



## Discussion on Buckling Load Optimization for Continuum Models Subjected to Eccentric Loads

Pedersen, Pauli; Pedersen, Niels Leergaard

*Publication date:*  
2018

*Document Version*  
Peer reviewed version

[Link back to DTU Orbit](#)

*Citation (APA):*  
Pedersen, P., & Pedersen, N. (2018). Discussion on Buckling Load Optimization for Continuum Models Subjected to Eccentric Loads. Abstract from 6th International Conference on Engineering Optimization (EngOpt2018), Lisbon, Portugal.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

## DISCUSSION ON BUCKLING LOAD OPTIMIZATION FOR CONTINUUM MODELS SUBJECTED TO ECCENTRIC LOADS

Pauli Pedersen<sup>(1)</sup>, Niels Pedersen<sup>(2)</sup>

<sup>(1)</sup>Technical University of Denmark, Mechanical Engineering, Solid Mechanics, Denmark  
*pauli@mek.dtu.dk*

<sup>(2)</sup>Department of Mechanical Engineering, Technical University of Denmark, Denmark  
*nlp@mek.dtu.dk*

**Keywords:** Buckling estimation, Eigenvalue formulations, Sensitivities, Analytical, FE

**Abstract:** Buckling load estimation of continua modeled by finite element (FE) should be based on non-linear equilibrium. When such equilibrium is obtained by incremental solutions and when sensitivity analysis as well as iterative redesigns are included, the computational demands are large especially due to optimization. Therefore, examples presented in the literature relate to few design variables and/or few degrees of freedom. In the present discussion a non-incremental analysis is suggested, and a simple sensitivity analysis as well as recursive redesign is proposed. The implicit geometrical non-linear analysis, based on Green-Lagrange strains, apply the secant stiffness matrix as well as the tangent stiffness matrix, both determined for the equilibrium corresponding to a given reference load, obtained by the Newton-Raphson method. For the formulated eigenvalue problem, which solution give the estimated buckling load, the tangential stiffness matrix is of major importance. In contrast to formulations based on incremental solutions, the tangent stiffness matrix is here divided into two matrices, the stress stiffness matrix that is linear depending on stresses and the remaining part of the tangent stiffness matrix. Examples verify the effectiveness of the proposed procedure. Buckling of homogeneous (uniform density) 2D finite element models are in agreement with available analytical 1D results. The obtained optimized density distribution for a cantilever with central load corresponds to improved bending stiffness, as expected. Then influence from eccentric load on a frame is reported, and in addition to stiffness improvement the redesigns also stabilize by change of eccentricity.

*Reference:*

*Pedersen, N.L., and Pedersen, P. : "Local analytical sensitivity analysis for design of continua with optimized 3{D} buckling behaviour" Struct. Multidisc. Optim., 57:293--304, {2018}*