

On performances of the Thick Level Set method in 3D quasi-static fracture simulation of quasi-brittle material

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Abstract

The Thick Level Set model, introduced in [1, 2], is a non-local damage model embedding displacement discontinuity.

By the way non-locality is treated in this model, high mesh density is only needed in the region surrounding the limited zone where damage evolves. In 2D, if we succeed to adapt the mesh around crack tips, this leads to acceptable problem size, even in serial computation context. In 3D, since cracks are surfaces, the refined zone still lead to a large problem that becomes difficult to solve by direct methods. In this contribution, we will first illustrate this problem with simulation examples. Then, we will present computational strategies investigated so far that address this issue.

Among many possible solutions, the two scale or GFEMgl computational framework applied to crack simulation [3] is a promising solution for the TLS method in 3D. This framework uses two interdependent problems to solve discontinuous problems represented by TLS model. The coarse level problem, addressing global behavior of the part, is enriched by discontinuous functions in the vicinity of the damaged zone to take into account local behavior of the cracks. This local behavior is captured by the fine level scale which corresponds to a set of independent problem resolution. Each of them is related to each enriched node support (i.e. set of elements over which the approximation function associated with the node is non-zero.) and is constructed by adapting element size to TLS requirement. Their boundary conditions are coming from coarse level displacement solution which are imposed loosely by penalization. By construction, refined element are embedded in original macro element support which permits this transfer from coarse level to fine level problems. After resolution, those local problem displacement solution fields are used, with some manipulation, as enrichment function at coarse level.

More in detail, in quasi-static TLS problems, the enriched coarse solution of previous time step is used as boundary conditions for the fine scale resolution at current time step. To get reasonable computational times, the resolution of fine scale problems are done in parallel. A MPI framework have been settled to dispatch fine scale meshing, assembly and resolution tasks. At global level, mesh, assembly and resolution are also dispatched among process. This work shows first results of this parallel framework.

References

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