Dynamical analysis on bolted connections of BARC structures: numerical and experimental studies

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Abstract. This study presents an investigation on the effects of test fixture connections and their associated nonlinearities for the purpose of establishing a standard fixture connection for general testing and test replication. This investigation will be done by varying the distance between bolted connections, the total number of connections and the size of the system to compare the effects of stiffness of fixture contribution on the dynamic response. In addition to modal analysis, random and forced vibrations experiment techniques are used. A nonlinear dynamic investigation will also be performed based on both numerical and experimental data. The contribution of a standard fixture with defined nonlinear characteristics is expected to allow for more uniform testing regarding the Box Assembly with Removable Component (BARC) structures.

Introduction

The BARC structure shown in Figure 1 has been recently introduced by Sandia National Labs and Kansas City National Security Campus as a challenge problem for the study of the effects of boundary conditions on vibration testing and modal analysis. Current efforts in studying shaker input excitations on the BARC structure have focused on either varying the degrees of freedom of the test or varying the input signal. The nonlinear effects that the bolted joints introduce into the BARC's dynamic response have not been fully investigated [1-3]. This study explores the varying width and the use of modifications seen in Figure 1. For sensitive applications, such as test fixture design, this arbitrary arrangement may prove to be more challenging to replicate, comparing both experimental and simulation test data [4-5]. While most researchers have primarily focused on modal analysis, random and forced vibrations are used to illuminate the nonlinear dynamic responses that arise due to the bolted connections.

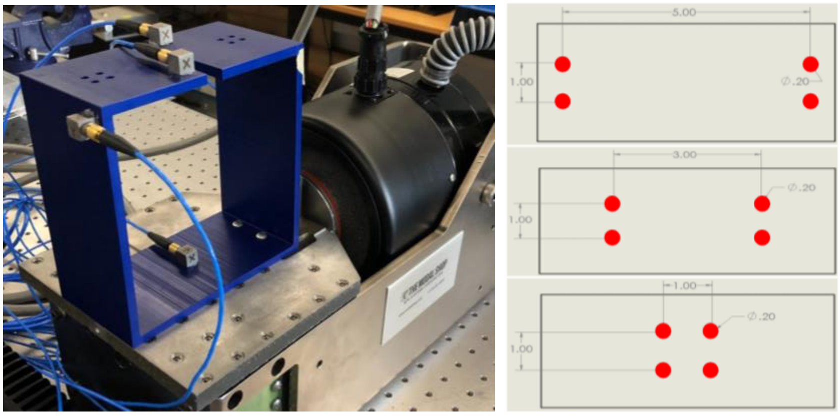

Figure 1: Experimental setup and varying width of fixed connections

Results and Discussion

The use of single-axis excitation has been found to reap the same results as multi-axis excitation. Results are validated with single-axis excitation experimentally. Finite element analysis (FEA) is also used as an investigation technique alongside the experimental techniques discussed. The anticipated effect due to the wider connection geometry is a relatively greater increase in the resonant frequencies due to total connection stiffness, where any number of bolts within the initial width will be negligible to the system. An additional description of associated nonlinear characteristics of standard boundary conditions will be produced with the final results of this work.

References

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