The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

INTERFACE-ENRICHED GENERALIZED FINITE ELEMENT METHODS FOR COUPLING MESHES, CONTACT, AND TOPOLOGY OPTIMIZATION

Alejandro M. Aragón[1,a,*], **Jian Zhang**[1,b], **Sanne J. van den Boom**[2,c], **Dongyu Liu**[1,3,d], **Angelo Simone**[4,e], **and Fred van Keulen**[1,f]

[1] Faculty of Mechanical, Maritime and Materials Engineering, Delft University of Technology, Mekelweg 2, 2628 CD Delft, The Netherlands
[2] Structural Dynamics, Netherlands Institute for Applied Scientific Research, Leeghwaterstraat 44-46, 2628 CA, Delft, The Netherlands,
[3] Faculty of Civil Engineering and Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN, Delft, The Netherlands
[4] Industrial Engineering, University of Padova, Via Venezia, 1, 35131 Padova PD, Italy
[a] a.m.aragon@tudelft.nl, https://am-aragon.science, [b] j.zhang-10@tudelft.nl,
[c] sanne.vandenboom@tno.nl, [d] d.liu-4@tudelft.nl, [e] angelo.simone@unipd.it,
[f] a.vankeulen@tudelft.nl

Keywords: *Enriched FEM, IGFEM, mesh coupling, contact, topology optimization*

Standard finite element methods (FEM) require finite element (FE) meshes that are fitted to discontinuities for solving problems containing interfaces. Creating such meshes is tedious and prone to error, rendering the technique inadequate for problems with evolving interfaces or when boundaries are not known *a priori*. Enriched finite element methods (EFEMs) offer an elegant solution to these types of problems. By augmenting the standard FEM space with enrichment functions that incorporate adequate interface kinematics, EFEMs enable a complete decoupling between discontinuities and FE meshes. Within EFEMs, the Interface-enriched Generalized Finite Element Method (IGFEM) was proposed to simulate interface problems by placing enriched degrees of freedom along discontinuities [1, 2]. In this presentation we overview IGFEM recent developments by reviewing ongoing work on interface problems and delving into field gradients recovery, coupling of non-conforming meshes, contact, and level set-based topology optimization for which we showcase the procedure for tailoring fracture resistance of brittle structures [3].

REFERENCES

[1] S. Soghrati, A.M. Aragón, C.A. Duarte, and P.H. Geubelle. An interface-enriched generalized finite element method for problems with discontinuous gradient fields. *Int. J. Num. Meth. Engng.*, 89(8):991–1008, 2012.

[2] A.M. Aragón, B. Liang, H. Ahmadian, and S. Soghrati. On the stability and interpolating properties of the hierarchical interface-enriched finite element method. *Comput. Methods. Appl. Mech. Eng.*, 362:112671, 2020.

[3] J. Zhang, F. van Keulen, and A.M. Aragón. On tailoring fracture resistance of brittle structures: A level set interface-enriched topology optimization approach. *Comput. Methods. Appl. Mech. Eng.*, 388:114189, 2022.