Engineers (ASME), Society of Engineering Science (SES), American Academy of Mechanics (AAM), American Society for Composites (ASC). He is a Past Chairman of both the Polymer Matrix Composites Committee, ASC, and the Composites Committee, ASME AMD. He is a Past President of the Society of Engineering Science (SES), and Past Member, Board of Directors of the Society of Engineering Science (SES).

Dr. Rajapakse currently serves on the Editorial Boards of several journals: Composite Science and Technology, J. Sandwich Structures and Materials, J. Reinforced Plastics and Composites, J. Strength, Fracture and Complexity, Composites Part B. He has delivered numerous Plenary/Keynote presentations at national and international conferences. He was Co-chair (with Jack Vinson, Leif Carlsson) of the Sixth International Conference on Sandwich Structures (ICSS6), Ft. Lauderdale, FL.

He was also Editor/Co-editor of over 25 books/conference proceedings on fracture, dynamic failure, composite materials, sandwich structures, wave propagation, quantitative non-destructive evaluation, sea ice mechanics. And, Editor/Co-editor of Special Issues of Journals (Composites Science & Technology, Composites Part B, Int. J. Fracture, Experimental Mechanics, Materials Science & Engineering).