Adhesive Properties Subject to Variation in Temperature, Thickness, and Working Time

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Abstract

Adhesive use is becoming increasingly common in manufacturing processes. The advantage of adhesives are light weight components, non-destructive fastening techniques and distribution of loads over the applied bond region. Modeling the behavior of adhesive bond lines in fastening joints can help in the design process to make an optimized joint, with minimal adhesive waste. However, the material properties provided by manufactures of adhesives often creates a gap in what is sufficient to accurately model the behavior of real-world adhesive conditions. To design optimized joints, the loading conditions, environmental conditions of service, thickness of bond, and bonding procedures all need to be refined for the adhesive of interest. The body of research presented for this thesis are the results of two phases of adhesive testing to meet these conditions for optimized adhesive joints. In Phase I, the temperature is varied and tested against two adhesives, Plexus MA832 and Pliogrip 7779/220b, and four specimen types. The specimens serve the purpose of providing the needed material properties to compose a traction separation law (TSL) in loading mode I and mode II. The needed material properties to compose an accurate TSL have been shown to be the mode I cohesive strength, mode I cohesive toughness, mode II cohesive strength, and mode II cohesive toughness. These properties can be measured with test specimens designed to isolate the specific loading mode and condition. The specimens used are the Dog Bone Tensile Specimen, the Double Cantilever Beam (DCB), Shear Loaded Dual Cantilever Beam (SLDCB), and Double Lap Shear. In Phase II the thickness, working time, and temperature are varied for Plexus MA832 with the DCB and SLDCB specimens. The adverse condition that the environmental temperature changes have on adhesive property behavior will be simulated with a temperature chamber. The chamber was used to test specimens at -30°C, -20°C, 20°C, 40°C and 45°C. The thickness varied in Phase II was 1.27± 0.34 [mm] for a thin bond and 10.38± 0.66 [mm] for a thick bond. The working time varied in Phase II had a control group bonded in the recommended working time for all thicknesses, and an expired working time where the specimens were not joined until 10 [min] had passed from the recommended working time. Triplicates of each specimen at the respective conditions were tested for both phase I and II. The use of adhesives in adverse temperature conditions is advised to be tested and refined in design before implementation into service. The findings of this report have shown that adhesive factors such as temperature conditions, thickness of bond, and working time can be found to have degraded performance on adhesive load carrying ability in mode I and mode II.

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