Numerical simulation and validation of impact-loaded iron ore pellets

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ABSTRACT

The handling of iron ore pellets is an important component of the production chain for many producers and users of iron ore pellets. Knowledge of this sub-process is very important for improving its efficiency and increasing product quality. After production in pelletizing plants, iron ore pellets pass through a number of transportation and handling systems, such as conveyor belts, silo filling, silo discharging and transport by rail and ship. During these treatments, the pellets are exposed to different stresses, resulting in the degradation of their strength and generation of fines.

Reliable numerical models that can predict the ability of the pellets to endure their handling are important tools for optimizing the design of equipment for iron ore handling. This paper describes the experimental and numerical work performed to investigate the impact fracture behaviour of iron ore pellets at different strain rates. A number of split Hopkinson pressure bar (SHPB) tests with different striker velocities are carried out and analysed to investigate the strain rate dependency of the fracture strength of iron ore pellets. An increase of approximately 30% of the fracture stress is observed from the dynamic SHPB measurements compared to the quasi static measurements. Fracture strength data for iron ore pellets are derived and expressed in terms of statistical means and standard deviations. A stress based, strain-rate dependent fracture model that takes triaxiality into account is suggested. The fracture model is used and validated against impact tests of iron ore pellets. In the validation experiment, iron ore pellets are fired against a steel plate, and the percentage of fractured pellets at different impact velocities are measured. Finite element (FE) simulations of the experiment are carried out and the probability of pellets fracturing during impact are calculated and compared with the experimental results.

A good agreement between the experiments and numerical simulations shows the validity of the model. The purpose of this study is to develop a numerical model that can be used to predict the probability of fracture of iron ore pellets in different dynamic loading situations, e.g., pellets hitting guide plates around conveyor belts or during ship loading.