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

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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}