Ultimate elastic wall stress (UEWS) test of glass fibre reinforced epoxy (GRE) pipe

Abstract

This paper presents an experimental investigation of the behaviour of filament wound glass fibre reinforced epoxy (GRE) composite pipe under hydrostatic and biaxial load conditions at temperatures up to 95 °C. The format of the experiments has been chosen to be compatible with the Future Pipe Industries (FPI) procedure using the ultimate elastic wall stress (UEWS) concept in the qualification and production control of GRE. The test appears to provide an attractive alternative to the current 1000 hour test procedure detailed in ASTM D2992 for the detection of manufacturing changes and reconfirmation of the design basis of the pipe. Six different stress ratios ranging from pure axial loading 0:1, 0.5:1, 1:1, 2:1, 4:1 and pure hoop 1:0 loading were tested. Three distinct failure modes were observed: tensile axial failure at pure axial loading, weepage at axial dominated loading from 0.5:1 to 2:1 and localized leakage failure under hoop dominated loading of 4:1 and 1:0. Full tensile-tensile UEWS and leakage based failure envelopes have been developed at a range of temperatures from 20 °C (RT) to 95 °C. Both showed a strong dependence on stress ratio and test temperatures. It was also shown that the UEWS based failure envelope at elevated temperatures generally degraded, except for the 2:1 loading where the UEWS strength increased.