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CONVERGENCE ANALYSIS OF CONFIGURATIONAL FORCES FOR BRITTLE CRACKS MODELED THROUGH $C^{\mathcal{K}}$-GENERALIZED FEM

Diego A. F. Torres, Clovis S. de Barcellos and Paulo T. R. Mendonça*

Graduate Program in Mechanical Engineering, Federal University of Santa Catarina,
Trindade Campus, 88040-900 Florianópolis, Santa Catarina, Brazil
diego.amadeu@gmail.com, clovis@grante.ufsc.br and mendonca@grante.ufsc.br

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This investigation aims to identify and to understand any advantage concerning better capturing of information provided by singular enrichments through performing enrichment over mesh-based smooth Partitions of Unity (PoU). Such PoU with higher regularity is an ingredient of the so-called C^k-GFEM framework [1], and is built from a moving least squares of degree zero considering mesh-based smooth weighting functions associated to arbitrary polygonal clouds. The C^k-GFEM is an efficient tool for modeling higher-order problems like Kirchhoff plate bending [2] since it does not impose any geometric restriction on the elements or clouds. This procedure shares similar features as the standard FEM regarding the domain partition and integration quadratures but, as neither the PoU nor enrichment functions are defined in natural domains, the integrations are performed only using global coordinates, which lead to great robustness in presence of mesh distortions [3]. Moreover, since the regularity can be changed only choosing different weighting functions, noting that convention FEM-based PoU can be used, the procedure is very appropriate for selective smoothness modeling in case of higher-order requirements only for some degrees of freedom [4]. More specifically, this work intends to show that higher regularity imparts the quality of stress approximations around singularities modeled with enrichment procedures, and for this purpose the two-dimensional linear elastic fracture mechanics is considered. Severity crack parameters are computed in order to verify the local quality of stress approximations around the singularity. The Eshlebian mechanics, which provides a simple and convenient way to obtain configurational forces [5] that are related to the $\mathcal{J}$-integral, is used. The configurational forces also provide information regarding the direction of a probably crack advance. The performance of the smooth approximations is compared to the C^0-GFEM / XFEM counterparts using conventional FEM-based PoU.

REFERENCES

[1] C. A. Duarte, D. -J. Kim and S. M. Quaresma. Arbitrarily smooth generalized finite element approximation. *Comput. Methods Appl. Mech. Engrg.*, Vol. **196**, 33–56, 2006.

[2] C. S. de Barcellos, P. T. R. Mendonça and C. A. Duarte. A C^k continuous generalized finite element formulations applied to laminated Kirchhoff plate model. *Comput. Mech.*, Vol. **44**, 377–393, 2009.

[3] P. T. R. Mendonça, C. S. de Barcellos and D. A. F. Torres. Analysis of anisotropic Mindlin plate model by continuous and non-continuous GFEM. *Finite Elem. Anal. Des.*, Vol. **47**, 698–717, 2011.

[4] P. T. R. Mendonça, C. S. de Barcellos and D. A. F. Torres. Robust C^k/C^0 generalized FEM approximations for higher-order conformity requirements: application to Reddy's HSDT model for anisotropic laminated plates. *Compos. Struct.*, Vol. **96**, 332–345, 2013.

[5] S. M. Häusler, K. Lindhorst and P. Horst. Combination of the material force concept and the extended finite element method for mixed mode crack growth simulations. *Intern. Journal Numer. Methods Engrg.*, Vol. **85**, 1522–1542, 2011.