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HEAT AND FLUID FLOW IN CONCRETE AS A COMPOSITE MATERIAL

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ABSTRACT

Concrete is investigated as a composite material model made of cement paste and aggregates. In this meso-level approach, heat and fluid flows and related mechanical effects have different kinetics related to the two basic constituents. Both cement paste and aggregates are treated as saturated-unsaturated porous materials with different porosities, permeabilities and diffusivities, hence where heat and fluid transfer are characterized by different time evolution. Examples of this type of concrete representations are given in literature, see e.g. [1] and [2]. Such models have a remarkable importance for understanding specific phenomena in concrete, especially those where aggregate type and content are important. One of this is spalling of heated concrete and hence this model will be used in future to explain and predict the occurrence of this phenomenon [3]. Moreover, since pp fibres are commonly used to prevent spalling, this further constituent has to be included in the model, starting from the basic investigation carried out in [4]. The experimental basis of this work is the extensive campaign related to heat and mass transfer and cyclic strain behaviour of concrete to temperatures up to 600^{o}C carried out in [5-9]. Temperatures, weight loss and strains are measured in concretes with different aggregates during heating and cooling, with and without compressive load over a period of several days. Heat, mass and mechanical results obtained from the tests are then directly integrated in the 3D fully coupled thermo-hydro-mechanical numerical model of heated concrete, called NEWCON, where aggregates are distinguished from the cement paste [10-15]. In this model, aggregates and cement paste are treated as multiphase systems where the voids of the skeletons are partly filled with liquid and partly with gas phase, [16-18]. As regards the mechanical field, NEWCON incorporates coupled thermal, creep and

shrinkage [19-25] effects, chemo-thermo-mechanical damage [26-29] and plasticity under low to high temperature levels.

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