Carbonation-induced corrosion in low CO_2 emission concrete

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Project partners:	Prof Vanderley John, University of Sao Paolo Prof Fernando Martirena, Universidad Central “Marta Abreu” de las Villas
Expected start date:	Early 2022
Funding:	Innovandi, the Global Cement and Concrete Research Network

Project details:

Modifying the composition of cement offers huge opportunities to decarbonise the construction industry. However, to ensure sustainability, it is crucial that these modern low-carbon binders allow the construction of long-term durable structures. One particular concern with concretes containing novel binders is the degradation caused by carbonation-induced corrosion of embedded reinforcing steel.

The overarching aim of this project is to fundamentally understand the impact of carbonation on microstructural features that are important to corrosion initiation and propagation, but poorly understood in concretes containing modern low-CO_2 binders. Specifically, the project will study the following features that influence corrosion kinetics: i) the concrete pore solution chemistry, ii) the pore structure of the steel-concrete interfacial regions, and iii) the moisture state of carbonated concrete, when subjected to wetting and drying environments. This will be achieved by combining thermodynamic modelling with deep experimental characterisation on laboratory prepared and field-exposed samples using a range of state-of-the-art techniques.

The research will be carried out within the Centre for Infrastructure Materials at the Department of Civil and Environmental Engineering, Imperial College London, in collaboration with ETH Zurich, Norwegian University of Science and Technology (NTNU) and Oregon State University. The project will be based at Imperial College London, with scientific visits to collaborating institutes and project partners (University of Sao Paolo and Universidad Central “Marta Abreu” de las Villas).

The main deliverables will be the phase assemblage, the pore solution chemistry, moisture retention and microstructural gradients at the steel-concrete interface, as a function of binder type, carbonation and exposure environment. The work will closely interface with other projects, in particular the PhD projects on corrosion kinetics and reactive iron transport modelling at ETH Zurich. We envisage that the research programme will deliver the fundamental understanding that will enable a mechanism based model for corrosion in carbonated systems, and to form the basis for standardisation and performance based durability design of low CO_2 cements.

Requirements:

The ideal candidate will be an enthusiastic and highly-motivated person who meets the academic requirements for enrolment for the PhD degree at Imperial College London. The candidate will have a good first class or upper second degree (or international equivalent) and Masters level qualification in Materials Science, Civil Engineering Materials, Geochemistry, Mineralogy or related areas. Knowledge and experience in chemistry, microstructure and durability of cementitious materials are desirable. A background in corrosion science or advanced materials characterisation would be desirable. You will have an inquisitive mind, strong intellect and hands-on rigorous approach to research. A strong command of the English language, excellent communication and team working skills are essential.

Funding and eligibility:

The studentship will provide funding for 3.5 years including UK/Home tuition fees, tax-free stipend at the standard UKRI London rate and research expenses. The funding can be used to partly support an International student.

How to apply:

Applicants wishing to be considered for this opportunity should send the following documents to Dr Hong Wong (hong.wong@imperial.ac.uk): recent CV, covering letter explaining their motivation and suitability, and contact details of two referees. Application via the Imperial College Registry is not necessary at this stage. Applications will be regularly reviewed until the position is filled. Please contact Dr Hong Wong for further details, informal discussions and information about the project.