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A finite element formulation in boundary representation for the analysis of nonlinear problems in solid mechanics

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The contribution deals with a finite element formulation, where a boundary representation of an arbitrary shaped domain is employed for the numerical analysis of problems in non-linear solid mechanics. The element formulation is based on the so-called scaled boundary finite element method (SB-FEM), see [1]. It allows an element formulations with an arbitrary number of edges. The basic idea is to scale the boundary representation with respect to a scaling center. In the present work an approximation of the displacement response in scaling direction is introduced. This feature allows the analysis of geometric and material non-linear problems in solid mechanics. In contrast to [2] we employ in this work Lagrange interpolation functions. The interpolation on the boundary in circumferential direction is independent of the interpolation in scaling direction. Internal degrees of freedom are eliminated by static condensation. It leads to an element formulation with an arbitrary number of nodes on the element boundary. In case of four node quadrilateral element, it turns out that the element is volumetric locking free for a specific choice of the scaling center. In general the element formulation could be used with Voronoi meshes and quadtree mesh generation. The advantage of the latter is discussed with respect to standard mesh generation. Numerical examples give rise to the performance of the present approach in comparison to other polygonal element formulations, like the virtual element method (VEM). Some benchmark tests demonstrate the capability of the element formulation and a comparison to standard mixed element formulations is presented.

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