FE² Multiscale Modeling of Chloride Ions Ingress in Recycled Aggregates Concrete

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SUPPORTS

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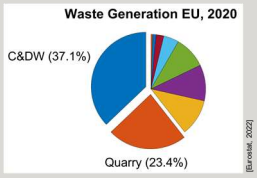
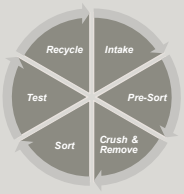
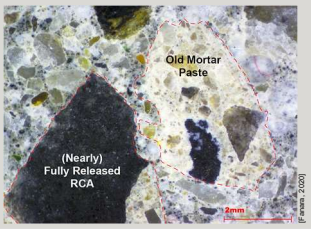
PROJECT OVERVIEW

Through an experimental and numerical study of concrete produced in the laboratory, the influence of the substitution of natural aggregates by recycled aggregates on durability is studied. The transport of chloride ions is highly dependent on the microstructure of the concrete, hence the importance of a multiscale approach.
As the production of recycled aggregates increases year after year, their use in reinforced concrete structures must be validated with numerical models to ensure the durability of these structures.

1. CONTEXT

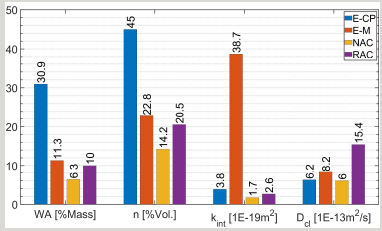






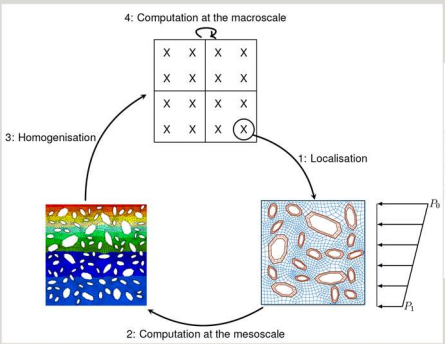
2. EXPERIMENTATION

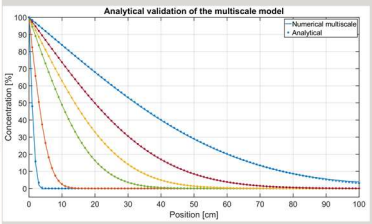
The water and chloride ions transfer properties have been determined experimentally on a cement paste, a mortar and two concretes: one with natural aggregates (NAs) and one with recycled concrete aggregates (RCAs).



3. NUMERICAL DEVELOPMENTS

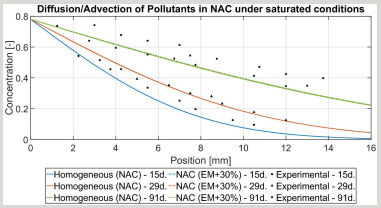
A multiscale model was developed using the finite element square method (FE²). It allows the direct modelling of the concrete microstructure in order to better understand the influence that aggregates have on the durability of a structure. Based on simple physical laws, such as Darcy's or Fick's, it allows to model the transfer of chlorides in an unsaturated environment.
The microstructure is embedded in the Representative Volume Element (RVE) developed, where the aggregates are impervious. The properties used at that scale are therefore those of homogenised mortar.

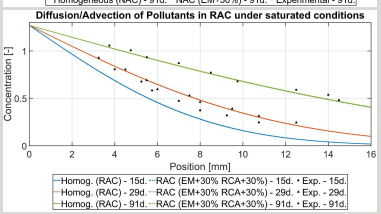




4. RESULTS

The model replicates experiments precisely. The RVE represents a slice of concrete and the properties of the homogenised mortar yield a response of a real concrete sample. The determination of the parameters at key in the use of RCAs is therefore easier as the model depicts a monthes-long experiment in a few hours only, by allowing the variation of the size of the RCAs as well as the quantity and properties of the adherent mortar. It was observed that the RCAs, due to their higher surface of diffusion compared to natural aggregates that are totally impervious, increase the diffusivity of chloride ions in concrete.





CONCLUSIONS

1. The substitution of NAs by RCAs yields poorer water and chloride transfer properties.
2. The multiscale model developed is validated for water and chloride transfers in unsaturated conditions.
3. The added diffusive surface plays a higher role than the properties of the adherent mortar in the RCAs.

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