

Accepted Manuscript

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PII: S0045-7825(14)00385-5

DOI: <http://dx.doi.org/10.1016/j.cma.2014.10.015>

Reference: CMA 10409

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date: 5 December 2013

Revised date: 18 August 2014

Accepted date: 16 October 2014

Please cite this article as: H.-A. Lee, G.-J. Park, Nonlinear dynamic response topology optimization using the equivalent static loads method, *Comput. Methods Appl. Mech. Engrg.* (2014), <http://dx.doi.org/10.1016/j.cma.2014.10.015>

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Nonlinear Dynamic Response Topology Optimization Using the Equivalent Static Loads Method

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ABSTRACT

A novel method for nonlinear dynamic response topology optimization is proposed using the equivalent static loads (ESLs) method. The ESLs are the loads that generate the same response field of linear static analysis as that of nonlinear dynamic analysis at each time step. In the proposed procedure, nonlinear dynamic analysis is performed, ESLs are made and linear static topology optimization is carried out with the ESLs. The process cyclically proceeds until the convergence criterion, which is specifically defined for this problem, is satisfied. Since the density method for topology optimization is utilized, the low-density finite elements can cause mesh distortion in nonlinear dynamic analysis. Transformation variables are introduced for a new update method for the incorporating process of the topology results into nonlinear dynamic analysis. Also, a new objective function is proposed to minimize the peaks of the time dependent transient responses. A couple of standard problems and a practical problem are solved to validate the proposed method.

Keywords: Nonlinear dynamic response topology optimization, structural optimization, equivalent static loads

1. Introduction

Topology optimization finds the optimal layout of a structure by determining the distribution of the material in the design region [1]. There are two methods for topology optimization: the homogenization method [2] and the density method [3]. Commercial software systems for topology optimization such as NASTRAN [4], GENESIS [5]

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