ICCES, 2023, vol.27, no.2
DOI: 10.32604/icces.2023.09713

PROCEEDINGS

A Data-Fusion Method for Uncertainty Quantification of Mechanical Property of Bi-Modulus Materials: An Example of Graphite

Liang Zhang[1,*] and Zigang He[1]

[1] College of Aerospace Engineering, Chongqing University, Chongqing, 400044, China
[*]Corresponding Author: Liang Zhang. Email: zhangl@cqu.edu.cn

ABSTRACT

The different elastic properties of tension and compression are obvious in many engineering materials, especially new materials. Materials with this characteristic, such as graphite, ceramics, and composite materials, are called bi-modulus materials. Their mechanical properties such as Young's modulus have randomness in tension and compression due to different porosity, microstructure, etc. To calibrate the mechanical properties of bi-modulus materials by bridging FEM simulation results and scarce experimental data, the paper presents a data-fusion computational method. The FEM simulation is implemented based on Parametric Variational Principle (PVP), while the experimental result is obtained by Digital Image Correlation (DIC) technology. To deal with scarce experimental data, Maximum Entropy Principle (MEP) is employed for the uncertainty quantification (UQ) and calibration of material parameters and responses, which can retain the original probabilistic property of a priori data. The non-parametric p-box is used as a constraint for data fusion. The method presented in this paper can quantify the mechanical properties of materials with high uncertainty, which is verified by a typical example of bi-modulus graphite. It is possible to find applications in the real-time estimation of structural reliability by combining with digital twin technology in the future.

KEYWORDS

Tension-compression asymmetry; uncertainty quantification; DIC test; maximum entropy principle; scarce experimental data

Acknowledgement: The support of National Natural Science Foundation of China (No. 12272068) is gratefully acknowledged.

Funding Statement: Funding for this work is supported by National Natural Science Foundation of China (No. 12272068); Initials of authors who received the grant: L. Z.; the URLs to sponsors' websites: https://www.nsfc.gov.cn/.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.