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ON THE USE OF VARIOUS CORRELATION CRITERIA FOR THE VALIDATION OF SATELLITES FEM

Abstract

Finite element models (FEMs) are widely used to predict the behavior of a complex structure such as a spacecraft before its realization. The capability of the model to accurately predict the performance of the actual system is vital for the successful completion of the mission and hence it is assessed by comparing the analytical results with experimental data. Modal assurance criterion (MAC) and normalized cross orthogonality (NCO) check are the most commonly employed methods in the space industry for the validation of FEMs. In order to match the degrees of freedom of analytical and experimental models, a test-analysis model is used in the NCO. In this study, Monte Carlo simulations were used to determine the robustness of a system equivalent reduction expansion process (SEREP) based test-analysis model when experimental and/or analytical modes of different spacecraft contain various levels of inaccuracy. It has been observed that, the probability to clear the NCO check is determined mainly by the number of modes used in the SEREP reduction. The capability of the FEMs to predict the response and the corresponding NCO value of the FEM is compared, and it is observed that sometimes, FEM models with lower NCO are better than FEM with higher NCO in predicting some responses. The effectiveness of MAC and NCO criteria on the response prediction of spacecraft models under the base excitation is also carried out. It is observed that neither MAC nor NCO is suitable to predict the forced response characteristics such as the force transmitted to the base, peak acceleration response, and dynamic displacement in the spacecraft. A new criterion termed as base force assurance criterion (BFAC) is defined using the experimentally determined dynamic force at the base and the finite element predicted force in a similar way as MAC was defined. In this study, the results obtained from the real FEM of the spacecraft were taken as the experimental results and those obtained from intentionally erroneous FEMs were considered as the analytical results. The method is applied to assess the performance of different spacecraft models under base excitation and observed that BFAC can correlate the acceleration and the dynamic displacement error in a better way than MAC or NCO.