A New Laboratory-Based X-ray Diffraction Technique for Pointwise Stress-Strain Measurements.

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Abstract

The explosion of data-driven modeling often uses so-called supervised learning models that require data in the form of stress-strain pairs. Measurement of these pairs typically involves a large number of separate experiments as standard methods such as digital imaging correlation (DIC) only provide spatial strain distributions and no information on local stresses. This makes generating such data experimentally prohibitively expensive. The solution lies in measuring the spatial distributions of stress and strain in a single geometrically complex specimen that samples a wide range of the stress space. This presentation introduces a groundbreaking experimental technique that enables pointwise stress-strain measurements in such geometrically complex specimens within a laboratory setting. We harness a high-flux metal jet X-ray source to conduct energy dispersive diffraction measurements along with DIC to get spatial information of elastic and total strain distributions in metallic specimens. Therefore, we have brought synchrotron technologies into a laboratory setting and opened the possibility of generating data for application in data-driven material models. The presentation will showcase the application of this innovative method to various specimen geometries, focusing on designing specimens and loading conditions that sample a wide range of the stress space. Through meticulous full-field measurements and advanced machine learning algorithms, we aim to develop data-driven material models that accurately capture complex elasto-plastic responses of metals.

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