## **Accepted Manuscript**

Stiffness optimization of non-linear elastic structures

Mathias Wallin, Niklas Ivarsson, Daniel Tortorelli

PII: DOI: Reference:	S0045-7825(17)30708-9 https://doi.org/10.1016/j.cma.2017.11.004 CMA 11663
To appear in:	Comput. Methods Appl. Mech. Engrg.
	24 May 2017 30 October 2017 2 November 2017

Volume 273, Published 1 Hay 2018	160x 0045 7428
Computer methods in applied mechanics and engineering	Kithers Lich Hugen Ann, YK Jida Ann, YK Jida Mann, YK Jida Mann, YK Jida Magazan Parading Materia Histophysic Histophysic
ScienceDirect	

Please cite this article as: M. Wallin, N. Ivarsson, D. Tortorelli, Stiffness optimization of non-linear elastic structures, *Comput. Methods Appl. Mech. Engrg.* (2017), https://doi.org/10.1016/j.cma.2017.11.004

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

### ACCEPTED MANUSCRIP

## Stiffness optimization of non-linear elastic structures

Mathias Wallin<sup>a,\*</sup>, Niklas Ivarsson<sup>a</sup>, Daniel Tortorelli<sup>b</sup>

<sup>a</sup>Division of Solid Mechanics, Lund University, Box 118, SE-22100 Lund, Sweden <sup>b</sup> Center for Design and Optimization, Lawrence Livermore National Laboratory, Livermore, CA, USA

#### Abstract

This paper revisits stiffness optimization of non-linear elastic structures. Due to the nonlinearity, several possible stiffness measures can be identified and in this work conventional compliance, i.e. secant stiffness designs are compared to tangent stiffness designs. The optimization problem is solved by the method of moving asymptotes and the sensitivities are calculated using the adjoint method. For the tangent cost function it is shown that although the objective involves the third derivative of the strain energy an efficient formulation for calculating the sensitivity can be obtained. Loss of convergence due to large deformations in void regions is addressed by using a fictitious strain energy such that small strain linear elasticity is approached in the void regions. A well posed topology optimization problem is formulated by using restriction which is achieved via a Helmholtz type filter. The numerical examples provided show that for low load levels, the designs obtained from the different stiffness measures coincide whereas for large deformations significant differences are observed.

*Keywords:* Topology optimization, stiffness optimization, finite strains, non-linear elasticity

#### 1. Introduction

Topology optimization has rapidly evolved and is now widely used in industry to create new innovative structural designs. The method is frequently used in the early design phase to find appropriate load paths wherein the goal is usually related to stiffness maximization as opposed to e.g. stress optimization, cf. [1]. The vast majority of the research on topology optimization is restricted to structures which operate in the linear regime, i.e. the deformations are assumed to be small and the material response linear. For an overview of the method and areas of applications see [2]. To increase the range of applicability of the method, other cost functions and non-linear response should be considered.

For linear structures, the definition of the stiffness is well-defined since the tangent of the load-displacement response is independent of the load level, cf. Fig. 1a. However,

<sup>\*</sup>Division of Solid Mechanics, Lund University, Box 118, SE-22100 Lund, Sweden. E-mail: mathias.wallin@solid.lth.se

Download English Version:

# https://daneshyari.com/en/article/6915700

Download Persian Version:

https://daneshyari.com/article/6915700

Daneshyari.com