The European Materials Modelling Council

Project idea presentation

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Innovative methods of preventing risk of corrosion caused by chloride ions and carbonation in designed and existing reinforced concrete structures

Aim of the project: Elaboration of innovative non-invasive methods of preventing the formation of corrosion, caused by the presence of chloride ions in the concrete and carbonation of concrete with numerical modeling of concrete.

The current method of electrochemical extraction of chlorides from concrete (ECE), cathodic protection and realkalisation carbonated (RB) concrete will be improved.

In the designed method, the construction will be provided with a "smart sensor" system that will inform both the chloride ion concentration and the pH value of the concrete at the steel surface. In the event of a critical concentration of chlorides at the surface of a steel or a pH value of corrosion-prone concrete, the sensor system connected remotely to the computer center will report the need for electrochemical extraction of chlorides or the reconditioning of carbonated concrete.

The role of "smart sensors" will meet "special concrete or cement paste" with high ability to conduct electric current. At the same time, the concrete used in the projected design or cement paste applied to the outer surface of the structure will serve as an external anode grating for both the ECE and the RB method.

The next step will be to apply directly the construction of the LPR and EIS corrosion current measurement method to check the effectiveness of the applied concrete rehabilitation method.

In addition, a method will be proposed to apply an anodic mesh made of carbon fiber from the outside of the structure.

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The main aim of the project is **numerical programming of processes occurring** in reinforced construction, both subjected to harmful effects of chloride ions and carbonation as well as processes taking place during the corrective actions, chloride extraction, cathodic protection and realkalisation of carbonated concrete, taking into account the observation of processes occurring at the level of microstructure changes.

The original approach in the proposed topic is a synergistic combination of electrochemical methods used so far in methods of diagnostics of reinforced concrete structures together with the numerical modeling of these processes and their control at the level of microstructure changes using modern XRD X-ray microdiffrading methods of polycrystalline materials.

It is also innovative to use flexible carbon fiber mats as an anode grating system that allows them to be reused multiple times and used in buildings of historical and cultural importance.

Using as a sensor system modern material which means a concrete characterized by high conductive properties in the electric field and at the same time highly resistant to the penetration of aggressive factors mainly chloride ions.

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The expected effect of the project will be the ability to apply the method in structures of high economic importance (bridges, foundations in strategically important industrial sites, foundations in salt mines exposed to salt) directly exposed to continuous chloride ions and carbonation causing factors.

The use of flexible carbon fiber mat will be possible when using the method in buildings with very complicated architectural layout and historical objects thanks to the possibility of easily matching these mats to surfaces with complicated geometric layout.

Modern concrete with good conductive properties will be used in industrial constructions exposed to continuous chloride ions, which will allow for their control and possible repair without interruption of the production process.

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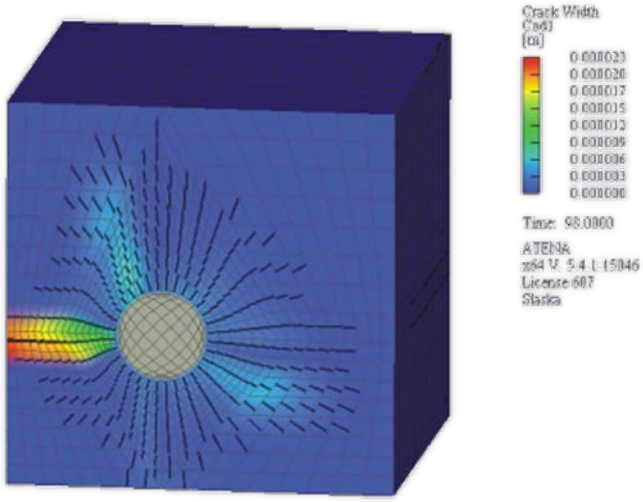
At the Silesian Technical University in Gliwice, works are being carried out in conditions similar to real ones (TLR4):

- Design and testing of properties of concrete with high conductivity and resistance to chloride ions tomasz.ponikiewski@polsl.pl; jacek.golaszewski@polsl
- Numerical modeling in and study of diffusion, migration and extraction processes of chlorides and cathodic protection with simultaneous observation of these processes at the level of microstructure changes zofia.szweda@polsl.pl
- Computational simulation of the processes of corrosion initiation, corrosion progress and damage of the concrete cover in the conditions of varying in time fields of moisture, temperature and the content of aggressive substances tomasz.krykowski@polsl.pl
- The use of carbon fiber mat in the Cathodic Protection process andrzej.sliwka@polsl.pl
- Remote corrosion monitoring system for reinforced concrete structures using concrete sensors built into existing structures mariusz.jasniok@polsl.pl; tomasz.jasniok@polsl.pl



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Due to the wide scope of the project we are looking for partners:

- from the larger academic centers in Europe with a technical profile experienced in conducting projects financed by European funds
- from the industry Companies dealing with the use of ECE and RB repair methods in reinforced concrete structures to test in practice the results of our laboratory tests

  (We are currently in contact with a Norwegian company dealing with the practice of chloride extraction and reconstruction of concrete)
- Construction companies that carry out large economic objects directly exposed to the continuous action of chloride ions and factors causing carbonation of concrete
- Companies manufacturing polycarbonate materials
- Companies manufacturing systems of all kinds of sensors together with software
- Manufacturers of software for numerical modeling of concrete (We are currently working with Atena developer - software for nonlinear analysis of reinforced concrete structures)