Abstract

Permeability is a parameter that may indirectly influence the durability of concrete structures by governing the rate of penetration of aggressive substances responsible for degradation under a pressure gradient.

The aim of this thesis is to study the interaction between the crack opening and the transfer of fluids in concrete of the Brazilian splitting tensile test (BSTT). Herein, the influence of aggregates size and volume fraction on hydro-mechanical properties of concrete is investigated. This study consists of two parts: the numerical and the experimental one. The first one focuses on the meso-scale modeling of a heterogeneous material like a concrete, which may be characterized by two features: multi-phase behavior and 3D crack propagation. The numerical study deals therefore with the coupling between crack opening and gas permeability according to a developed hydro-mechanical model at a meso-scale. The objective of the second, experimental part, is to provide data for numerical models and to validate the latter. This work is carried out on mortar specimens with 3 different aggregate sizes, submitted to gas transfer during a BSTT.

The numerical meso-scale model is based upon a 3D lattice approach to represent the heterogeneity of the material and the failure mechanism of concrete. This model considers concrete as a two-phases material in which aggregates melt within a cement paste. Because a non-adapted meshing process was used to mesh the microstructure, a weak discontinuity was introduced in the first enhancement of the kinematics.

The second enhancement of kinematics introduced here is the displacement discontinuity (strong) to represent crack opening (discontinuous displacement-field).

The hydro-mechanical model represents the transport of fluids (gases) through the concrete, depending on Darcy's law for a uncracked section (porosity) and

Poiseuille's law for a cracked section (laminar fow). In this model, the interaction between the crack opening, obtained from the mechanical model (meso-scale), and the gas permeability is investigated.

The experimental work is presented for the validation of the hydro-mechanical model. The numerical results show good agreement with some previous experimental and theoretical studies.