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ANALYSIS OF A STRUCTURAL DETAIL USING A TWO-SCALE APPROACH

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Summary The aim of this work is to solve mechanical problems on large structure containing details. We seperate the scale of the structure from the one of the detail (two-scale analysis). The structural scale is solved using a mesh which does not take into account the detail. The detail is introduced either by an "extended" homogenization or by an enrichment strategy. The homogenization or the enrichment is obtained from a local analysis of the detail on a distinct mesh from the structural one. On this local mesh, the X-FEM approach is used to carry out the analysis. The detail is considered embedded in an infinite media, so that the boundary conditions are not an issue.

The eXtended Finite Element Method (X-FEM) has a wide range of potential applications. We will deal with a new application in the field of multi-scale analysis and particularly the influence of a detail on a large structure. Usually, a detail in a structure is taken into account by a global refined mesh around the detail (often prohibitive) or by a global-local approach (wich may lead to very inaccurate results). In this paper, we suggest a two-scale approach using the capabilities of X-FEM.

The first step is to separate the scales. Two different meshes are needed : one for the discretisation of the detail and another mesh which will be coarse for the structure. We allow these two meshes to be completely independent from each other.

The purpose of the detail analysis is to obtain elementary solutions as a response to imposed "structural" loads. The X-FEM aproach is used to solve this specific detail problem to avoid to mesh complex details or to take into account several detail geometries on the same mesh. With X-FEM, the physical surfaces do not need to be meshed. The detail geometries (or voids) is located on the mesh using the level sets technique [1] [2]. Regarding the boundary conditions for the detail analysis, we consider the detail embedded in an infinite media with zero displacement at infinity (considering the detail has no impact at an infinite distance).

The elementary detail solutions are then used to perturb the structural problem. Two approaches are studied : "extended" homogenization and enrichment strategy using the partition of unity [5]. In the first approach, the regular element stiffness of the structural problem are replaced by the homogenized element stiffness for those elements close to the detail. The homogenized stiffness matrix is deduced from the elementary solutions computed during the resolution of the detail problem. In the second approach, the formulation of the elements close to the detail is enriched using the partition of unity. The classical finite appoximation is enriched by addition of degrees of freedom multiply by specific functions deduced from the detail analysis.

To check the effectiveness of the two-scale method, our solution is compared with the one obtained with an overkill mesh taking into account the detail on several classical benchmark problems.

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