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Shape design sensitivities improvement using convected unstructured meshes. (English)
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Summary: This paper focuses on various forms of direct differentiation methods for design sensitivity computation in the shape optimisation of continuum structures and the role of convected meshes on the accuracy of the sensitivities. A *Pseudo-Analytical Sensitivity Analysis* (P-ASA) method is presented and tested. In this method the response analysis component uses unstructured finite element meshes and the sensitivity algorithm entails shape-perturbation for each design variable. A material point is convected during a change of shape and the design sensitivities are therefore intrinsically associated with the mesh-sensitivities of the finite element discretization. Such mesh sensitivities are obtained using a very efficient boundary element point-tracking analysis of an affine notional underlying elastic domain. All of the differentiation, with respect to shape variables, is done exactly except for the case of mesh-sensitivities: hence the method is almost analytical. In contrast to many other competing methods, the P-ASA method is, by definition, independent of perturbation step-size, making it particularly robust. Furthermore, the sensitivity accuracy improves with mesh refinement. The boundary element point-tracking method is also combined with two popular methods of sensitivity computation, namely the global finite difference method and the semi-analytical method. Increases in accuracy and perturbation range are observed for both methods.

MSC:

74P10 Optimization of other properties in solid mechanics
74S05 Finite element methods applied to problems in solid mechanics
74S15 Boundary element methods applied to problems in solid mechanics

Keywords:

shape optimization; sensitivity analysis; analytical gradients; convected unstructured FE meshes

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