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A fictitious-like domain approach for the non-intrusive coupling between 2D and 3D models

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ABSTRACT

The simulation of composite structures requires to take into account critical phenomena (like delamination) happening at small scales. This leads to very large nonlinear problems. Our purpose is to reduce the complexity of the problem by a non-intrusive coupling a plate model with a 3D modeling near critical areas, in order to create a hybrid model, efficient and accurate (figure 1,2).

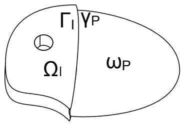

Figure 1: Hybrid modeling of a thin structure

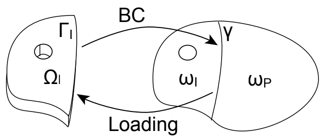

Figure 2: Iterative process

Sub-modelling techniques where boundary conditions are deduced from a global computation and applied to local 3D computations are often use but can lead to important errors on the local quantities of interest. We propose a strategy based on a non-intrusive coupling technique [1] avoiding this drawback. The hybrid 3D-plate model is defined as the limit of an iterative process which alternates global-plate and local-3D computations. The method makes use of two overlapping models, a 2D one (plate or shell, which remains unchanged during the whole analysis) and a 3D refined one where structural details, complex non-linearites such as contact or delamination can be introduced. In the overlapping region the 2D model can therefore be seen as a fictitious domain / model. One interest of the method is that the 3D domain of interest can be treated with a dedicated research software with most advanced models and solvers. The zooming step requires the definition of lifted 3D quantities from the plate computation. Semi-analytic reconstruction of the 3D solution is possible but would require reconstruction of higher derivatives which would be quite intrusive. So, in the spirit of homogenization, we propose to pre-compute localization operators which relate 2D quantities to 3D ones by means of appropriate "cell problems" . The associated stress and warping distributions can the be used in order to define various boundary conditions on the 3D problems (Neumann, weak [2] and strong Dirichlet, Robin). The global correction step is a plate resolution with updated loading inside the zone of interest.

The method is implemented by means of a *python* script which drives two instances of *code_aster* (for both the global and local resolutions). The advantage of the various zooming boundary conditions as well as the effects of the shift will be discussed on academic assessments.

REFERENCES

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