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EXPERIMENTAL CHARACTERIZATION OF GLASS FIBRE REINFORCED EPOXY COMPOSITE FOR THE EXTRACTION OF MATERIAL PARAMETERS AND FAILURE ENVELOPE VALIDATION

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Summary: Composite materials have started substituting conventional materials in various applications due to the customizability of material properties. However due to their anisotropy and inhomogeneity, there are no standard material models (mechanical properties) that are readily available to simulate their behaviour. It is required to develop material models derived from various experiments conducted on the material of interest.

This work aims to study the effect of temperature and loading rate on the material behaviour of a glass epoxy composite through mechanical characterization of test pieces machined from a filament wound pipe. Failure envelopes for the composite pipe were generated from an in-house code based on individual ply and stack-up information. The equivalent properties for the developed model are then applied to the pipe and analysed through a finite element (FE) package to correlate the simulation results of pipe damage with the generated failure envelopes.

The mechanical properties of the glass epoxy composites were experimentally determined under three loading rates and three different temperatures. The axial properties were measured by conducting uniaxial tensile tests (as per ASTM standard 3039/D 3039M-95a) at constant strain rates of 1.3 mm/min, 250mm/min and 5000mm/min and at temperatures of 25°C, 80°C and 120°C. Our study showed that the tensile strength of the specimens increased with loading rate at a constant temperature and that the strength decreased with temperature at a constant loading rate. The uniaxial compression properties were measured as per ASTM standard D6641/D6641M – 09 with an anti-buckling fixture at 1mm/min and 250mm/min at room temperature. The compressive strength was found to be 2.5 times the tensile strength. The strain was measured with strain gauges adhered to the specimens before the tests and the strains were recorded through a data logger as well as a clip-on extensometer, both capable of measuring in the order of micro-strains. The hoop strength was measured by conducting circumferential tensile tests using a special fixture as per standard BS EN 1394:1997, method B. The hoop strength was about 3.7 times the axial tensile strength at loading rate of 1mm/min at ambient conditions. The circumferential stiffness was measured through ring stiffness tests conducted as per BS EN 1228:1997.

The experiments have been completed and simulation in Abaqus will be carried out in future followed by the comparison with the failure envelope.