Simulating the behavior of laminated glass under impact using the finite particle method

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Abstract

Safety glass is used extensively in buildings and vehicles. Due to the brittle nature of glass, cracking may occur under impact and results in loss of life and property. In recent years, several numerical studies have been carried out to investigate the behaviour of laminated glass under impact, and there are three numerical methods to solve this problem, i.e., the finite element method (FEM), the discrete element method (DEM), and the combined finite-discrete element method (FDEM) [1]. Each method has its own advantages and limitations.

This work introduces the Finite Particle Method (FPM) [2] to solve this problem. Different from traditional methods based on the variational principle, the FPM is constructed on vector mechanics [3]. It discretes the analysis domain into a group of particles, whose motions are described by the Newton's second law, which makes it suitable for describing discontinuous deformation and analyzing nonlinear problems.

In this paper, fracture analysis of 3D glass model is conducted based on FPM, combined with an extrinsic cohesive zone model. A self-programmed computational platform based on the fundamental theory of FPM is developed to solve this problem, and GPU parallel computing is adopted to improve computation efficiency. Several examples are presented to demonstrate the performance and applicability of the proposed method on simulating the fracture behavior of glass.

References

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