A meshfree collocation method for implicit-explicit switching in coupled thermo-mechanics problems – Coupled Problems 2017

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ABSTRACT

In this work, we present an implicit meshfree collocation method that is consistent with the standard explicit smoothed particle hydrodynamics method, SPH, for elastic-plastic problems (Gray *et al.* [1]). The numerical method is based on the smoothed particle approach, making it a true meshfree method. Because of this, no background mesh is needed to integrate the set of coupled thermo-mechanics equations. The mechanical solver uses an incremental deformation approach by solving a meshfree static equilibrium equation. The thermal solver uses a meshfree discretization of the time dependant heat diffusion equation based on the work of Jubelgas [2] and Rook *et al.* [3]. The thermal algorithm uses the conjugate gradient method to solver the system of equations since the coefficient matrix is symmetric, sparse, and positive definite (SSPD). On the other hand, to obtain sufficient levels of precision, the mechanical solver requires meshfree correction terms that lead to a non-symmetrical stiffness matrix. Because of this, the BiCGstab algorithm is used to solve the set of equations that are of the form F=**K**u.

The proposed implicit smoothed particle method can be used in conjunction with the standard SPH method to solve multi-temporal scale problems. Many industrial simulations contain both short duration transients (can be solved with standard SPH), as well as long duration quasi-steady responses (can be solved with the proposed implicit method). By using the proposed implicit meshfree approach, implicit-explicit switching can be used to treat efficiently the different temporal scales. This paper will introduce the implicit formulation and discuss various on the fly criteria used to judge if the implicit or explicit solver should be used. A coupled thermo-mechanical test case is presented that shows the use of the proposed method, as well as the performance improvement over using only an explicit SPH solution.

REFERENCES

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