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IDENTIFICATION AND VALIDATION OF A DISCRETE ELEMENT MODEL OF CONCRETE SUBMITTED TO IMPACTS

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Concrete is widely used in protection systems of sensitive infrastructures such as nuclear power plants. Existing design methods for concrete protection structures under impacts are mainly based on full size experiments and empirical formulae that are not economical. Although impacts have a low probability of occurrence, they induce complex phenomena and different modes of damage.

In the present paper, an advanced model is proposed to predict damage in reinforced concrete structures under impact.

The model is based on the discrete element method (DEM). This approach derives from the original distinct element method for granular materials proposed by Cundall and Strack [1], where cohesive interactions have been added for concrete cohesive material. The DEM model allows easily handling the occurrence of discontinuities and dealing with large deformation; it was implemented in Europlexus, a finite element software dedicated to the analysis of fast transient phenomena, it is coupled with the finite element method [2].

The paper first presents the constitutive discrete element (DE) models developed for concrete with a focus on compaction under high confinement and on strain rate dependency of tensile strength and fracture energy. A disordered polydisperse assembly of rigid spherical elements is used. DE do not represent aggregates, the proposed interaction laws between DE are inspired by observations at the macroscopic scale. The identification of constitutive parameters is carried out thanks to simulations of laboratory tests performed to concrete samples under quasi-static tension and compression, confined compression. Parameters characterizing the strain rate dependency are identified with results of spalling tests performed with an Hopkinson bar apparatus [3].

In the second part of the paper, the whole DEM approach is validated thanks to simulations of hard impact tests performed on concrete targets with penetration and perforation.

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