A METHOD FOR ESTIMATING CONSTITUTIVE PROPERTIES OF A C/C-SiC COMPOSITE MATERIALS BASED ON A BRAZILIAN DISC SPECIMEN

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A state-of-the-art design of CMC part, aimed for space or hypersonic purposes, demands a reliable and cost-effective method for estimating and quantifying the mechanical properties of the composite material. However, composite in general and ceramic matrix composite, in particular, tends to present complex anisotropic mechanical properties. Thus, one must conduct several different tests – each of them is used to measure a single constitutive property. This procedure demands significant time and effort to estimate all of the constitutive properties of the material. The current work introduces a more efficient method for estimating the constitutive properties of a C/C-SiC composite material. The proposed test method suggested here for CMC composites is based on a Brazilian disc (BD) test. A thin circular plate is loaded by compression along its diameter. The CMC-BD test generates axially compression loads and transverse tension stresses (maximized at the disc's center). Shear strains are also present, especially when an orthotropic material is tested with a load not in-line with material symmetry direction. These multi-axial strain fields can be measured today with digital image correlation (DIC) methods. Hence, one can measure different strain components simultaneously and spatially present within the specimen. The current study investigated a 40mm C-C/SiC disc cut out of an 8-harness $[0/90]_{5s}$ lamina. The disc was subjected to a repeating non-distractive compression load. Each time the disc was loaded three times and then was rotated to the next rotation angle. During the test, the load was recorded with the associated DIC images from both sides of the disc. The DIC images were used to analyze the strain fields using DIC algorithms. Finally, constitutive properties were evaluated based on the force–angle – strain field correlations. The talk will elaborate on the analytic and numerical method for estimating the constitutive properties and will discuss the pros and cons of this method versus properties measurement based on ASTM tests.

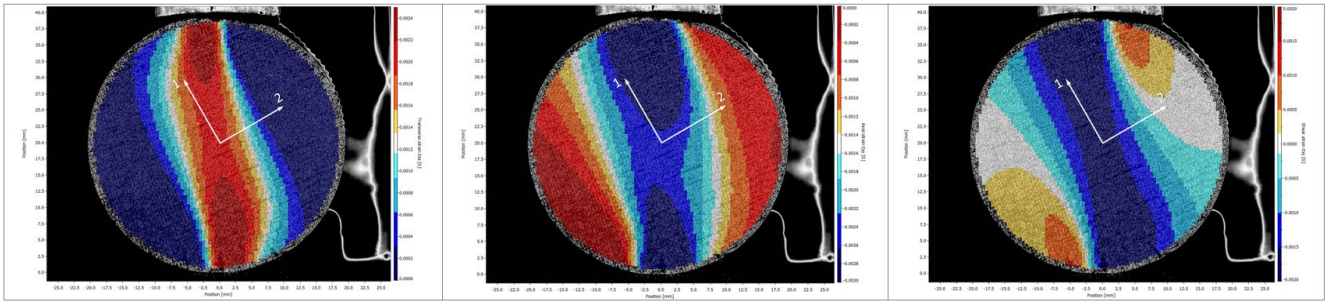

Figure 1 – Measured In-Plane strain fields for a rotated disc of 30° (from left: ε_{xx}, ε_{yy} , ε_{xy}); different scales and colorbars were used for each case

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