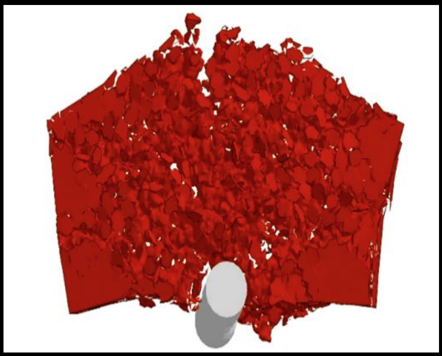
Holistic approach of (Rock Fragmentation) Digital simulation



Digital simulation is becoming an essential tool for engineering complex industrial projects due to its rapid implementation and low cost, when compared with in situ experiments. Paradoxically, it is little used in the blasting industry, despite its origin dating back to the Manhattan project. Although the Manhattan project, aiming at modelling the nuclear detonation process, dates back to the Second World War, we had to wait until the mid 1990s for research workers to become interested in the potential of digital simulation to predict the interaction between rock and explosives. To begin with, digital simulations attempted to model the interaction of well-known phenomena or materials (the effect of a shell on armour plating, a bomb on buildings, air on an aircraft's wing, etc.), so the deterministic approach naturally dominated. When it is a question of dealing with blasting issues, the unknown features of the rock led to a fundamental difference in the approach among the pioneers in the field. Katsabanis & Liu, Favreau, Preece and Chung, Dare-Bryan, Wade & Randall chose to capitalise on the assets of deterministic approaches from closely related industries. In Europe, Bernard explored another avenue, based on his University research carried out at the beginning of the 1990s, and developed a so-called holistic simulation and forecasting model, capitalising on deterministic theories. Considering that the time to resolve deterministic equations is de-correlated from the industrial time, he proposed a pragmatic approach making a summary of the deterministic principles, enabling perfectly identified, and well-known causations to function together (e.g. Newton's physics), in order to meet the present challenges and needs of the sector, here and now.

Objectives

by T. Bernard

Digital simulation (or digital experiments) offers a computer reproduction of a complex physical phenomenon, whose evolution we wish to study. Hence, digital simulation has enabled us to reap the benefits of the trial and error process, whilst integrating progress made in terms of the knowledge of the physical phenomena, thanks to the increase in calculation capabilities of computers. The phenomena could not have been studied using traditional experimental techniques.

Provided that we have an accurate knowledge of the structure and characteristics of the elements that we want to have interacting, the chief challenge with simulation is to imitate reality as closely as possible, by accurately reproducing each of its mechanisms.

Exhaustively simulating the sequence of all the causes and effects induced by blasting is a challenge that the most sophisticated models have been unable to meet, despite the increasing computing power available for civilians and industry. Far from hiding the unfinished nature of their simulation, the developers of these software programmes emphasize the impossibility of accurately reproducing natural mechanisms, in particular due to their complexity.

An accurate and complete reproduction of the natural mechanisms coming into play would not only suppose taking into account the physical and chemical characteristics of the explosive, the drilling pattern of the blast, the position of the holes in space, and of course the initiation sequence, but also a very wide knowledge of the geology and the geo- mechanical properties of each of the elementary particles of rock, which is unattainable in the present state of science and techniques. Besides, astrophysics has encountered the same limits. The complexity of cosmic phenomena has led astrophysicists to use digital simulation for fifty years. The majority of the astrophysical phenomena today are governed by a corpus of physical laws with no analytical solution. Therefore, digital calculations are used to provide an approximate expression for the solution but the physical mechanisms that come to play become too expensive in terms of computing time, leading to the necessity of finding new approaches. Now, we know since Newton that the laws of physics that govern the heavens and the Earth are the same.

The holistic approach to the phenomena involved in blasting enables us to avoid the deterministic stumbling block, by accepting the principle that we are simulating the effect of a known product, the explosive, on an environment that is only partly and imperfectly known, rock. It is of interest to note that the debate raging in the world of the digital simulation of blasts has already taken place within fundamental physics and that decisive objections contradict some of the basic principles of the deterministic theories.

Application

by T. Bernard

The students will first learn about the process of holistic approach of digital simulation based on an example of rock fragmentation by explosive.

After getting familiar with the process, they will build a model that will simulate the impact of an asteroid on Earth. The model will include trajectography in the earth atmosphere, then the student will select either to model the impact on solid ground or water and will select to model either the impact of the seismic waves, or the cratering effect for ground impact or tsunami effect for water impact. The final goal is to obtain damage zone for people and structures depending on the initial conditions of the asteroid.

EVALUATION

- Theory and Application will be evaluated continuously through continuous assesment with regular short exams or presentations.
- Final oral presentation (40%).

See also

http://www.dna-blast.com/Blasting-Design-Simulation-Optimization/Company.html

Contact

☎ +33 950 44 55 43
✉ t.bernard@tbtech.fr