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On Elastic Anisotropy of Fused Filament Fabricated Acrylonitrile Butadiene Styrene Structures

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Abstract : Fused filament fabrication is one of the most widespread additive manufacturing techniques because of its low-cost implementation. Its initial development was based on part fabrication with thermoplastic materials. The influence of the manufacturing parameters such as the filament orientation through the nozzle, the deposited layer thickness, or the speed deposition on the mechanical properties of the parts has been widely experimentally investigated. It has been recorded the remarkable variations of the anisotropy in the function of the filament path during the fabrication process. However, there is a lack in the development of constitutive models describing the mechanical properties. In this study, integrated digital image correlation (I-DIC) is used for the identification of mechanical constitutive parameters of two configurations of ABS samples: +/-45° and so-called “oriented deposition.” In this last, the filament was deposited in order to follow the principal strain of the sample. The identification scheme based on the gap reduction between simulation and the experiment directly from images recorded from a single sample (single edge notched tension specimen) is developed. The macroscopic and mesoscopic analysis are conducted from images recorded in both sample surfaces during the tensile test. The elastic and elastoplastic models in isotropic and orthotropic frameworks have been established. It appears that independently of the sample configurations (filament orientation during the fabrication), the elastoplastic isotropic model gives the correct description of the behavior of samples. It is worth noting that in this model, the number of constitutive parameters is limited to the one considered in the elastoplastic orthotropic model. This leads to the fact that the anisotropy of the architectured 3D printed ABS parts can be neglected in the establishment of the macroscopic behavior description.

Keywords : elastic anisotropy, fused filament fabrication, Acrylonitrile butadiene styrene, I-DIC identification
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