World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:14, No:04, 2020

Sensitivity and Uncertainty Analysis of One Dimensional Shape Memory Alloy Constitutive Models

Authors : A. B. M. Rezaul Islam, Ernur Karadogan

Abstract : Shape memory alloys (SMAs) are known for their shape memory effect and pseudoelasticity behavior. Their thermomechanical behaviors are modeled by numerous researchers using microscopic thermodynamic and macroscopic phenomenological point of view. Tanaka, Liang-Rogers and Ivshin-Pence models are some of the most popular SMA macroscopic phenomenological constitutive models. They describe SMA behavior in terms of stress, strain and temperature. These models involve material parameters and they have associated uncertainty present in them. At different operating temperatures, the uncertainty propagates to the output when the material is subjected to loading followed by unloading. The propagation of uncertainty while utilizing these models in real-life application can result in performance discrepancies or failure at extreme conditions. To resolve this, we used probabilistic approach to perform the sensitivity and uncertainty analysis of Tanaka, Liang-Rogers, and Ivshin-Pence models. Sobol and extended Fourier Amplitude Sensitivity Testing (eFAST) methods have been used to perform the sensitivity analysis for simulated isothermal loading/unloading at various operating temperatures. As per the results, it is evident that the models vary due to the change in operating temperature and loading condition. The average and stress-dependent sensitivity indices present the most significant parameters at several temperatures. This work highlights the sensitivity and uncertainty analysis results and shows comparison of them at different temperatures and loading conditions for all these models. The analysis presented will aid in designing engineering applications by eliminating the probability of model failure due to the uncertainty in the input parameters. Thus, it is recommended to have a proper understanding of sensitive parameters and the uncertainty propagation at several operating temperatures and loading conditions as per Tanaka, Liang-Rogers, and Ivshin-Pence model.

Keywords : constitutive models, FAST sensitivity analysis, sensitivity analysis, sobol, shape memory alloy, uncertainty analysis
Conference Title : ICAMAME 2020 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering
Conference Location : New York, United States
Conference Dates : April 23-24, 2020