The eXtended Finite Element Method and level sets to handle inequality constraints

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ABSTRACT

The eXtended Finite Element Method (X-FEM) is well known as an extension of the finite element method to break regularity of the approximation inside finite elements. The modeling of cracks in solid mechanics was a natural launching pad application for the X-FEM.

We consider another type of irregularity in this presentation. Namely, the one occurring in variational formulations involving inequalities. Consider a quasi-static small strain problem for which the material is compressible up to a limit. The constraint is thus of inequality type: the divergence of the displacement field is bounded by a constant. It turns out that the analytical solution to this type of problems involves a jump in derivative of the strain on the boundary of the domain where the constraint is active thus degrading the performance of higher order finite elements. Also, inequality constraints may lead to convergence issues of the classical iterative schemes as the augmented Lagrangian.

We will describe a new approach coined Inequality Level Set (ILS) in which the domain over which the constraint is active is the main unknown and is located by a level set. The level set is moved iteratively until convergence. Since the boundary of the active domain is known explicitely, it can be enriched and allow the use of higher order elements. From the mechanical point of view, the correct location of the boundary corresponds to vanishing configurational forces on the boundary.

The above approach was introduced in [1] and we will describe also more recent work related to contact.

REFERENCES

[1]. N. Bonfils, N. Chevaugeon, N. Moës, Treating volumetric inequality constraint in a continuum media with a coupled X-FEM/level-set strategy, *Computer Methods in Applied Mechanics and Engineering*, **205–208,** 2012.