Effects of Geometric Scaling on the Strain Rate Sensitivity of Composite Materials

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ABSTRACT

The rate sensitivity of composite materials is well know, albeit contrasting observations of various researchers, owing to differences in materials characterized, test coupon geometries, test methods and apparatus used. The rate sensitivity is typically studies using small test coupons to maximize the strain rates achieved while minimizing the loads required to fail the specimens. The composite material strengths have been known to be sensitive to geometric dimensions (1,2), both planar and thickness. In the present study, the influence of geometric scaling on the rate sensitivity of the composite materials under tensile loading is being investigated experimentally. The material systems under study are Newport NB321/7781 fiberglass/epoxy and Toray T800/Pxxx carbon unitape/epoxy systems. These materials have been characterized extensively for rate sensitivity as part of a previous investigation. The observations were restricted to small scale coupons and could be masked by inherent scaling effects. Thus, the in-plane tensile and shear properties along principal material directions are being studied using scaled tensile coupons. The tensile properties are being characterized using $[0]_n$ laminated coupons and the shear properties using $[+45/-45]_{ns}$ laminated coupons. The present study is limited to scaling of width and height (i.e., planar scaling) while the thickness is held constant.

The tests are being conducted at stroke rates ranging between 0.01in/s to 100 in/s. The quasi-static rate tests are conducted using an electromechanical testing machine, while the high speed tests will be conducted using a MTS high rate servo hydraulic test system. To facilitate a comparison between coupons of different gage lengths at a specific strain rate, the tests have to be conducted at different stroke rates depending on the gage length of the specimen. In addition, the testing machine compliance has to be accounted for during the computation of required stroke rates.

Preliminary tests on the NB321/7781 fiberglass/epoxy material system indicate the presence of geometric scaling even at quasi-static rate. The strength tends to decrease with increasing gage length or gage volume as indicated in figure 1.

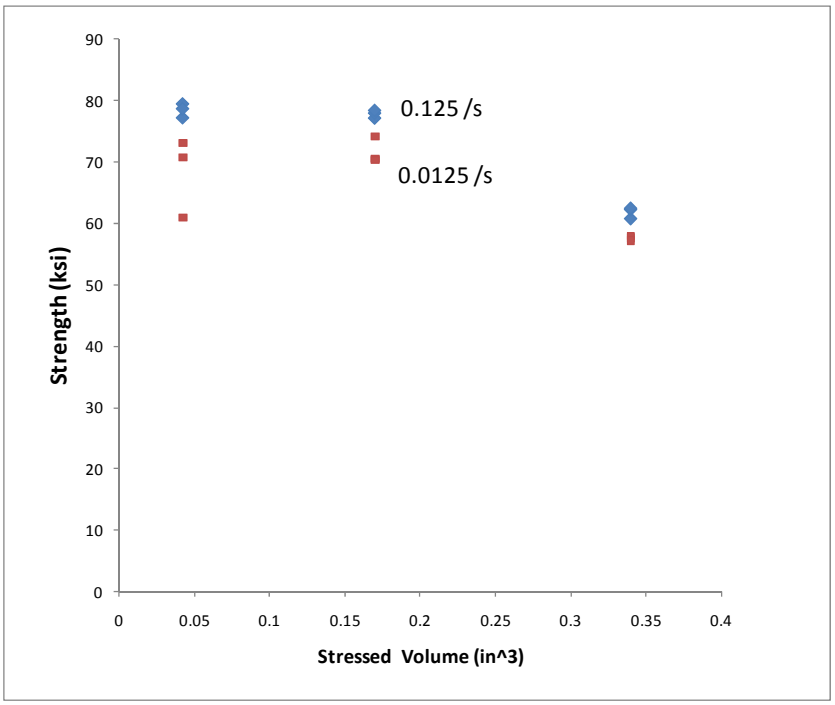

Figure 1: Observed scaling effects for [0]4 Newport fiberglass specimens at two strain rates

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