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M3Or1A-02: Investigating the applicability of existing mechanical test standards for fibre-reinforced polymer matrix composites at cryogenic temperatures

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In recent years, due to the emerging growth of industry sectors focused on achieving Net-Zero energy sources; the research, development, and application of fibre-reinforced polymer (FRP) composites in the cryogenic liquid storage and distribution fields has grown significantly. When exposed to extreme temperatures, FRP composites can exhibit significant changes in their properties, as reported in literature. The development of capabilities for mechanical testing of FRP composites under cryogenic conditions is of the utmost importance to determine material performance and provide assurance of material quality.

At present, there is a limited number of literature sources that provide consistent and reliable mechanical test results generated from cryogenically testing FRP composites. This is due to the lack of standards available to provide guidance on test methods, specimen dimensions, apparatus, and instrumentation for the successful characterization of mechanical properties of FRP composites under these extreme temperatures. This is considered a major barrier to the increased uptake of FRP composite materials and processes in liquid hydrogen (LH2) and liquified natural gas (LNG) distribution and storage applications, especially when compared to metals.

The aim of this study is to assess the applicability of existing tensile and compressive test standards, as well as investigate and validate the mechanical properties of FRP composites with different resins, fibres and layup compositions, when tested as low as -165 ℃. The experimental findings have provided preliminary evidence of material-dependant behaviour in cryogenic temperatures, but mainly highlighted the room for improvement in terms of specimen and test preparation, equipment and practices, in order to be able to confidently characterise FRP composites under these conditions.

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