Fatigue crack growth analysis using Bootstrap S-version finite element model

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ABSTRACT

The objective of this paper was to predict the fatigue life, surface crack and initial faw size distribution of fatigue surface crack growth. A statistical analysis is carried out to evaluate the distributions of initial faw size as an input uncertain parameter. The prediction of remaining life to schedule the maintenance is important to prevent serious accidents from occurring. The three-point and four-point bendings are analysed using the Bootstrap S-version fnite element model (BootstrapS-FEM) whereby the bootstrap resampling method is embedded into S-version fnite element model. The validation process is conducted between the predictions, deterministic and previous experimental results. The BootstrapS-FEM with lognormal distribution shows a more accurate trend against normal distribution based on the coefcient of determination, normalised root-mean-square error and mean absolute percentage error. The prediction of fatigue life for three-point and four-point bendings by BootstrapS-FEM was well compared with previous experimental results within range from 5 to 17% of percentage errors. These errors were acceptable to the purpose of prediction which are less than 20%. The uncertainties in structural components are considered by the upper and lower bounds in probabilistic analysis. The BootstrapS-FEM results show a better agreement with previous experimental results and deterministic solutions. Initial faw size distributions are evaluated to prior scheduled inspection for the prevention of a catastrophic failure. The risk of a catastrophic failure can be evaluated based on the initial crack size distribution and specifed fatigue life for ensuring safety and reliability of the fatigue crack structures.

KEYWORDS: Fatigue; Crack growth; S-version finite element model; Bootstrap resampling method; Probabilistic analysis

DOI: https://doi.org/10.1007/s40430-020-2268-8

ACKNOWLEDGEMENTS

This study were funded by RDU170383 and RDU1703184 from Universiti Malaysia Pahang (UMP) and Fundamental Research Grant Scheme (FRGS/1/2017/TK03/ UMP/02/24) and (FRGS/1/2018/STG06/UMP/02/16) from Kementerian Pendidikan Malaysia (KPM) with number RDU170124 and RDU190134 respectively.