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Research of the Load Bearing Capacity of Inserts Embedded in CFRP under Different Loading Conditions

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Abstract : Continuous carbon fiber reinforced plastics (CFRP) exhibit a high application potential for lightweight structures due to their outstanding specific mechanical properties. Embedded metal elements, so-called inserts, can be used to join structural CFRP parts. Drilling of the components to be joined can be avoided using inserts. In consequence, no bearing stress is anticipated. This is a distinctive benefit of embedded inserts, since continuous CFRP have low shear and bearing strength. This paper aims at the investigation of the load bearing capacity after preinduced damages from impact tests and thermal-cycling. In addition, characterization of mechanical properties during dynamic high speed pull-out testing under different loading velocities was conducted. It has been shown that the load bearing capacity increases up to 100% for very high velocities (15 m/s) in comparison with quasi-static loading conditions (1.5 mm/min). Residual strength measurements identified the influence of thermal loading and preinduced mechanical damage. For both, the residual strength was evaluated afterwards by quasi-static pull-out tests. Taking into account the DIN EN 6038 a high decrease of force occurs at impact energy of 16 J with significant damage of the laminate. Lower impact energies of 6 J, 9 J, and 12 J do not decrease the measured residual strength, although the laminate is visibly damaged - distinguished by cracks on the rear side. To evaluate the influence of thermal loading, the specimens were placed in a climate chamber and were exposed to various numbers of temperature cycles. One cycle took 1.5 hours from -40 °C to +80 °C. It could be shown that already 10 temperature cycles decrease the load bearing capacity up to 20%. Further reduction of the residual strength with increasing number of thermal cycles was not observed. Thus, it implies that the maximum damage of the composite is already induced after 10 temperature cycles.

Keywords : composite, joining, inserts, dynamic loading, thermal loading, residual strength, impact
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