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Experimental investigation and finite element modelling of the influence of hydrostatic pressure on adhesive joint failure

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Abstract

Structural adhesives have been increasingly used in automotive industries in conjunction with lightweight structural components to maximize weight reduction in modern car design. They are used to bond various kind of lightweight materials such as FRP composites or metallic alloys and provide a good distribution of force across joining area without damaging the substrates. For automotive applications, bonded components have been often used in complex loading environments which brings failure prediction of adhesive joints a key of success for this technology. As polymer-based materials, hydrostatic pressure can have a major impact on adhesive joint failure in addition to temperature and strain rate. Its influence can be investigated using a specific test fixture known as a modified-Arcan fixture. This article presents the characterization of epoxy-based adhesive using a series of modified-Arcan tests to apply different loading taking in account effect of hydrostatic pressure onto adhesive joints. A high-order exponential Drucker-Prager failure criterion is chosen to interpret the yield and failure surface. Finally, the non-linear behaviour of adhesive is identified via 0° and 90° Arcan tests which correspond respectively to tri-axial and shear modes and the validation of this behaviour is carried out by mix-mode 60° and 120° Arcan tests. The simulation shows a good agreement only with the result in direction 60° while in direction 120° the divergence is obvious due to the different in damage mechanism of this mode.

Keywords*:* adhesive bonding, modified-Arcan test, The high-order Drucker-Prager criteria, FEM simulation