

# A COMPUTATIONNAL APPROACH TO HANDLE COMPLEX MICROSTRUCTURE GEOMETRIES

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Multi-scale analysis of components usually leads to solving micro-structures with complex geometries (composites, textiles, reinforced concrete, ...). The finite element analysis of such fine scales is tedious since the mesh must conform to material interfaces, voids, cracks,...

In this presentation, we propose to use the "eXtended Finite Element Method" (X-FEM) as way to avoid complex meshing of microstructures. With the X-FEM, the physical surfaces do not need to be meshed. Moreover, since it is based on the finite element method, extension to nonlinear constitutive laws is straightforward.

The material surfaces (or voids) are located on the mesh using the level sets technique. The mesh thus controls both the quality of the geometrical representation of the micro-structure and the interpolation of the displacement field. A geometrical adaptive strategy is used to control the quality of the micro-structure representation. This strategy uses the surface curvature of the material interfaces which is computed based on the second gradient of the level set.

In order to assess the accuracy of the proposed approach, benchmark problems are solved (2D circular and 3D spherical inclusions in infinite media) with a sequence of refined meshes. The energy error with respect to the exact solution is plotted as a function of the mesh size. These plots show that the X-FEM provides a rate of convergence very close to the FEM case (while not meshing the material interfaces!).

Numerical experiments demonstrating the performance of the X-FEM to handle complex micro-structure will be shown. They involve composites woven, non-woven and random micro-structures. In the random case, the X-FEM approach is especially efficient since the same mesh may be used for all draws.

## References

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