CURE DEPENDENT LOADING RATE EFFECT ON STRENGTH OF THERMOSET POLYMERS

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Thermoset polymers are extensively employed in engineering, especially in aerospace and automotive. However, in these fields they are typically thermally treated to obtain optimal material properties and avoid post-curing effects. Recently, thermosets can be also found in various structural engineering applications such as e.g. bonded anchors. In these cases thermal activation is typically not possible resulting in an undefined curing state. One of the most crucial design problems is the long-term behavior under sustained load. In order to accurately predict the tertiary creep behavior of a viscoelastic material, the loading rate effect needs to be characterized. In case of thermosets, also the curing degree dependence of the aforementioned material properties has to be accounted for. In this study the loading rate effect on strength is analyzed for different curing states which are derived from relevant in-situ conditions. Two adhesive products have been studied, one epoxy based and one vinyl ester based. The materials are characterized through tensile tests at different rates. The strain was monitored using digital image correlation (DIC). Four degrees of cure, assessed by means of DSC measurements, has been obtained by curing and post-curing the materials at different temperatures. The results reveal that the loading rate effect on strength on strongly dependent on the curing degree of the polymer. Interestingly, opposite trends are observed for the two adhesives. Finally, a simplified model able to describe the curing-degree dependent rate effect on strength is proposed as essential element for realistic numerical simulations of tertiary creep in incompletely cured thermosets.