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ROBUST AND ACCURATE GLOBAL-LOCAL ANALYSIS WITH THE GENERALIZED FINITE ELEMENT METHOD

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ABSTRACT

The global-local or sub-modeling procedure in the FEM is broadly used in industry for the analysis of cracks and other singularities or localized stress concentrations in large, complex, three-dimensional domains. The global-local FEM (*GL-FEM*) involves two steps. First, the solution of the problem is computed on a coarse, global, quasi-uniform mesh like the one shown in Figure 1. The cracks or local features are in general *not* discretized. Next, small sub-domains containing crack(s) are extracted from the global domain and analyzed using the global solution as boundary conditions.

The basic assumption of the approach is that the global solution at the boundary of the local domain is sufficiently accurate or that the local domain is large enough such that the effect of a crude boundary condition is small far from the boundary of the local domain. The minimum size of a local domain for acceptable accuracy is, however, problem dependent and greatly depends whether or not the cracks are modeled in the global problem.

In this paper, we demonstrate that the limitations of the *GL-FEM* can be removed by going one step further in a global-local analysis. The local solution is used as an enrichment function for the global problem through the partition of unity framework of the generalized finite element method (GFEM) [1, 3, 5, 6]. The procedure leads to corrections of the global right hand side without any change in the global stiffness matrix, and therefore the cost of this additional step is similar to additional load cases in a static analysis [2, 4]. Figure 2 illustrates the procedure. The effectiveness of the approach in terms of convergence rates and computational cost is investigated in this paper. We also analyze the effect of inexact boundary conditions applied to local problems and the size of the local domains on the accuracy of the enriched global solution.

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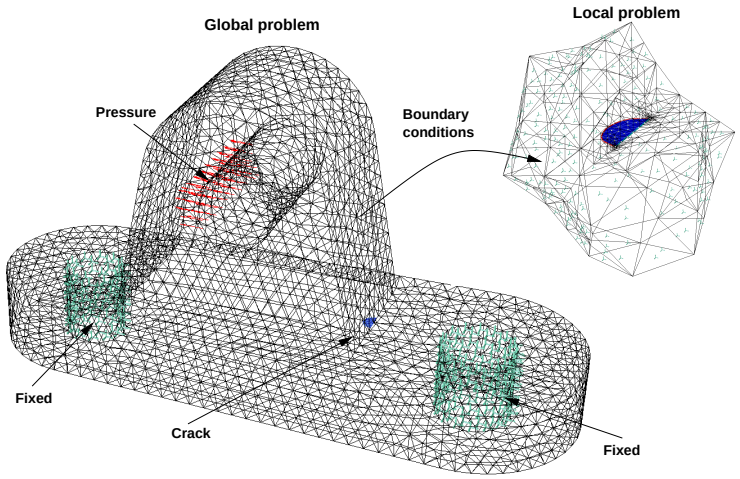

Figure 1: *Global-local FEM (*GL-FEM*) analysis of a 3-D bracket with a small half-circle crack. The solution computed on a coarse global mesh provides boundary conditions for the extracted local domain.*

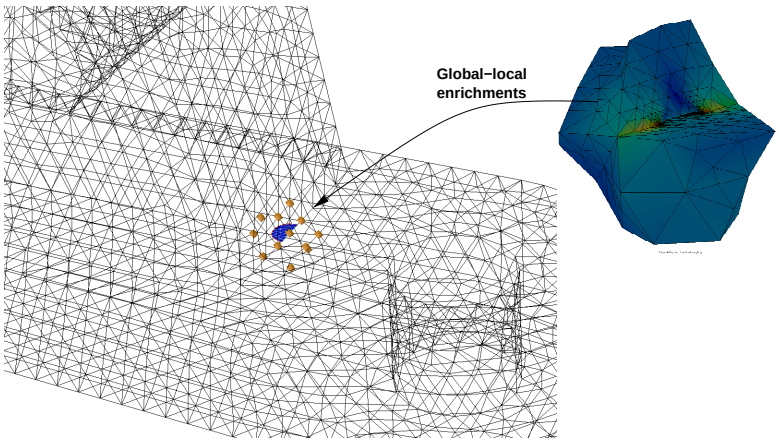

Figure 2: *Enrichment of the coarse global mesh with a local solution.*

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