XXI congresso national de Ingeniaria Estructural - Campeche, 14-17 Nov. 2018

Damage of concrete under severe loadings: from models to structural applications

Jacky Mazars, Grenoble Institute of Technology – Grenoble France

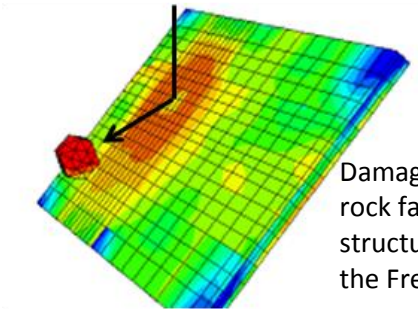
In a world where sustainable development has become an unavoidable topic, the safety and the durability of infrastructures are major goals. And the reasons for their degradation are numerous, especially in relation:
- with aging of materials under the effect of climatic variations and/or under the effect of an "aggressive" environment (salt or other chemical, freeze-thaw,....);
- with the effects of excessive loadings due to accidental causes (natural or technological risks) or intentional causes (terrorist attacks).

Having a good control of these different aspects requires both, i/ a good mastery for the design of the structures and for the manufacture of the materials, and ii/ a thorough knowledge of how materials and structures react in case of “aggression”.

In such a context, it has been shown that the central phenomenon of non-linearity in concrete is damage due to micro-cracking. Introduced by Kachanov (1958) to describe the tertiary creep phase in metals, the concept of damage was first applied to concrete by Mazars (1986). This concept leads to propose "smeared crack models", now used for many quasi brittle materials: concretes, rocks, ceramics, composites, masonry, ...

At the theoretical level, damage models are part of the thermodynamics of irreversible processes. During last decades, many developments have been proposed. In fine, their writing aims to account for the peculiarities of concrete behavior (tensile-compression dissymmetry, confinement effect, aging, time effects, strain rate effects, ...) and also to make their computing efficient, especially in the context of calculations by finite elements.

The resulting tools make it possible to approach the analysis of the functioning of real structures under severe loadings (earthquake, blast, impact,…) and/or their durability.
For this, simplified and enriched procedures are proposed to allow the resolution of large problems while ensuring the quality of the results (Mazars, Grange 2015).



Damage modeling of a rock fall on a R.C. structure of protection in the French Alps.

During the presentation, in order to demonstrate the relevance of the modelling strategy, a variety of applications will be proposed: the analysis of the behavior of structural elements under complex loading, the functioning of structures under earthquake or impact (Desprez et al.2014), and also damage effects analysis at early age when shrinkage is restrained (Mazars et al. 2018).

Kachanov, L. M. (1958). “On the Creep Fracture Time.”IZV Akad. Nauk USSR Otd. Teck., 8, 26-31, (in Russian).

Mazars J., 1986, A description of micro and macroscale damage of concrete structure. Engineering Fracture Mechanics, Vol25, p729-737.

Desprez C., Kotronis P., Mazars J., (2014), Seismic Vulnerability Assessment of a RC Structure before and after FRP Retrofitting, Bulletin of Earthquake Engineering

Mazars J., Grange S., 2015, Simplified Modeling of Reinforced Concrete Structures for Engineering Issues, Computers and Concrete.

Mazars J., Grange S., Briffaut M., Simplified Modeling Strategy for the Thermomechanical Analysis of Massive Reinforced Concrete Structures at an early age, Appl. Sci. 2018, 8, 448; doi:10.3390/app8030448.