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ENHANCING ISOGEOMETRIC ANALYSIS BY THE SCALED BOUNDARY TECHNIQUE

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By leveraging the information of a typical CAD model in the analysis, the intensive process of discretisation can be circumvented. This unification has led to the “Isogeometric Analysis” [1]. As the CAD model provides information only of the boundary, a 2D/3D stress analysis of the domain is still one major step away. In this work, the concepts of isogeometric analysis [1] and the scaled boundary finite element method [2] are combined. The current paper focuses on the implementation for 2D elastic analysis and for plate bending analysis. The boundary of the geometric model is handled as in the isogeometric analysis, and the solution in the problem domain is obtained by the scaled boundary finite element method.

In a 2D stress analysis, the scaled boundary finite element method is able to model n-sided domains. Only the edges of a domain are divided into line elements. Any type of displacement-based 1D formulation (NURBS, Spectral elements, etc.) can be employed. The solution within the subdomain is expressed semi-analytically [2]. This framework offers high flexibility in representing trimmed NURBS surfaces. It also allows the combination of the NURBS with other discretisation techniques. For example, we can use NURBS on curved boundaries and spectral or other types of interpolating functions elsewhere. When applied to model strain/stress singularities as occurring at crack tips and multi-material junctions, this framework does not require asymptotic enrichment. No special integration or other techniques is required to compute the stiffness matrix. The singular stress field is solved semi-analytically. The stress intensity factors are obtained directly from their definitions.

In a plate bending analysis, the 3D geometry of the plate is considered. The mid plane of the plate is represented by NURBS and the solution along the transverse direction of the plate is expressed analytically. For thin to moderately thick plates, a simple expression for the element stiffness matrix is obtained. The proposed formulation is free from shear locking owing to its 3D-consistent nature.

Numerical examples are presented to illustrate the unique features, accuracy and efficiency of the proposed formulation.

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