NUMERICAL SIMULATION OF EXTREME EVENTS WITH MATERIAL POINT METHOD

Xiong Zhang [1,*]

[1] Professor, School of Aerospace Engineering, Tsinghua University, Beijing, China,
[*] Corresponding author. Tel: +86 10 62782078; E-mail address: xzhang@tsinghua.edu.cn

***Keywords**: Material Point Method, Extreme Events, Hypervelocity Impact, Sloshing, Fluid-Structure Interaction*

Abstract

Extreme events, such as hypervelocity impact, shock and explosion, metal forming, slope failure, and liquid sloshing, are highly nonlinear problems. In these kinds of problems, materials are severely distorted, fragmented, melted, or even vaporized. Both purely Lagrangian and Eulerian methods suffer some difficulties so that it is desirable to develop new approaches to better tackle these challenging problems. The material point method (MPM) is a fully Lagrangian particle method which utilizes the advantages of both Lagrangian and Eulerian methods. Although the MPM has demonstrated obvious advantages in tackling extreme deformation problems, its accuracy and efficiency are lower than that of the FEM for small and moderate deformation problems.

In this talk, the basic formulation of the MPM and our developments on the MPM and its different coupling scheme with the FEM for extreme events are briefly reviewed. A 3D explicit parallel MPM code, MPM3D®, has been developed for the numerical simulation of extreme events using object-oriented design by C++ program language with Qt, VTK and CMake, and can be run on different platforms including Windows, Linux and Mac OS. Numerical examples such as hypervelocity impact, perforation, explosion, slope failure, metal cutting, and fluid-structure interaction are presented to demonstrate the application of MPM3D®, which shows that MPM3D® is a powerful tool for extreme events simulation.

Acknowledgement

This work was supported by the National Natural Science Foundation of China (11672154).

References

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