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DAMAGE DEVELOPMENT AND DETECTION IN POLYMERIC COMPOSITES

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Fiber Reinforced Polymer (FRP) composite materials have been in use for about 70 years and significant achievements have taken place in their design and fabrication. They have been increasingly accepted for many essential, structural applications, particularly those that benefit from their high strength to density ratio, electrical properties and behaviour in corrosive environments. In spite of these significant engineering advances, some concerns about reliability remain because failures still occur without detection by conventional in-service inspection practices. These failures are also at variance with the care taken in design.

Design approaches for polymeric composite structures often rely on anisotropic reinforcement fibers to provide the strength required to sustain the loads while the isotropic matrix holds the fibers in position and provides load transfer among the fibers. Reinforcement plays the dominant role in the strength of FRP, with the matrix usually providing less than 13% contribution to any mechanical properties used in structure design.

The success of Non Destructive Evaluation (NDE) to detect flaws and defects in metal structures has not gone unnoticed, and much use of these NDE techniques is aimed at finding overt defects in FRP structures with the intent of preventing undesirable, and perhaps non-conforming, material from entering service. Ultrasound is a major technique used and interpretation of flaws is based on standards that are similar to those used for metal alloys.

All of the constituent materials in FRP are non-linear viscoelastic materials that undergo continuous changes forced by combined service conditions. This presentation will provide brief description of damage development and how this damage can lead to failure of FRP materials. The session will then describe methods for detecting damage development so that FRP reliability can be optimized. Some of these methods can be applied to most FRP structures in use today, regardless of their age or origin.