256 Shades of Gray: Application of Image Processing to Evaluate the Effect of Sample Geometry and Constant Shear Strain Rates in the Picture-Frame Test

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Abstract. Shearing or trellising is recognized as the primary deformation mechanism in textile-reinforced composite forming processes. A popular method for characterization of the shear properties of a ply is the picture-frame test. The test setup involves the clamping of a cruciform shaped specimen in a frame hinged at its corners. During the processing of the test results, it is often assumed that the shear distribution in the central square of the sample is uniform, such that a shear force vs. shear angle relation can be calculated based on kinematics. One thing to note is that a constant displacement rate of the frame yields a nonlinear shear-strain rate throughout the test. Relying on Digital Image Correlation (DIC), this study considers two concepts in relation to the picture-frame test: First, the effect of sample geometry is tested, i.e. whether modifications of the standard cruciform shape influence the uniformness of the shear-strain field. Two different materials are considered: a woven carbon-fiber prepreg and a thermoplastic cross-ply sheet. Second, methods of obtaining constant shear rate data are explored. The methods involve programming of a universal testing machine with a multilinear approximation of a nonlinear crosshead displacement rate and post-processing data obtained with a constant crosshead rate.