NOVEL APPROACH TO RAPIDLY SOLVE FREQUENCY RESPONSE FOR STRUCTURAL VIBRATION AND ACOUSTICS ANALYSES

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ABSTRACT

A good design of large, complex structures requires knowledge of the mode shape and forced response near major resonances to ensure deflection, vibration, and the resulting stress and deformation are below acceptable levels, and to lead design changes where necessary.

Finite element analysis (FEA) is widely used to predict Frequency Response Functions (FRF) of the structure. However, as the complexity and detail of the structure grows, the system matrices, and the computational resources needed to solve them, get large and especially for direct solver. Furthermore, the need to use small frequency steps to accurately capture the resonant response peaks can drive up the number of FRF calculations required. Thus the FRF calculation can be computationally expensive for large structural systems.

This paper will discuss several approaches based on iterative solver that can significantly accelerate the overall process by approximating the frequency dependent response. Approximation approaches based on Krylov Galerkin Projection (KGP) and Padé calculate the forced response at only a few frequencies, then use the response and its derivatives to reconstruct the FRF in-between the selected direct

calculation points. This paper first validates the two approaches with analytic solutions for a simply supported plate, and then benchmarks several numerical examples to demonstrate the accuracy and efficiency of the new approximate methods.