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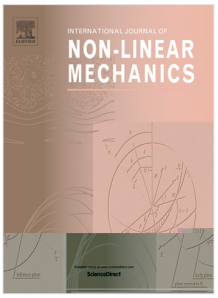

Locally enhanced reduced order modeling for the nonlinear geometric response of structures with defects

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Locally Enhanced Reduced Order Modeling for the Nonlinear Geometric Response of Structures with Defects

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Abstract

This paper focuses on the reduced order modeling (ROM) of structures with local defects undergoing large deformations, i.e., within the nonlinear geometric range. At the contrary of prior investigations, it is desired here to construct such ROMs by enhancing the nonlinear reduced order model of the corresponding virgin structure, i.e., the one without the defect, not by carrying out a separate modeling effort. To this end, the first objective is on the formulation of local enrichments of the displacements basis functions that complement those of the virgin structure to accurately capture not only the displacements but also the stresses of the structure with defect. The second objective of this investigation is on assessing which parameters of the reduced order model would need to be updated if the defect, and thus the enrichments, were to change. With regard to local enrichments, it is proposed that such functions can be constructed from the linear static analysis of the zone affected by the defect subjected to an imposed far field displacement derived from the virgin structure basis functions. Validation results on the finite element model of a beam-like panel with a notch do confirm the appropriateness of these basis enrichments and, moreover, suggest that only the linear stiffness and stress coefficients relating to the enrichments would need to be updated if the defect changes, which represents a significant computational benefit. The implementation of the above process with a localized numerical model of the defect, e.g., using generalized finite element (GFEM), is briefly discussed.

Keywords: Reduced order modeling, structures, nonlinear geometric, local defect, notch, crack

1. Introduction

The development of nonintrusive reduced order modeling methods for the nonlinear geometric response of structures has seen solid and steady growth over the last two decades, see