Calibration of a Ultrasonic Fatigue Testing Machine using Digital Image Correlation Technique

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Abstract The calibration of machine operational mode and the measurement systems used for Ultrasonic Fatigue Testing (UFT) is important to ensure its safe and accurate operation according to design objectives. This work presents a new statistical calibration approach using Digital Image Correlation (DIC) technique. Bayesian framework is used to quantify uncertainty of measurements system and its propagation into the stress-life prediction curves. This is essential as a considerably high dispersion of stress-life data in the high and very high cycle regime has been reported. Firstly, the measurement systems including displacement lasers and highspeed camera system readings are cross calibrated with a numerical finite element model. Secondly, a statistical learning of stress-deformation relationship is established using a Hierarchical Bayesian Inference technique (HBI) based on DIC system measurements of strain and laser displacement measurements of ultrasonic machine specimen's tip. Thirdly, HBI is used to introduce an additional layer of hierarchy aimed at inferring uncertainty in the stress-life curve through learned stress distributions and the distribution of number of cycles to fatigue failure. The results discuss the sources of uncertainties in UFT and indicate that HBI can systematically quantify the uncertainties.