Modelling of heat and moisture transfer in concrete at high temperature

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ABSTRACT

Concrete exposed to high temperature, for example fire event, present two main principal mechanisms which can lead to the spalling phenomenon (sudden ejection of the external sheets of concrete in contact with the maximum temperature on the exposed face, with the consequent reduction area of the specimen).The first one is related to the incompatibility of thermal deformations between aggregates and cement paste. The second one corresponds to the heat and mass transfer taking place in the concrete microstructure as the result of high temperatures, which causes water evaporation and pore pressure build up.

In this context, the first previous work of the group was focusing on the first of those mechanisms [1, 2] by means of temperature-driven purely mechanical analysis of a meso-structural model which including cracking via zero-thickness interface elements.

Further work was focusing on the second of those mechanisms by means of a thermo-hygro model to analyse the pore pressure build up as temperature increase. Temperature distributions are obtained from separate thermal diffusion analysis (uncoupled), and only one pressure variable is considered to describe the water transfer process where the water dehydration is included. In previous works [3], like a first approximation the pore saturation state was based on the isothermal sorption curves [4]. The present work incorporates some modifications which lead to improved results. The pore state is now defined by a curve of type $S(r)$ developed within the research group itself, which relate the saturation degree S with the pore radius r. On the other hand the total water flux is now formulated like a sum of liquid water flux and water vapour flux.

Obtained numerical results are presented which shows clear improvement with respect to previous [3], at the same time that the model developed exhibits the expected behaviour to then couple it with the meso-mechanical model.

REFERENCES

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