Development of an Optimization Software System for Nonlinear Dynamics using the Equivalent Static Loads Method

Hyun-Ah Lee

Center of Novel Synthesis of Structural and Mechanical Systems, Hanyang University, Seoul, 133791, Korea

Gyung-Jin Park

Department of Mechanical Engineering, Hanyang University, Ansan City, Gyeonggi-do, 426791, Korea, gjpark@hanyang.ac.kr

Tel: +82-31-400-5246 Fax: +82-31-407-0755

In the real world, systems show nonlinear responses under dynamic loading conditions. Linear static response structural optimization has been developed quite well by using linear static response analysis. Finite element analysis regarding the nonlinearities or dynamic effects has also been developed very well. However, conventional optimization methods considering the nonlinearities or dynamic effects are fairly difficult and expensive. The equivalent static loads method for non-linear static response structural optimization (ESLSO) has been proposed for structural optimization of the systems with various responses: linear dynamic response, nonlinear static response, and nonlinear dynamic response. Equivalent static loads (ESLs) are linear static loads which generate the same response field by not linear static analysis. Not linear static analysis is performed to evaluate the response (displacement, stress or strain, etc.) fields and ESLs are calculated from the responses. Linear static response structural optimization is carried out using the ESLs. The design procedure using ESLSO varies according to the characteristics of the analysis (linear dynamic, nonlinear static or nonlinear dynamic analysis) and the characteristics of the responses (displacement, stress or strain). ESLSO uses commercial structural optimization and finite element analysis software systems. Software systems should be selected based on the characteristics of the structures. Therefore, the interface between structural optimization and analysis software systems is required, and automation of the process for calculation of ESLs is also needed for the reduction of engineering cost. The software system for ESLSO is explained. A software system for the interface and calculation of ESLs is coded and it is made by C++ languages on the Windows operating system. Based on the characteristics of the structures, a design procedure is defined and a software system for ESLSO is developed for the automated design. First, a finite element model is defined and the type of analysis

is selected. The user can define the information for ESLSO from menus in the software system for ESLSO. If the finite element model for structural optimization and finite element analysis exist and the information for ESLSO is written in the software system, the software system for ESLSO runs automatically. Each module based on the characteristics of the response is coded as a class.