Fast Modal Frequency Response Analysis of Large Scale Finite Element Structures with Recursive Component Mode Synthesis

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The automotive industry has pursued the design of a vehicle that rides comfortly and quietly. Recently, there has been growing concern that analysts continue to increase the excitation frequency range of dynamics response analysis in the frequency domain. Subsequently, the size of the finite element (FE) model for dynamic response analysis also grows. Therefore, it has been motivated to develop a method for calculating dynamic response of large scale finite element structures which can reduce computational cost while obtaining sufficient accuracy.

The conventional approach of dynamic response analysis in the frequency domain is based on the Lanczos method. Recently, multi-level component mode synthesis or multi-level substructuring method such as AMLS, ACMS, AMS, and RCMS (Recursive CMS) has been introduced as a generalization of the classical Component Mode Synthesis (CMS) method on multi-levels. These approaches have been proven as quite effective in eigenvalue analysis for large scale problems.

In this case study, the RCMS method is used in order to consider large scale industry vehicle FE models such as a large automobile system considering non-proportional damping. After the eigenvalue analysis is finished, the dynamic response analysis of the automobile continues with the modal frequency response analysis. This paper presents an efficient algorithm, Fast Frequency Response Analysis (FFRA) algorithm, to solve the modal frequency response problem for large structures with structural damping. The goal of the FFRA algorithm is O(m^2) operations at each excitation frequency. Therefore, this paper presents the combination of RCMS and FFRA method together for solving the dynamics response analysis of large scale finite element structures.