Application of the improved equivalent static loads optimization theory on the crash condition of vehicle components

Abstract

Based on the equivalent static loads (ESLs), a novel nonlinear structural optimization method (OESL) to solve nonlinear dynamic problems is proposed. In the optimization process, the ESLs produce the same response field of linear static analysis as that of nonlinear dynamic analysis at each time step. The linear static optimization analysis with the ESLs is carried out to renew the design variables. This optimization theory depends on the linear optimization results too many which may lead to the low convergence efficiency. In this paper, an improved nonlinear structure optimization theory based on the ESLs method and the golden section theory (OESLG) is proposed. The simple method of golden section theory is applied to greatly enhance the update rate of design variables and significantly improve the convergence rate of the optimization analysis. We use the new optimization method in the crash analyses of vehicle components. First, the B-pillar collision case provides a new design concept with the poor thick plate and the OESLG to achieve better vehicle side impact performance and lighter car body weight. Furthermore, comparative analyses show the better efficiency of OESLG than OESL and genetic algorithm (GA) with the similar results. Second, the dynamic resistance analysis of automobile fender is carried out with OESLG and OESL. The optimization efficiency of OESLG is obviously higher than OESL. Depending on the optimization results, the final results of the engineering model meet the target requirements with a light weight.

Keywords: equivalent static loads; nonlinear structural optimization; linear structural optimization; golden section method; sensitivity analysis;