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# A NEW MULTISCALE X-FEM APPROACH APPLIED TO 3D PLASTIC CRACK PROPAGATION

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The computation of crack propagation in 3D elastic-plastic media is an important industrial challenge that implies an accurate description of physical quantities (stress, strain, internal variables ...) in a limited area around the crack front, especially when local fracture criteria are concerned. In this context an accurate, robust and efficient modelling tool is needed.

The eXtended Finite Element Method (X-FEM) proposed by Belytschko *et al* [1] in 1999 has been developed over the past tow decades by a large community [2] [3] [4] and has been applied successfully to many different industrial fracture mechanics problems. In the context of non-linear behaviour over-integrated elements may be used. Consequently the cost of this method can increase drastically for engineer-sized problems. Thus, to improve the efficiency of the method and focus the computational cost on parts that needs it, coupling between the X-FEM and an Adaptive Mesh Refinement strategy seems promising. Doing so a relevant modelling for the very different scales of the problem is possible: the engineer-sized structure scale, the crack surface and the small zone of high stress gradients near the crack front. In the present paper, the implementation of this tool in the Cast3M industrial finite element code [5] is firstly presented, with a particular attention on the field transfer methodology which is crucial in non-linear context. Then, two examples are considered to point out the benefits of the method.

The 3D case of multiple cracks in a non-linear material is discussed as a first example. It is representative of the mechanical analysis undertaken to assess potential interaction between quasi-laminar or tilted cracks. In particular, X-FEM/AMR coupling is shown to be directly applicable to 3D non-linear case for complex crack geometry, saving time and effort of discretisation, and thus allowing the modelling of numerous cracks configurations. Numerical results are directly validated by associated experiments.

Secondly, the mixed mode propagation of a single crack in an elastic-plastic media is considered. For this case, a finely meshed enriched zone follows the crack front during its propagation. To achieve this iterative modelling, due to the non-linear behaviour, a field transfer procedure is developed. This fields transfer allows to save the loading history on a evolving mesh. Simulations have been carried out in 2 and 3 dimensions and the first results fit experimental data.

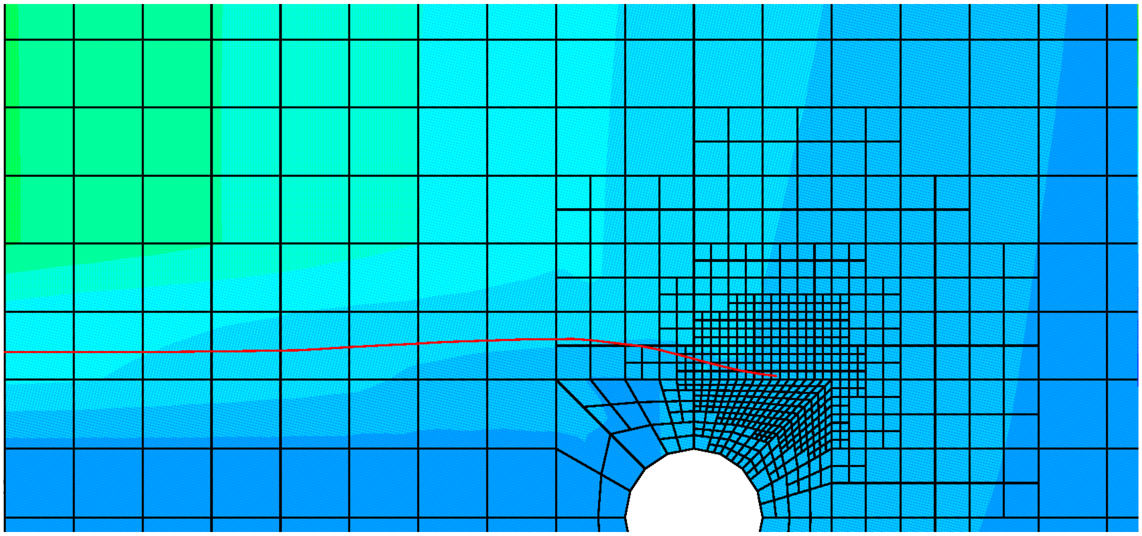

**Figure 1**: 2D mixed mode crack propagation

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