A Particle Finite Element Method with Nodal Integration for free-surface fluid flows

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ABSTRACT

This work presents the implementation of a nodal integration algorithm within a Particle Finite Element Method (PFEM) framework and its application to free-surface fluid dynamics problems.

The PFEM combines the solution of the Finite Element Method governing equations with an efficient remeshing algorithm [1]. The PFEM has proved to be an efficient strategy to model problems where severe changes of topology occur. Thanks to its Updated Lagrangian formulation and remeshing procedure, the PFEM is able to track accurately the evolving shape of the deforming bodies while maintaining a high quality of the mesh also in large deformations processes.

However, remeshing operations induce the elimination of the mesh connectivities and the loss of elemental data. On the other hand, the use of re-mapping procedures, due to the interpolation operations, introduces a new source of error into the solution scheme. These issues make the PFEM more appropriate to problems in which it is not required the storage of historical variables at the element level, explaining why there exists a larger literature of PFEM formulations for fluids rather than for solids (see *e.g.* a recent PFEM literature review in [2]).

To overcome this limitation, very recently in [3], the use of a nodal integration scheme in a PFEM framework has been investigated and successfully applied to geotechnical problems.

This work focuses on free-surface fluid dynamics problems and, in this context, it compares the performances of a PFEM with nodal integration and with the Gauss standard integration. The two strategies are analyzed in terms of solution's accuracy, computational time, and non-linear convergence. Several 2D and 3D benchmark problems with both Newtonian and non-Newtonian fluids will be presented and discussed.

REFERENCES

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