6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

DE-FEM: A NEW ENRICHED FORMULATION FOR MODELING WEAK AND STRONG DISCONTINUITIES

Alejandro M. Aragón[1,*], Jian Zhang[1], Sanne J. van den Boom[1], Elena De Lazzari[1], Dongyu Liu[2], Max van der Kolk[1], Matthijs Langelaar[1], Angelo Simone[2,3], and Fred van Keulen[1]

[1] Faculty of Mechanical, Maritime and Materials Engineering
Delft University of Technology, Delft, the Netherlands

[2] Faculty of Civil Engineering and Geosciences
Delft University of Technology, Delft, the Netherlands

[3] Department of Industrial Engineering University of Padua, Padova, Italy

Keywords: *Enriched Methods, Weak/Strong Discontinuities, Fictitious Domain Methods*

Weak and strong discontinuities play an important role in the analysis of a wide range of problems, such as fracture or multi-phase materials. In standard Finite Element Analysis (FEA), discontinuities are explicitly taken into account by ensuring that any material interfaces, domain boundaries, and/or cracks coincide with element sides. Because creating such a matching mesh can be a challenging exercise, especially when dealing with moving discontinuities, enriched formulations such as the eXtended/Generalized Finite Element Method (X/GFEM) have recently gained considerable visibility. X/GFEM treats discontinuities in an elegant manner by decoupling them from the discretization. Yet, many properties of standard FEA that were taken from granted are lost in X/GFEM.

The Discontinuity-Enriched Finite Element Method (DE-FEM) [1] was recently introduced as a novel enriched formulation to model weak and strong discontinuities with a unified formulation. DE-FEM recovers the appealing properties of standard FEA, while keeping the mesh-discontinuity decoupling feature offered by X/GFEM.

In this presentation, we will demonstrate the versatility of DE-FEM in the context of fracture mechanics, granular materials, immersed domains, and fluid-structure interaction. We illustrate the method for modeling 2-D and 3-D cracks, and NURBS-enhanced discontinuities. Furthermore, we demonstrate DE-FEM as an immersed boundary (or embedded domain) method for problems in elasticity and in the context of fluid dynamics and fluid-structure interaction. Finally, we show the stability of the method with regards to the condition number of the resulting system matrices.

REFERENCES

[1] A. M. Aragón and A. Simone, The Discontinuity-Enriched Finite Element Method. *Int. J. Numer. Meth. Eng.*, Vol. **112** (11), pp. 1589–1613, 2017.