Keynote Speaker

Introduction to Spectral Element Method (SEM) with Applications to Smart Structures

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Abstract

The vibrating shape of a structure varies as the frequency of vibration varies. Thus, the standard finite element model formulated by using the frequency independent polynomial shape functions may require the subdivision of a structure element into finer elements in order to improve the solution accuracy, especially at high frequency. However, if the frequency dependent (or dynamic) shape functions are adopted to formulate the finite element model, such a finer subdivision may not be necessary. This idea has led to the exact dynamic stiffness matrix method. Because the exact dynamic stiffness matrix is the stiffness matrix formulated in the frequency domain, they can be readily assembled by using the exactly same method that used in the standard finite element method (FEM). In the literature, the FFT-based dynamic stiffness matrix method is often named spectral element method (SEM). Because the exact dynamic stiffness matrix is formulated from the exact dynamic shape functions which satisfy the governing equations of motion, it represents the dynamic behavior of a structural element exactly. Thus, the SEM is often justifiably referred to as an exact element method. Accordingly, in contrast with the standard FEM, the SEM enables one to use only one finite element for a uniform structural member, regardless of its length, without requiring any further subdivision of the structural member to improve the solution accuracy. This may reduce the total number of degrees of freedom used in the analysis to significantly lower the computation cost. In this keynote speech, the fundamental theory of SEM will be introduced first, and then its application to a typical one-dimensional smart structure will be presented as an illustrative example problem.