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”SHM#6 - Effects Of Multi-Axis Random Vibration Environments On Fatigue-Life And Durability Predictions”

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One of the main features of a product is its capability to withstand harsh environments that may compromise its durability over time. Therefore, screening laboratory tests are usually performed in the early stages of the product development process to predict the fatigue life beforehand. In this context, random vibration testing has become one of the most frequently employed procedures to ensure the durability and suitability of a product during his working life. Nowadays, the most performed tests are still single-axis shaker tests, due to cost of the equipment and for their reduced complexity compared to a multi-axial tests. However, real working environments almost always present a multi-axial loading condition. As a consequence, neglecting this aspect may lead to large errors in the estimation of the component durability and cause failures that can endanger equipment and people during the product lifetime. International standards propose to excite the unit under test with single-axis excitations along different directions sequentially, in order to mimic a multi-axial vibration environment by means of single-axis testing procedures. In this scenario, this work presents a testing campaign where sequential single-axis testing procedures are studied and compared with multi-axial vibration environments. Tests were run by taking advantage of the multi-axis shaker table available at the University of Ferrara, which is capable of exciting the unit under test along three independent translational degrees of freedom (DOFs). In particular, a cantilever beam is studied in order to assess the fatigue behaviour and the durability of the specimen under three different types of loading: 3 DOFs multi-axis uncorrelated vibration, a first sequential single-axis vibration and a second sequential single-axis vibration with inverted excitation sequence. Finally, the criticalities of the matter are analysed, exposing the inadequacy of single-axis testing to validate components subjected to multiaxial vibration environments.

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