NARODOWE CENTRUM NAUKI

OPUS-19

2020/37/B/ST8/02805

A Multi-scale Model of Reinforcement Bars Corrosion Based on the Concentrated Electrolyte Theory and Three Dimensional Hierarchical Structure of Concrete

Prof. dr hab. inż. Robert Filipek

Principal Investigator

Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie

Wydział Inżynierii Materiałowej i Ceramiki

Abstract

We all know how nasty and frustrating can be rusting of so many metal objects which we encounter almost everywhere in our technologically developed societies. But not so many of us probably realize that corrosion of iron based materials is also happening in places not visible to naked eye yet still having a great impact on our safety and convenience of everyday life. Each day we stay in houses, pass over footbridges, drive through bridges and viaducts, from time to time wait at airports, bus and railway stations. Many of these constructions are made of the so called reinforced concrete which means that the mass of concrete material is structurally supported, stabilized and strengthen by a mesh of steel wires and rods embedded in the concrete. Unfortunately, these reinforcement bars (known as *rebars* by civil engineers) are not immune to the degradation caused by this malignant process of corrosion which in this case is particularly insidious because it is hidden from our direct view.

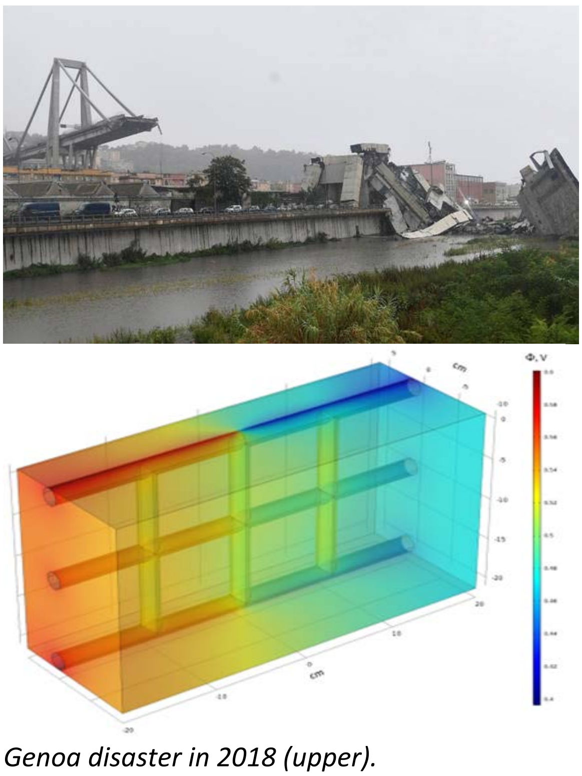
The last construction disaster in Genoa in 2018 made it clear and reminded us of the necessity to monitor the state of rebars to ensure the safety of reinforced concrete structures. We also need better practices for the protection procedures both before and during the constructions works. All these topics should be based on well understood principles of corrosion processes and should take into account a number of factors affecting the corrosion of steel embedded in concrete.

The principal objective of the proposed project is to develop, test, and apply a model to improve safety and maintenance economy of reinforced concrete structures in a long time scale.

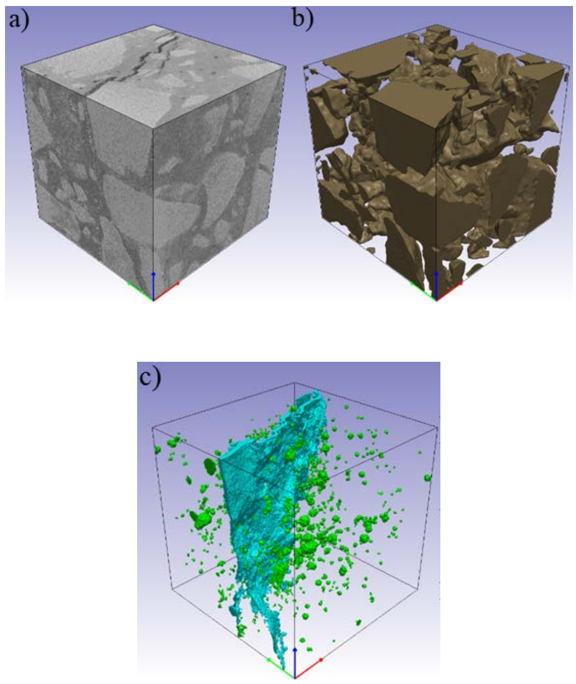
It will be proposed a standardized and better than existing description of the degradation processes of reinforced bars in real concrete structures caused and accelerated by various factors such as chlorides from de-icing, carbonization due to carbon dioxide present in air, cracks in material, and changing in time exposure conditions (e.g. temperature and humidity).

Progress in the field will be possible thanks to the combination of advanced theory, modern computation techniques, and laboratory studies related to determination of various physicochemical parameters which are necessary to provide realistic and long term description of corrosion risk in real-world reinforced concrete structures.

The results of the project will also contribute to the development of non-destructing research methods, in particular the better interpretation of electrochemical impedance spectroscopy and galvanostatic pulse results.



Genoa disaster in 2018 (upper).
Potential distribution in corroding steel rebar in concrete (down).



3D concrete structure: a) raw μCT data, reconstructed: b) aggregates, c) cracks (blue) and air pores (green).